Alterations to:
Oxford Academy & Central School District and New Bus Maintenance Facility

SED Control No’s:
08-15-01-04-0-010-017 Primary School
08-15-01-04-0-007-014 High School
08-15-01-04-0-002-021 Middle School
08-15-01-04-5-020-001 New Bus Maintenance Facility
08-15-01-04-0-016-002 Primary / High School Greenhouse

BCA Project No. 2018-099

Bernier, Carr & Associates Engineers, Architects, and Land Surveyors, P.C.
401 East State Street, Suite 200
Ithaca, New York 14850
(607) 319-4053 / Fax (315) 782-7192

Set # ________

VOLUME II OF II
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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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:
   2. New York State Department of Labor Rules and Regulations.
   3. Occupational Safety and Health Administration (OSHA).
   6. Local Codes and Ordinances.
   8. New York Board of Fire Underwriters.
   9. New York State Education Department “Manual of Planning Standards”.

1.05 GLOSSARY
A. ACI American Concrete Institute
B. AGA American Gas Association
C. AGCA Associated General Contractors of America, Inc.
D. AIA American Institute of Architects
E. AISC American Institute of Steel Construction
F. AFBMA Anti-Friction Bearing Manufacturer’s Association
G. AMCA Air Moving and Conditioning Association, Inc.
H. ANSI American National Standards Institute
I. ARI Air Conditioning and Refrigeration Institute
J. ASHRAE American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc.
K. ASME American Society of Mechanical Engineers
L. ASPE American Society of Plumbing Engineers
M. ASTM American Society for Testing Materials
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.

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 (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 and plumbing connections.
1.11 UTILITY COMPANY SERVICES

A. Make arrangements with the Owner’s gas supplier for relocation of existing gas lines. Provide service to the building as required. Coordinate all activities between the Owner and supplier. The installation of the gas service shall comply with the published standards, including but no limited to NFPA 54 and NFPA 58. PAY ALL UTILITY SUPPLIER CHARGES; INCLUDE CHARGES IN THE BASE BID.

1.12 ROUGHING

A. Due to small scale of Drawings, it’s 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 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.

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.

1.13 COORDINATION DRAWINGS

A. Before construction work commences, Contractors for all trades shall submit coordination drawings in the form of reproducible transparencies drawn at not less than 3/8 inch scale. Such drawings will be required throughout all areas for all trades. These drawings shall show resolutions of trade conflicts in congested areas. Mechanical equipment rooms shall be drawn early in coordination drawing process simultaneous with all other congested areas. Prepare Coordination Drawings as follows:
1. The HVAC Trade shall prepare the base plan Coordination Drawings showing all ductwork, all pertinent heating piping, and equipment. These drawings may be sepias of the required ductwork Shop Drawings. The drawings shall be coordinated with lighting fixtures, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Owner’s Representative. Provide adjustments to exact size, location, and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of contract. Minor revisions need not be re-drawn.

2. HVAC Contractor shall provide sepia transparencies and/or prints and submit the base plan to all major trades’ Contractors.

3. The Plumbing Trade shall draft location of piping and equipment on the base plan, indicating areas of conflict and suggested resolutions.

4. The Electrical Trade shall draft location of lighting fixtures, cable trays, and feeders over 1-1/2 inches on the base plan, indicating areas of conflict and suggested resolution.

5. The General Contractor shall indicate areas of architectural/structural conflicts or obstacles and coordinate to suit the overall construction schedule.

6. The General Contractor shall expedite all drawing work and coordinate to suit the overall construction schedule. He shall then review these drawings and compare them with the architectural, structural, equipment, and other drawings and determine that all of the work can be installed without interference. In the case of unresolved interferences, he shall notify the Owner’s Representative. The Owner’s Representative will then direct the various Contractors as to how to revise their drawings as required to eliminate installation interferences.

7. If a given trade proceeds to resolving conflicts, then if necessary, that Trade shall change its work at no extra cost in order to permit others to proceed with a coordinated installation. Coordination approval will be given by areas after special site meetings involving all Trades.

   B. Coordination Drawings are intended for the respective Contractor’s use during construction and shall not replace any Shop Drawings, or record drawings required elsewhere in these Contract Documents.

1.14 REMOVAL WORK

   A. Where existing equipment removals are called for, submit to Owner’s Representative a complete list of 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 laws 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.

1.15 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. Gas-fired equipment and system shall meet AGA Regulations and shall have AGA label.
5. Electrical equipment and systems shall meet UL Standards and requirements of the NEC.

1.16 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.

1.17 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.

1.18 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.

1.19 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 inch 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.

1.20 FLASHING, SEALING, FIRE-STOPPING
A. See Specification Section 22 0515 - Plumbing Firestopping.
1.21 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.

1.22 ACCESS PANELS
   A. Access panels shall be furnished by the Mechanical and Plumbing Trades and installed by
      General Contractor. Location and size shall be the responsibility of each 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 manufactured by Milcor, or approved equal. Provide General Contractor with a
      set of architectural black and white prints with size and approximate locations of access panels
      shown.

1.23 CONCRETE BASES
   A. Provide concrete bases for all floor-mounted equipment (unless otherwise noted). Provide
      3,000 pound 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.

1.24 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, and wiring as required.
   G. Refer to Manufacturer drawings and specifications for requirements of kitchen equipment,
      laboratory equipment and special equipment. Verify connection requirements before bidding.

1.25 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.
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.”

1.26 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 season's winterizing in presence of Owner’s operating staff.

1.27 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.

1.28 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.

1.29 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.

1.30 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.
1.31 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.

1.32 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 items noted as completed or the current status of the item. Upon receipt, the Engineer will schedule a final inspection.

1.33 ALL TRADES TEMPORARY HEAT
   A. Refer to the Standard General Conditions of the Contract for Construction and Supplementary Conditions.

1.34 PLUMBING TEMPORARY FACILITIES
   A. Refer to the Standard General Conditions of the Contract for Construction and Supplementary Conditions.

1.35 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.

PART 2 PRODUCT - NOT USED
PART 3 EXECUTION - NOT USED

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:
B. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.
C. Underwriters Laboratories Inc.:
   3. UL 1479 - Fire Tests of Through-Penetration Firestops.
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 3300 - 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/cm^3.
   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.

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:
      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.
   D. Ceiling tacks.

1.02  RELATED REQUIREMENTS
   A. Section 22 1005 - Plumbing Piping.

1.03  REFERENCE STANDARDS

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.
   D. Substitutions: See Section 01 6000 - Product Requirements.

2.02  NAMEPLATES
   A. Description: Laminated three-layer plastic with engraved letters.
      2. Letter Height: 3/8 inch (____ mm).
      3. Nameplate Height: 3/4”.
      4. Background Color: Black.

2.03  PIPE MARKERS AND ACCESSORIES
   A. Snap-on Marker: One piece wrap around type constructed of pre-coiled 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 pre-coiled 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:
         b. Length of color field: 8 inches.
      3. Outside Diameter of Pipe or Insulation 2-1/2 to 6 inches:
         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.

2.08 CEILING TACKS
A. Description: Steel with 3/4 inch (20 mm) diameter color coded head.
B. Color code as follows:
   1. Plumbing Valves: Green.

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 (150 to 200 mm) 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: 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 manufacturers nameplate is obstructed locate nameplate to be readily visible.

D. Equipment Identification Legend: Equipment identification shall match tags as scheduled on drawings.
3.06 CEILING TACKS
   A. Provide ceiling tacks to locate valves or equipment as specified above T-bar type panel ceilings.
      Locate in corner of panel closest to equipment.

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 0515 - Plumbing Firestopping.
   B. Section 22 1005 - Plumbing Piping.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
   A. See Section 01 3300 - Submittal Procedures for submittal process.
   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 3 years of documented experience.
   B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 5 years of 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:
         b. Knauf Fiber Glass.
         c. Owens Corning Corporation.
         d. Substitutions: See Section 01 6000 - Product Requirements.
      2. Preformed Pipe Insulation: Minimum density 3 pcf; ASTM C 547.
         a. Class 1 (Suitable for Temperatures Up to 450 degrees F): ‘K’ (‘Ksi’) value of 0.26 at
            75 degrees F (____ at 24 degrees C).
      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. Flexible Elastomeric Cellular Insulation:
      1. Manufacturers:
         a. Armacell International.
         b. Rubatex Corporation.
         c. Enviro-tec Corporation.
         d. Substitutions: See Section 01 6000 - Product Requirements.
      2. Preformed Pipe and Fitting Insulation: ASTM C 534, Type I.
      3. FM tested and approved, meeting the following:
         a. Maximum Water Vapor Transmission: 0.10 perm-inch based on ASTM E 96, Procedure A.
         b. K of 0.27 at 75 degrees F based on ASTM C 518 or C 177.
         c. Fire Spread/Smoke Developed Rating: 25/50 or less based on ASTM E 84.
      4. Polyethylene and polyolefin insulation is not acceptable.
   C. High Density Jacketed Insulation Inserts for Hangers and Supports:
      1. Manufacturers:
         b. Knauf Fiber Glass.
         c. Owens Corning Corp.
         d. Substitutions: See Section 01 6000 - Product Requirements.
      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.
3. For Use with Flexible Elastomeric Foam Insulation: Hardwood dowels and blocks, length or thickness equal to insulation thickness, other dimensions as required.

D. Cements:
2. Fibrous Glass Hydraulic Setting Thermal Insulating and Finishing Cement: ASTM C 449/C 449M.

2.02 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.
   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. Canvas Jacket: Cotton duck, fire retardant, complying with NFPA 701, 4 oz/sq yd. or 6 oz/sq yd (220 g/sq m) as specified.
C. 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.

2.03 ADHESIVES, MASTICS, AND SEALERS
A. Lagging Adhesive (Canvas Jackets): Childer's CP-50A, Epolux's Cadalag 336, Foster's 30-36, or approved equal.
B. Vapor Seal Adhesive (Fibrous Glass Insulation): Childers' CP-82, Epolux's Cadoprene 400, Foster's 85-75 or 85-20, or approved equal.
C. Vapor Barrier Mastic/Joint Sealer (Fibrous Glass Insulation): Childers' CP-30, Epolux's Cadalar 670, Foster's 95-44 or 30-35, or approved equal.
D. Adhesive (Flexible Elastomeric Foam): Armstrong's 520, Childers' CP-80, Epolux's Cadoprene 488, Foster's 82-40, or approved equal.
E. Adhesive (Reinforcing Membrane): Childers’ Chil-Spray WB CP-56, Robson Thermal Mfg. Ltd. Black Lag, or approved equal.
F. Mastic (Reinforcing Membrane): Childers’ AK-CRYL CP-9, Robson Thermal Mfg. Ltd. RT-10, or approved equal.

2.04 MISCELLANEOUS MATERIALS
A. Insulation Fasteners:
   2. Type: Weld pins, complete with self-locking insulation retaining washers.
B. Pressure Sensitive Tape for Sealing Laminated Jackets:
   2. Type: Same construction as jacket.
C. Wire, Bands, and Wire Mesh:
   1. Binding and Lacing Wire: Nickel copper alloy or copper clad steel.
   2. Bands: Galvanized steel, 1/2 inch wide x 0.015 inch thick with 0.032 inch thick galvanized wing seals.
3. Wire Mesh: Woven 20 gauge steel wire with 1 inch hexagonal openings, galvanized after weaving.

D. Reinforcing Membrane: Glass or Polyester, 10 x 10 mesh. Alpha Associates Style 59, Childers Chil-Glas, Foster's MAST-A-FAB, or approved equal.

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 (i.e., riser clamps, U-bolts, or trapezes) fully encircle pipe with two (2) protection shields and two (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 inches and larger.
   2. Insulation Inserts for Use with Flexible Elastomeric Foam Insulation:
      a. Where clevis hangers are used, install insulation shields with hardwood filler pieces, same thickness as adjoining insulation, inserted in undersized die cut or slotted holes in insulation at support points.
      b. Where hardwood blocks are used, contour to match the curvature of pipe, and shield.
      c. Coat dowels and blocks with insulation adhesive, and insert while sill wet.
      d. Vapor seal outer surfaces of dowels and blocks with adhesive after insertion.
      e. Provide minimum two (2) dowels plugs or one filler block per hanger.

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 feet.
   b. Vertical Pipe Runs: 9 feet.

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 gauge 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 ounce canvas jacket between two (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 ounces per square yard unless otherwise specified.
   2. For piping over 2 inch size: 6 ounces per square yard 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 inch 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 inch 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 gauge wires a minimum of four (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 gauge 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 ounce or 6 ounce 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 ounce or 6 ounce 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 1-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 INSTALLATION OF FLEXIBLE ELASTOMERIC CELLULAR INSULATION
   A. Slit insulation and install over pipe. Seal longitudinal and butt joints with adhesive.
   B. Insulate fittings and valves with miter cut sections. Use templates provided by the manufacturer and assemble the cut sections in accordance with the manufacturer's printed instructions.
      1. Insulate threaded fittings and valves with sleeved fitting covers. Over lap and seal the covers to the adjoining pipe insulation with adhesive.
   C. Carefully mate and seal with adhesive all contact surfaces to maintain the integrity of the vapor barrier system.
   D. Insulated Covers for Pumps:
      1. Do not extend pump insulation beyond or interfere with stuffing boxes, or interfere with adjustment and servicing of parts requiring regular maintenance or operating attention.
   E. Piping Exposed to the Elements:
      1. Apply flexible elastomeric foam insulation to piping with adhesive.
      2. Apply reinforcing membrane around piping insulation with adhesive or mastic.

3.07 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 1-1/2 inch (____ mm).
   (a) Thickness: 1 inch (____ mm).
2) Pipe Size Range: Over 1-1/2 inch.
   (a) Thickness: 2 inch.

2. Domestic Hot Water Recirculation:
   a. Glass Fiber Insulation:
      1) Pipe Size Range: All sizes.
         (a) Thickness: 1 inch (25 mm).
3. Tempered Domestic Water Supply:
   a. Glass Fiber Insulation:
      1) Pipe Size Range: Up to 1-1/2 inch (____ mm).
         (a) Thickness: 1 inch (____ mm).
      2) Pipe Size Range: Over 1-1/2 inch.
         (a) Thickness: 2 inch.
4. Tempered Domestic Water Recirculation:
   a. Glass Fiber Insulation:
      1) Pipe Size Range: All sizes.
         (a) Thickness: 1 inch (25 mm).
5. Domestic Cold Water:
   a. Glass Fiber Insulation:
      1) Pipe Size Range: Up to 1-1/2 inch.
         (a) Thickness: 1/2 inch.
      2) Pipe Size Range: Over 1-1/2 inch.
         (a) Thickness: 1 inch.
6. Roof Drain Bodies:
   a. Glass Fiber Insulation:
      1) Thickness: 1 inch.
7. Roof Drainage Within 10 Feet (3 Meters) of the Exterior:
   a. Glass Fiber Insulation:
      1) Pipe Size Range: All sizes.
         (a) Thickness: 1 inch (25 mm).
8. Roof Drainage Run Horizontal at Roof Level:
   a. Glass Fiber Insulation:
      1) Pipe Size Range: All sizes.
         (a) Thickness: 1 inch (25 mm).
9. Plumbing Vents Within 10 Feet (3 Meters) of the Exterior:
   a. Glass Fiber Insulation:
      1) Pipe Size Range: All sizes.
         (a) Thickness: 1 inch (25 mm).
10. Cold Condensate Piping:
    a. Flexible Elastomeric Cellular Insulation:
       1) Pipe Size Range: All sizes.
          (a) Thickness: 1/2 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.
5. Piping buried in the ground, unless otherwise specified herein.
6. Items installed by others, unless otherwise specified herein.
7. Sanitary drainage piping, unless otherwise specified herein.
8. 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, specialties, and connections for piping systems.
   1. Sanitary sewer.
   2. Domestic water.
   4. Pipe hangers and supports.
B. Valves.
   1. Gate valves.
   2. Globe valves.
   3. Ball valves.
   4. Plug valves.
   5. Butterfly valves.
   6. Check valves.
   7. Water pressure reducing valves.

1.02 RELATED REQUIREMENTS
A. Section 08 3100 - Access Doors and Panels.
B. Section 09 9123 - Interior Painting.
C. Section 22 0516 - Expansion Fittings and Loops for Plumbing Piping.
D. Section 22 0515 - Plumbing Firestopping.
E. Section 22 0553 - Plumbing Identification.
F. Section 22 0719 - Plumbing Piping Insulation.

1.03 REFERENCE STANDARDS
C. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2011.
D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
F. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV; 2011.
G. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV; 2012.
I. ASME B31.9 - Building Services Piping; 2014.
L. ASSE 1003 - Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems; 2009.


S. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV); 2013.


V. ASTM C14M - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Metric); 2015.


AG. ASTM D3517 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe; 2014.


AM. AWWA C550 - Protective Interior Coatings for Valves and Hydrants; 2013.

AN. AWWA C606 - Grooved and Shouldered Joints; 2011.
AO. AWWA C651 - Disinfecting Water Mains; 2005.
AS. MSS SP-67 - Butterfly Valves; 2011.
AT. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends; 2011.
AU. MSS SP-71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends; 2011.
AV. MSS SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends; 2011.
AW. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; 2013.
AY. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.
AZ. MSS SP-139 - Copper alloy gate, globe, angle and check valve for low pressure/low temperature plumbing applications; 2014.

1.04 SUBMITTALS
A. See Section 01 3300 - Submittal Procedures for submittal process.
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. Perform work in accordance with applicable codes.
B. Valves: Manufacturer's name and pressure rating marked on valve body.
C. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.
D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.
E. 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 end caps and closures on piping and fittings. Maintain in place until installation.
C. 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 GENERAL REQUIREMENTS

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

2.02 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

A. Cast Iron Pipe: ASTM A74 extra heavy weight.
   1. Fittings: Cast iron.

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

2.03 SANITARY SEWER PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A74, service weight.
   1. Fittings: Cast iron.

B. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.

C. Copper Tube: ASTM B306, DWV.

2.04 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
   3. Mechanical Press Sealed Fittings: Double pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, non toxic synthetic rubber sealing elements.
      a. Manufacturers:
         3) Substitutions: See Section 01 6000 - Product Requirements.

2.05 NATURAL GAS PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
   3. Jacket: AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil (0.25 mm) polyethylene tape.

2.06 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
   2. Joints: 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.
2.07 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:
2. Hangers for Pipe Sizes 1/2 Inch (15 mm) to 1-1/2 Inches (40 mm): Malleable iron, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 Inches (50 mm) 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 (80 mm): Cast iron hook.
6. Wall Support for Pipe Sizes 4 Inches (100 mm) and Over: Welded steel bracket and wrought steel clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

C. Plumbing Piping - Water:
2. Hangers for Pipe Sizes 1/2 Inch (15 mm) to 1-1/2 Inches (40 mm): Malleable iron, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 Inches (50 mm) and Over: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 Inches (50 mm) to 4 Inches (100 mm): Carbon steel, adjustable, clevis.
5. Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
6. Wall Support for Pipe Sizes to 3 Inches (80 mm): Cast iron hook.
8. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.08 GATE VALVES

A. Manufacturers:
4. Substitutions: See Section 01 6000 - Product Requirements.

B. Up To and Including 2 inches:
1. MSS SP-80 & MSS SP-139 low lead, Class 125, bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge disc, solder ends.

C. 2 Inches (50 mm) and Larger:
1. MSS SP-70, epoxy coated cast iron body, outside screw and yoke, handwheel, resilient wedge disc, flanged ends. Provide chain-wheel operators for valves 6 inches (150 mm) and larger mounted over 8 feet (2400 mm) above floor.

2.09 GLOBE VALVES

A. Manufacturers:
3. Substitutions: See Section 01 6000 - Product Requirements.

B. Up To and Including 3 Inches (80 mm):
1. 1, Class 125, bronze body, bronze trim, handwheel, bronze disc, solder ends.

C. 2 Inches (50 mm) and Larger:
1. 1, Class 125, iron body, bronze trim, handwheel, outside screw and yoke, renewable bronze plug-type disc, renewable seat, flanged ends. Provide chain-wheel operators for valves 6 inches (150 mm) and larger mounted over 8 feet (2400 mm) above floor.

2.10 BALL VALVES
A. Manufacturers:
   5. Substitutions: See Section 01 6000 - Product Requirements.
B. Construction, 4 Inches (100 mm) and Smaller: MSS SP-110, Class 150, 400 psi (2760 kPa) CWP, bronze or ductile iron two piece body, 304 stainless steel or chrome plated brass ball, full port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder, threaded, or grooved ends with union.
C. Construction, 2-1/2 inch (_____ mm) and Smaller: MSS SP-110 & MSS SP-139 low lead, Class 150, 400 psi (2760 kPa) 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 or threaded ends with union.

2.11 PLUG VALVES
A. Manufacturers:
   1. Homestead Valve.
   3. Substitutions: See Section 01 6000 - Product Requirements.
B. Construction 2-1/2 Inches (65 mm) and Larger: 300 psi (2065 kPa) CWP, cast bronze body, elastomer coated ductile iron disc with integrally cast stem, and copper-tube dimensioned grooved ends. Disc coating shall be UL classified in accordance with ANSI/NSF-61 for Potable water service.)
C. Construction 2 Inches (50 mm) and Larger: 300 psi (2065 kPa) CWP, ductile iron body with extended neck, electroless-nickel plated or stainless steel disc, pressure responsive EPDM seat rated to +250 degrees F / +120 degrees C, and stainless steel stem. (Stem shall be offset from the disc centerline to provide full 360-degree circumferential seating.) Lever handle or gear operator.
D. Construction 2 inches and Less: 100 psig WOG, gas cock type with cast iron or bronze body, bronze plug, square head, wrench operator, and threaded ends.
E. Construction 2-1/2 inches and Larger: 200 psig WOG, lubricated type with standard port opening, cast iron or semi-steel body, sealed lubrication system with lubricant fitting and dial indicator, cylindrical plug or teflon tapered plug, lubricant grooves in body or plug, flanged ends, and capable of lubrication with valve under pressure and plug in any position. Wrench operator.

2.12 BUTTERFLY VALVES
A. Manufacturer:
   5. Substitutions: See Section 01 6000 - Product Requirements.
B. Construction 2 inch (_____ mm) and Larger: MSS SP-67 & MSS SP-139 low lead, 200 psi (1380 kPa) CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle.
C. Provide gear operators for valves 8 inches (150 mm) and larger, and chain-wheel operators for valves mounted over 8 feet (2400 mm) above floor.
2.13 SPRING LOADED CHECK VALVES
   A. Manufacturers:
      3. Substitutions: See Section 01 6000 - Product Requirements.
   B. Class 125, iron body, bronze trim, stainless steel springs, bronze disc, Buna N seals, wafer style ends.

2.14 SWING CHECK VALVES
   A. Manufacturers:
      4. Substitutions: See Section 01 6000 - Product Requirements.
   B. Up to 2 Inches (50 mm):
      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 (50 mm):
      1. MSS SP-71, Class 125, iron body, bronze swing disc, renewable disc seal and seat, flanged or grooved ends.

2.15 WATER PRESSURE REDUCING VALVES
   A. Manufacturers:
      4. Substitutions: See Section 01 6000 - Product Requirements.
   B. Up to 2 Inches (50 mm):
      1. ASSE 1003, bronze body, stainless steel, and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded single union ends.
   C. Over 2 Inches (50 mm):
      1. ASSE 1003, cast iron body with interior lining complying with AWWA C550, bronze fitted, elastomeric diaphragm and seat disc, flanged.

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. Grooved joint piping systems shall be installed in accordance with the manufacturer's guidelines and recommendations. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by same manufacturer as joints. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. A factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall
periodically review the product installation. Contractor shall remove and replace any improperly installed products.

C. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

D. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

E. Install piping to maintain headroom, conserve space, and not interfere with use of space.

F. Group piping whenever practical at common elevations.

G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 0516.

H. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
   1. Refer to Section 22 0719.

I. Provide access where valves and fittings are not exposed.
   1. Coordinate size and location of access doors with Section 08 3100.

J. Install vent piping penetrating roofed areas to maintain integrity of roof assembly. Terminate at least 18 inches above roof.

K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

L. Provide support for utility meters in accordance with requirements of utility companies.

M. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.

N. Install bell and spigot pipe with bell end upstream.

O. Install valves with stems upright or horizontal, not inverted. Refer to Section 22 0523.

P. Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.

Q. Use non-hardening pipe dope on gas piping threads, do not use thread seal tape.

R. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.

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

T. Sleeve pipes passing through partitions, walls and floors.

U. 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 (100 mm).
   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.

V. Pipe Hangers and Supports:
   1. Support horizontal piping as indicated.
   2. Install hangers to provide minimum 1/2 inch (15 mm) space between finished covering and adjacent work.
   3. Place hangers within 12 inches (300 mm) of each horizontal elbow.
   4. Use hangers with 1-1/2 inch (40 mm) 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. 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. Use grooved mechanical couplings and fasteners in accessible locations, risers, pipe chases, and other locations as approved by the engineer.
B. Install unions downstream of valves and at equipment or apparatus connections.
1. Unions are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as unions and disconnect points.)
C. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
D. Install gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
E. Install globe valves for throttling, bypass, or manual flow control services.
F. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.
G. Provide spring loaded check valves on discharge of water pumps.
H. Provide plug valves in natural gas systems for shut-off service.

3.05 TOLERANCES
A. Drainage Piping: Establish invert elevations within 1/2 inch (10 mm) vertically of location indicated and slope to drain at minimum of 1/8 inch per foot (1:100) slope for pipes 2-1/2 inches in diameter and less, 1/8 inch per foot slope for pipes 3 inches to 6 inches in diameter and 1/16 inch per foot slope for pipes 8 inches and larger in diameter.
B. Water Piping: Slope at minimum of 1/32 inch per foot (1:400) 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. If testing piping connected to existing systems, perform hydrostatic test at 75 psig for 4 hours.
   4. The water utilized for the tests shall be obtained from a potable water source of supply.

J. Gas Piping:
   1. Before backfilling or concealment perform air test of duration and pressure as required by the local gas company. However, not less than 15 psi for one hour, without drop in pressure. Test gas piping with air only. Check joints for leaks with soap suds.

K. Inspection and Testing of Backflow Prevention Assemblies:
   1. Backflow prevention assemblies shall be tested at the time of installation and immediately after repairs or relocation.
   2. The testing procedure shall be performed in accordance with one of the following standards:
      a. ASSE Series 5000 - Standards 5013, 5015, 5020, 5047, 5052 or 5056.

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 SERVICE CONNECTIONS
A. Provide new sanitary sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves, pressure reducing valve.
   1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Calk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.
   2. Provide 18 gage, 0.0478 inch (1.21 mm) galvanized sheet metal sleeve around service main to 6 inch (150 mm) above floor and 6 feet (1800 mm) minimum below grade. Size for minimum of 2 inches (50 mm) of loose batt insulation stuffing.

C. Provide new gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure of 7 inch wg (1.75 kPa). Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.

D.

3.09 SCHEDULES
A. Pipe Hanger Spacing.
   1. Cast Iron Piping
      a. All Sizes:
         1) Maximum Horizontal Spacing: 5 feet (may be increased to 10 feet where 10-foot pipe lengths are installed).
         2) Maximum Vertical Spacing: 15 feet.
   2. Copper or Copper-Alloy Tubing.
      a. 1-1/4 inch diameter and smaller:
         1) Maximum Horizontal Spacing: 6 feet.
         2) Maximum Vertical Spacing: 10 feet.
      b. 1-1/2 inch diameter and larger:
         1) Maximum Horizontal Spacing: 10 feet.
         2) Maximum Vertical Spacing: 10 feet.
   3. Steel Pipe.
      a. All Sizes:
         1) Maximum Horizontal Spacing: 12 feet.
         2) Maximum Vertical Spacing: 15 feet.

END OF SECTION
SECTION 22 1006
PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Floor drains.
B. Cleanouts.
C. Hydrants.
D. Double check valve assemblies.
E. Water hammer arrestors.
F. Balancing valves.

1.02 RELATED REQUIREMENTS
A. Section 22 1005 - Plumbing Piping.
B. Section 22 4000 - Plumbing Fixtures.

1.03 REFERENCE STANDARDS
A. ASME A112.6.3 - Floor and Trench Drains; 2001 (R2007).
B. ASME A112.6.4 - Roof, Deck, and Balcony Drains; 2008 (Reaffirmed 2012).
C. ASSE 1012 - Backflow Preventer with Intermediate Atmospheric Vent; 2009.
D. ASSE 1013 - Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers; 2011.
E. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance; 2011.

1.04 SUBMITTALS
A. See Section 01 3300 - 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 round, adjustable nickel-bronze strainer. Provide drain with 3” outlet and trap below floor, or as indicated on drawings.

2. Manufacturers:
   d. Substitutions: See Section 01 6000 - Product Requirements.

3. Accessories: Floor drain trap seal.
   a. Sure Seal manufacturing, model SS3000.
   b. Substitutions: See section 01 6000 - Product Requirements.

2.02 CLEANOUTS

A. Manufacturers:
   5. Substitutions: See Section 01 6000 - Product Requirements.

B. Cleanouts at Interior Finished Floor Areas (CO-A):
   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.

2.03 HYDRANTS

A. Manufacturers:
   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. Zurn, Model Z-1330; or approved equal.

C. Exterior Hydrants (WH-B):
   1. ASSE 1019; freeze resistant, self-draining type with nickel bronze lockable box for flush with grade installation. 3/4” hose thread spout, lockshield and removable key, and integral vacuum breaker.
   2. Zurn, Model Z-1300; or approved equal.

D. Interior Wall Hydrant (WH-C):
   1. Exposed, anti-siphon, wall faucet for use in moderate climate installation, complete with external vacuum breaker, all bronze interior components, vandal-resistant operating stem, rough bronze exterior and 3/4” male hose connection.
   2. Zurn, Model Z-1341; or approved equal.

2.04 DOUBLE CHECK VALVE ASSEMBLIES

A. Manufacturers:
   4. Substitutions: See Section 01 6000 - Product Requirements.
B. Double Check Valve Assemblies:
   1. ASSE 1012; Bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.

2.05 BALANCING VALVES
A. General:
   1. Lead Free manual calibrated balancing valve.
B. Manufacturers:
   4. Approved Equal.
   5. Substitutions: See Section 01 6000 - Product Requirements.
C. Construction: Brass or bronze body with union on inlet, with integral automatic flow rate cartridge. EPDM O-rings.
D. Construction: Lead-Free Brass body, Stainless Steel ball construction, TFE seat rings. Valves to have differential pressure readout ports across valve seat.
E. Calibration: Automatically control flow within 10 percent of selected rating, over operating differential pressure range 2 to 35 psi (____ kPa).
F. Control Mechanism: adjustable positive memory stop.

2.06 WATER HAMMER ARRESTORS
A. Manufacturers:
   1. Precision Plumbing Products, Inc.: www.pppinc.net
   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 (1 to 120 degrees C) and maximum 150 psi (1000 kPa) working pressure.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
C. Install floor cleanouts at elevation to accommodate finished floor.
D. Pipe relief from backflow preventer to nearest drain.
E. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to each fixture or group of fixtures.

END OF SECTION
SECTION 22 1500
GENERAL-SERVICE COMPRESSED-AIR SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Pipe and pipe fittings.
   B. Air compressor.

1.02 RELATED REQUIREMENTS
   A. Section 22 0523 - General-Duty Valves for Plumbing Piping.
   B. Section 22 0553 - Plumbing Identification: Identification of piping system.

1.03 REFERENCE STANDARDS
   B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
   C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
   I. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2013.
   J. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.
   K. NEMA MG 1 - Motors and Generators; 2014.

1.04 SUBMITTALS
   A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturers catalog literature with capacity, weight, and electrical characteristics and connection requirements.
   C. 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 three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Protect piping and equipment from weather and construction traffic.

1.07 WARRANTY
   A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
   B. Provide five year manufacturer warranty for reciprocating air compressors.

PART 2 PRODUCTS

2.01 PIPE AND PIPE FITTINGS
   A. Steel Pipe: ASTM A53/A53M, Schedule 40 black.
2. Joints: Threaded or welded to ASME B31.1.

B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.

2.02 AIR OUTLETS
   A. Quick connectors and regulator: provide 1/2", 125 psig P32 compact regulators and 1/2" 20 series couplers.

2.03 UNIONS AND COUPLINGS
   A. Unions:
      1. Ferrous Pipe: 150 psi (1034 kPa) malleable iron threaded unions.
      2. Copper Tube and Pipe: 150 psi (1034 kPa) bronze unions with soldered joints.
   B. Flexible Connector: Neoprene with brass threaded connectors.

2.04 COMPRESSOR
   A. Manufacturers:
   B. Reciprocating Compressors:
      1. Unit: Heavy duty cast iron construction reciprocating compressor with positive displacement. Splash lubrication system. Aluminum head.
      3. OSHA style belt guard.
      4. Pressure sensor for start/stop control.
      5. ASME coded tank and pressure releif valve.
      6. Pressure gaguge in receiver.
      7. Automotive style inlet filter/silencer.
      8. Fin and tube intercooler.
      9. Sight glass oil gauge.
   C. Capacity:
      1. Continuous Delivery: 35 cfm (_____ L/s) of free air.
      2. Available pressure: 175 PSIG.
      3. Tank size: Vertical Non-pedestal 120 gallon.
   D. Electrical Characteristics:
      1. 10 hp (____ kW).
      2. 460 volts, three phase, 60 Hz.
   E. Air Dryer
      1. MTA DEITech-0035 cycling refrig. air dryer
         a. 120V single phase.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Install equipment in accordance with manufacturer's instructions.
   B. Install valved drip connections at low points of piping system. Refer to Section 22 0523.
   C. Identify piping system and components. Refer to Section 22 0553.

3.02 FIELD QUALITY CONTROL
   A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Compressed Air Piping Leak Test: Prior to initial operation, clean and test compressed air piping in accordance with ASME B31.1.

C. Repair or replace compressed air piping as required to eliminate leaks, and retest to demonstrate compliance.

D. Cap and seal ends of piping when not connected to mechanical equipment.

END OF SECTION
SECTION 22 4000
PLUMBING FIXTURES

PART 1  GENERAL

1.01  SECTION INCLUDES
   A. Water closets.
   B. Lavatories.
   C. Sinks.
   D. Mop sinks.
   E. Drinking fountains.
   F. Eye wash fountains.

1.02  RELATED REQUIREMENTS
   A. Section 22 0719 - Plumbing Piping Insulation
   B. Section 22 1005 - Plumbing Piping.
   C. Section 22 1006 - Plumbing Piping Specialties.
   D. Section 22 3000 - Plumbing Equipment.

1.03  REFERENCE STANDARDS
   A. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use; 1997
      (Reaffirmed 2002).
   B. ASME A112.18.1 - Plumbing Supply Fittings; 2012.
   C. ASME A112.19.1M - Enameled Cast Iron Plumbing Fixtures; The American Society of
      Mechanical Engineers; 2008 (R2011).
   D. ASME A112.19.2 - Ceramic Plumbing Fixtures; 2013.
   E. ASME A112.19.3 - Stainless Steel Plumbing Fixtures; 2008 (R2013).
   F. ASME A112.19.4M - Porcelain Enameled Formed Steel Plumbing Fixtures; 1994 (R2004).
   G. ASME A112.19.5 - Flush Valves and Spuds for Water Closets, Urinals, and Tanks; 2011.
      2018.
   J. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.
   M. 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 5 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 GENERAL
   A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.02 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. Flush Volume: 1.28 gallon, maximum.
      2. Flush Valve: Exposed (top spud).
      4. Manufacturers:
         e. Substitutions: See Section 01 6000 - Product Requirements.
   B. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
      1. Exposed Type: Chrome plated, with escutcheon, integral screwdriver stop, seat bumper.
      2. Manufacturers:
         d. Substitutions: See Section 01 6000 - Product Requirements.
   C. Seats:
      1. Manufacturers:
         e. 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:
         e. 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.
### 2.03 LAVATORIES, LAV-A:

**A. Lavatory Manufacturers:**

5. 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 20-1/2 inch (___ by ____ mm) minimum, with 4 inch (100 mm) high back, rectangular basin with splash lip, front overflow, and soap depression.

1. Drilling Centers: 4 inch (100 mm).

**C. Mount at Accessible height.**

**D. Supply Faucet Manufacturers:**

6. Substitutions: See Section 01 6000 - Product Requirements.

**E. Supply Faucet:** ASME A112.18.1; chrome plated cast brass supply fitting with water economy aerator with maximum flow of 0.5 gallon per minute (low-flow) (1.9 liters per minute (low-flow)), indexed handles. Vandal resistant assembly.

**F. Accessories:**

1. Chrome plated 17 gauge, 0.0538 inch brass P-trap with clean-out plug and arm with escutcheon.
2. Offset waste with perforated open strainer.
3. Screwdriver stops.
4. Flexible supplies.

**G. Carrier:**

1. Manufacturers:
   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.

### 2.04 SINK, SK-APS:

**A. Sink Manufacturers:**

5. Substitutions: See Section 01 6000 - Product Requirements.

**B. Single Compartment Undermount Sink:** ASME A112.19.3; 56 inch x 16.5 inch x 5-1/2 inch outside dimensions, 16 gauge thick, Type 304 stainless steel, undercoated.

**C. Supply Faucet:**

1. Manufacturers:
d. T&S Brass Model: www.tsbrass.com
e. Substitutions: See Section 01 6000 - Product Requirements.

D. Accessories:
1. Chrome plated 17 gauge brass P-trap with clean-out plug and arm with escutcheon.
2. Screwdriver stops.
3. Flexible supplies.

E. Drain 3-1/2 inch; Just Manufacturing Co. Model No. J-ADA-35-SSF Type 304 stainless steel crumb cup strainer, removable stainless steel basket, locking shell. 1-1/2 inch O.D., 17 gauge chrome plated brass offset tailpiece system or approved equal.

2.05 SINK, SK-BPS:

A. Sink Manufacturers:
5. Substitutions: See Section 01 6000 - Product Requirements.

B. Single Compartment Bowl Undermount: ASME A112.19.3; 16.5 by 16 by 5-1/2 outside dimensions 16 gauge thick, Type 304 stainless steel, undercoated.

C. Supply Faucet:
1. Manufacturers
   c. MOEN, Inc : www.moen.com
   e. Substitutions: See Section 01 6000 - Product Requirements.

D. Accessories:
1. Chrome plated 17 gauge brass P-trap with clean-out plug and arm with escutcheon.
2. Screwdriver stops.
3. Flexible supplies.

E. Drain 3-1/2 inch; Just Manufacturing Co. Model No. J-ADA-35-SSF type 304 stainless steel crumb cup strainer, removable stainless steel basket, locking shell. 1-1/2 inch O.D., 17 gauge chrome plated brass offset tailpiece system or approved equal.

2.06 SINK, SK-AHS:

A. Sink Manufacturer:
1. Existing

B. Supply Faucet:
1. Manufacturers
   c. MOEN, Inc : www.moen.com
   e. Substitutions: See Section 01 6000 - Product Requirements.

C. Accessories:
1. Existing

D. Drain:
1. Existing

2.07 SINK, SK-BHS, SK-ABG:

A. Sink Manufacturers:
5. Substitutions: See Section 01 6000 - Product Requirements.


C. Supply Faucet:
1. Manufacturers
   b. Cashel; Model 4" chrome Pull-out Faucet: www.cashelllc.com
   c. Substitutions: See Section 01 6000 - Product Requirements.

D. Accessories:
   1. Chrome plated 17 gauge brass P-trap with clean-out plug and arm with escutcheon.
   2. Screwdriver stops.
   3. Flexible supplies.

E. Drain 3-1/2 inch; Cashel Type 304 stainless steel crumb cup strainer, removable stainless steel basket, locking shell. 1-1/2 inch O.D., 17 gauge chrome plated brass offset tailpiece system or approved equal.

2.08 SINK, SK-AMS:

A. Sink Manufacturers:
5. Substitutions: See Section 01 6000 - Product Requirements.

B. Double Compartment Bowl Countertop Mount: ASME A112.19.3; 33 by 19 by 5-1/2 outside dimensions 18 gauge thick, Type 304 stainless steel, self rimming and undercoated, with ledge back drilled for trim.

C. Supply Faucet:
1. Manufacturers
   c. MOEN, Inc: www.moen.com
   e. Substitutions: See Section 01 6000 - Product Requirements.

D. Accessories:
   1. Chrome plated 17 gauge brass P-trap with clean-out plug and arm with escutcheon.
   2. Screwdriver stops.
   3. Flexible supplies.

E. Drain 3-1/2 inch; Just Manufacturing Co, Model No. J-ADA-35-SSF type 304 stainless steel crumb cup strainer, removable stainless steel basket, locking shell. 1-1/2 inch O.D., 17 gauge chrome plated brass offset tailpiece system or approved equal.

2.09 SINK, SK-BMS:

A. Sink Manufacturers:
5. Substitutions: See Section 01 6000 - Product Requirements.
B. Single Compartment Bowl Countertop Mount: ASME A112.19.3; 31 by 21 by 5-1/2 outside dimensions 18 gauge thick, Type 304 stainless steel, self rimming and undercoated, with ledge back drilled for trim.

C. Supply Faucet:
   1. Manufacturers
      c. MOEN, Inc: www.moen.com
      e. Substitutions: See Section 01 6000 - Product Requirements.

D. Accessories:
   1. Chrome plated 17 gauge brass P-trap with clean-out plug and arm with escutcheon.
   2. Screwdriver stops.
   3. Flexible supplies.

E. Drain 3-1/2 inch; Just Manufacturing Co. Model No. J-ADA-35-SSF type 304 stainless steel crumb cup strainer, removable stainless steel basket, locking shell. 1-1/2 inch O.D., 17 gauge chrome plated brass offset tailpiece system or approved equal.

2.10 SINK, SK-ABG:

A. Sink Manufacturers:
   5. Substitutions: See Section 01 6000 - Product Requirements.

B. Single Compartment Bowl Countertop Mount: ASME A112.19.3; 21 by 19 by 7-1/2 outside dimensions 18 gauge thick, Type 304 stainless steel, self rimming and undercoated, with ledge back drilled for trim.

C. Supply Faucet:
   1. Manufacturers
      c. MOEN, Inc: www.moen.com
      e. Substitutions: See Section 01 6000 - Product Requirements.

D. Accessories:
   1. Chrome plated 17 gauge brass P-trap with clean-out plug and arm with escutcheon.
   2. Screwdriver stops.
   3. Flexible supplies.

E. Drain 3-1/2 inch; Just Manufacturing Co. Model No. J-ADA-35-SSF type 304 stainless steel crumb cup strainer, removable stainless steel basket, locking shell. 1-1/2 inch O.D., 17 gauge chrome plated brass offset tailpiece system or approved equal.

2.11 DRINKING FOUNTAINS

A. Drinking Fountain Manufacturers:
   4. Substitutions: See Section 01 6000 - Product Requirements.
   5. Fountain: Single level wall mounted freeze resistant drinking fountain, vandal resistant, heavy duty 14 gauge stainless steel construction, with wall panel and mounting bracket. Mounted at ADA height
2.12 MOP SINK, MS-A:

A. Service Sink Manufacturers:
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Basin: 36 by 24 by 12 inch (___ by ___ by ___ mm) high white precast terrazzo molded stone, floor mounted, with two inch (___ mm) wide shoulders, 6 inch drop front, 36in stainless steel wall guard on back, stainless steel threshold, and stainless steel beehive strainer.

C. Trim: ASME A112.18.1 concealed wall type polished chrome plated solid cast brass supply with lever handles, atmospheric vacuum breaker spout with pail hook, wall brace and 3/4" male garden hose thread outlet, replaceable spring check cartridges with integral supply stops for servicing cartridges, and adjustable threaded wall flanges. Inlet supply arms on 8 inch centers.
   1. Manufacturers:
      b. Substitutions: See Section 01 6000 - Product Requirements.

D. Accessories:
   1. 3 feet (___ m) of 3/4 inch (___ mm) diameter plain end reinforced rubber hose.
   2. Hose clamp hanger.
   3. Mop hanger with 3 grips on a stainless steel bracket.
   4. One 36 inch molded wall guards.

2.13 EMERGENCY EYE WASH, EW-A:

A. Emergency Wash Manufacturers:
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Emergency Wash: ANSI Z358.1; free standing, non-clogging eye wash with quick opening, full-flow valves, stainless steel eye wash receptor, twin eye wash heads with internal flow control, filter, and flip top dust cover, chrome plated brass control valve and fittings.

C. Provide with optional thermostatic mixing valve S19-2000-EFX8-SS.

2.14 PIPING INSULATION ACCESSORIES:

A. Provide products that comply with the following:

B. Piping Safety Covers: Truebro Lav-Guard.
   1. Characteristics: 3-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 (TAB), 0 mm Area of Burning (ABE), 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: 3-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.
C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

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

3.03 INSTALLATION
A. Install each fixture with trap, easily removable for servicing and cleaning.
B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.
C. Install components level and plumb.
D. Install and secure fixtures in place with wall carriers and bolts.
E. Seal fixtures to wall and floor surfaces with sealant as specified in Section, 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:
      a. Standard: 15 inches (380 mm) to top of bowl rim.
      b. Accessible - Adults and Children (grades 7-12): 17 inches minimum and 19 inches maximum to top of seat, 18 inches centerline.
      c. Accessible - Children (grade 1-6): 15 inches to top of seat.
      d. Accessible - Children (UPK-Kindergarten): 12 inches to top of seat.
   2. Water Closet Flush Valves:
      a. Standard: 11 inches (280 mm) minimum above bowl rim.
3. Lavatory:
   a. Standard: 31 inches (785 mm) to top of basin rim.
   b. Accessible - Adults: 34 inches (865 mm) to top of basin rim.
   c. Accessible - Children: 31 inches to top of basin rim.

4. Emergency Eye Wash:
   a. Standard: 38 inches (965 mm) to receptor rim.

B. Fixture Rough-In

1. Water Closet (Flush Valve Type):
   a. Cold Water: 1 Inch (25 mm).
   b. Waste: 4 Inch (100 mm).
   c. Vent: 2 Inch (50 mm).

2. Lavatory:
   a. Hot Water: 1/2 Inch (15 mm).
   b. Cold Water: 1/2 Inch (15 mm).
   c. Waste: 1-1/4 inch (_____ mm).

3. Sink:
   a. Hot Water: 1/2 Inch (15 mm).
   b. Cold Water: 1/2 Inch (15 mm).
   c. Waste: 1-1/2 Inch (40 mm).
   d. Vent: 1-1/2 inch (_____ mm).

4. Mop Sink:
   a. Hot Water: 3/4 inch (_____ mm).
   b. Cold Water: 3/4 inch (_____ mm).
   c. Waste: 3 Inch
   d. Vent: 1-1/2 Inch (40 mm).

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. Work Included:
   1. Cleaning of HVAC system air handling units and their respective supply and return air ductwork systems. HVAC systems include but are not necessarily limited to the following major components:
      a. All air handling units (AHU’s) including fans/blowers, casings/housings, coils, mixing boxes/plenums, dampers, filter sections, and condensate drain pans.
      b. Supply and return air ductwork.
      c. Duct and plenum mounted grilles, registers, louvers, diffusers and dampers.
      d. Terminal boxes and coils installed in existing ductwork.
   2. Sanitize all HVAC system air handling units, ductwork and all additional areas as specified herein.
   3. Install closures at all locations where ductwork penetrations are made for cleaning purposes.

B. Areas and Items Not to be Cleaned:
   1. Building exhaust ductwork.
   2. All ductwork scheduled for demolition, as indicated on the Contract Drawings.

C. Related Requirements Specified Elsewhere:
   1. Section 02 2626 – Lead Hazard Assessment:
      a. The interior of air handling units referenced above and their respective supply and return air ductwork have been sampled and found to be contaminated with lead dust. The Contractor shall assume that all ductwork, plenum spaces, grilles, registers, louvers, diffusers, dampers, terminal boxes, all interior system surfaces, equipment, and materials including filter sections and filters are lead dust-contaminated. System cleaning will disturb lead and shall be conducted in accordance with applicable sections of this Specification, the Occupational Safety and Health Administration’s (OSHA) Lead Standard for Construction (29 CFR 1926.62) and all other applicable federal, state, and local regulations regarding the disturbance, removal, cleaning, containerizing, transport and disposal of lead.

D. Work by Others:
   1. After removal by Contractor, the Owner will replace filters in all supply sides of the air handling units.
   2. Owner will perform the shutdown and lock-out of all air handling units.

E. Descriptions of Systems: Approximate sizes, locations, quantities and dimensions of systems and components to be cleaned are shown on the drawings. Contractor shall field verify and work to actual installed conditions of all such systems and components.

1.02 REFERENCED STANDARDS AND PUBLICATIONS

A. The following current standards and publications of the issues currently in effect form a part of this specification to the extent indicated by any reference thereto:
6. American Society of Heating Refrigeration an Air Conditioning Engineers (ASHRAE): "Ventilation for Acceptable Indoor Air Quality".

1.03 CONTRACTOR’S QUALIFICATIONS

A. The Contractor shall fulfill the qualification requirements as defined below. A Subcontractor may be utilized to fulfill these requirements.

B. Subcontractors may be used by the Contractor to fulfill the qualification requirements defined below.

1. Duct cleaning shall be conducted by a member of the National Air Duct Cleaners Association (NADCA), or shall maintain membership in a nationally recognized non-profit industry organization dedicated to the cleaning of HVAC systems.

2. Contractor shall have a minimum of one (1) Air System Cleaning Specialist (AACS) certified by NADCA on a full time basis, or shall have staff certified by a nationally recognized certification program and organization dedicated to the cleaning of HVAC systems.

3. A person certified as an AACS by NADCA, or maintaining an equivalent certification by a nationally recognized program and organization, shall be responsible for the total Work herein specified.

4. Contractor must have past experience in the field of HVAC system cleaning, and submit records of experience to the Architect.

5. Contractor shall possess and furnish all necessary equipment, materials and labor to adequately perform the specified services.

   a. The Contractor shall maintain a copy of all current MSDS documentation and safety and training certifications at the site at all times, as well as comply with all other site documentation requirements of applicable OSHA programs, this specification.

C. Work Performed During the School Year: the Contractor's Supervisor and workers or his subcontractor shall be US EPA Lead Certified for the State of New York.

D. Contractor shall submit to the Environmental Consultant, the MSDS's for all chemical products proposed to be used on this project.

1. Contractor shall provide proof of maintaining the proper license(s), if any, as required to do Work in this State. Contractor shall comply with all Federal, State, and local rules, regulations, and licensing requirements.

1.04 STANDARDS

A. NADCA Standards: Perform all services specified herein in accordance with the current published standards of the National Air Duct Cleaners Association (NADCA).

1. Unless specifically noted otherwise, NADCA Standards shall be followed with no modifications or deviations being allowed.

2. Where conflicts between this specification, or other sections of the Project Manual, the NADCA standards, and/or federal/state/local regulations occur, comply with the most stringent requirement as determined by the Architect.

1.05 PROJECT SCHEDULE

A. Provide sufficient personnel, materials, and equipment necessary to meet the specified construction schedule start and completion dates.

1. Provide a detailed work schedule which defines the start and finish dates for all segments of work and is in accordance with the overall construction schedule.

2. The Contractor’s detailed work schedule will be reviewed for conformance with the project construction schedule by the Architect. Changes required by the Architect to meet the
project construction schedule must be reviewed and agreed to by the Contractor prior to detailed work schedule acceptance.

3. The detailed work schedule must be submitted within 1 week of Notice to Proceed.

1.06 SEQUENCE OF OPERATIONS

A. Perform all work on a system-by-system basis in sequence as directed by the Architect.

B. Obtain Environmental Consultant’s and Architect’s acceptance of each cleaned and sanitized HVAC system before proceeding to the next system. Do not proceed to the next system without authorization from the Environmental Consultant and the Architect. Authorization to proceed will be predicated upon satisfactory completion of work in each previous system.

1.07 COMMUNICATION, SCHEDULING AND COORDINATION

A. Direct all questions regarding work, schedule, shut down request, etc., to the Architect. Confirm all verbal requests in writing. Report to, and comply with directives of the independent Environmental Consultant in all lead related aspects of the work.

B. Submit all system shut down requests 3 working days prior to need for same.

C. Coordinate all system shut down, lockout/tagging and system restarts and purge operations with Owner.

D. At least 1 week (5 working days) prior to Contractor’s initial on-site mobilization, meet with the Architect and the Environmental Consultant to perform complete jobsite walk-through to identify proposed ductwork access/entry points.

E. Provide a minimum of 72 hours written notice to the Architect and the Environmental Consultant for the following actions:
   1. Utility relocations of any kind.
   2. Installation or connection of temporary utilities of any kind.
   3. Shutdown of HVAC systems.

F. Provide a minimum of 10 working days notice to the Environmental Consultant and Architect in advance of each occurrence of the following:
   1. Demolition or need for demolition.

G. Submit to Architect and maintain at the jobsite an emergency phone list of Contractor’s key personnel incorporating at least the following information:
   1. Name.
   2. Company Name or Department.
   3. Project Role.
   4. Office Telephone Number.
   5. Home Telephone Number.
   6. Pager Number.
   7. Cellular Phone Number.

1.08 PROGRESS REPORTS

A. Provide written narrative of project progress and status at the completion of each work shift.
   1. Include brief description of work completed and work proposed to be performed on the next following work shift.
   2. Provide list of questions, problems, conditions encountered, information needs, to Architect.
   3. Deliver reports to Environmental Consultant and Architect at the conclusion of each respective work shift.

PART 2 PRODUCTS

2.01 CLEANING AND SANITIZING PRODUCTS

A. All cleaning and sanitizing products must be approved by the Architect. MSDS sheets of proposed cleaning solutions and any other chemicals planned to be brought on-site must be...
submitted 2 weeks prior to the start of abatement work. Cleaning solutions other than those submitted shall not be used unless approved by Architect in writing.

B. All cleaning and sanitizing products shall be EPA approved/registered as applicable for their respective uses in cleaning and sanitizing of ventilation systems and HVAC ductwork.

C. All chemicals used for cleaning shall be non-flammable, alkaline based and non-corrosive to metals.

D. Sanitizing agent shall be Oxine by Bio-Cide International, Inc., or approved equal.

PART 3 EXECUTION

3.01 INSPECTIONS AND PREPARATIONS

A. Prior to the start of actual cleaning procedures:
   1. Perform a visual inspection of the HVAC system to determine appropriate methods, tools, and equipment required to satisfactorily complete the project.
   2. Notify Architect of any damaged system components found during the inspection prior to commencement of the Work. Contractor shall not be responsible for existing damage. Existing damage shall be fully documented by Contractor prior to the commencement of Work. The Contractor shall submit damage report to Environmental Consultant and Architect prior to commencing duct cleaning.
   3. Conduct a site evaluation and establish a specific coordinated plan which details how each area of the building will be protected during the various phases of the project.
   4. Review, establish and coordinate procedures with the Environmental Consultant and Architect for the following minimum items:
      a. Staging and scheduling of work.
      b. Clearing work spaces of movable items.
      c. Requirements for tagging and locking out apparatus and equipment.
      d. Location and access route to contractor assigned storage area(s).
      e. Architect and Environmental Consultant for staff contact, security, and health and safety requirements.

B. Prior to cleaning each respective HVAC system:
   1. Identify locations of required new access openings within each air conveyance system to facilitate the Work. The quantity, size and location shall be submitted to the Architect for review and approval, prior to the start of cleaning Work. Changes during Work progress shall be approved by the Architect and recorded prior to proceeding.

C. The Contractor shall provide pictorial documentation of duct and air handler conditions prior to start of Work and upon completion and acceptance of work. Findings are to be documented by either still photographs or on video tape for all areas.

3.02 HEALTH AND SAFETY

A. Safety Standards: Comply with all applicable federal, state, and local requirements for protecting the safety of Contractor’s employees, building occupants, and the environment. In particular, all applicable standards of the Occupational Safety and Health Administration (OSHA) shall be followed when working in accordance with this specification.
   1. Flame retardant polyethylene sheeting 6 mil thick shall be utilized, as necessary, to protect building surfaces, materials, and equipment from lead contamination. Follow all requirements identified in Section, Lead Hazard Control.
   2. Prior to the start of any Work, the HVAC systems must be shut down, locked and tagged by the School District, Owner and verified by the Contractor’s Supervisor. All areas supplied by the System being cleaned must be evacuated of all personnel not involved with the cleaning operation.
   3. Under no circumstances will negative air machines, filters, or debris collection equipment be repaired, cleaned or otherwise opened within the building. All equipment must be serviced and/or cleaned outdoors in a designated location or at the Contractor’s facilities.
4. All work within the duct system, including AHU supply and return fans, which require workers to work within the duct system must be conducted in accordance with all the requirements of OSHA's Permit-required Confined Space Standard, 29 CFR 1910.146. Certificates documenting employee confined space training required by the OSHA Standard must be submitted prior to the start of Work.

5. Use of cleaning fluids and sanitizers that require an employee to enter or Work within the duct system, including supply and return fans shall be considered confined space work.

B. Occupational Safety: No processes or materials shall be employed in such a manner that they will introduce additional hazards into occupied spaces.

1. Prior to start of Work, the Contractor shall set-up all necessary barricades and protect all floors, walls, equipment, and furniture as noted in Specification. Any damage in work areas or adjacent to work areas caused by the Contractor’s actions will be repaired or replaced by the Contractor at no cost to the Owner.

2. Building areas shall be cleaned using approved means by the end of work in each area and all covers, enclosures, warning signs and barricades shall be removed once satisfactory clearance sampling results have been obtained.

C. Disposal of Debris: All debris specified as lead-contaminated, or that any tests determine to be lead-contaminated, shall be removed and disposed of as lead waste in accordance with applicable federal, state and local requirements. All debris shall be removed from the work area at the end of each shift or when Work in the area is completed, whichever is earlier. Removed debris shall be placed in a Contractor supplied fully enclosed and lockable dumpster, that will be located in an Owner/Architect approved location. The Contractor is responsible for all costs associated with the transportation and disposal of waste and debris.

D. Asbestos-Containing Materials (ACM) and Lead Containing Materials External to HVAC Systems:

1. Asbestos-containing materials and lead are present in the vicinity of work areas. Contractor shall conduct work in a manner that avoids disturbance of such materials. If disturbance cannot be avoided to complete the work, the work shall be conducted in accordance with all Federal and State regulations governing the disturbance of such materials.

2. Asbestos-containing non-friable paper duct insulation is present on some sections of the ductwork and is schedule to be removed under Specification Section 02 8213 - Asbestos Abatement. The Contractor is responsible for taking necessary precautions to prevent the disturbance of these materials. If disturbance cannot be avoided the work must be done in accordance with State and Federal regulations.

3. If, during the performance of Work, the Contractor finds any previously unidentified hazard, or suspected asbestos or inorganic lead material which is damaged or which is likely to be disturbed or damaged by the Contractor’s Work, the Contractor shall notify the Architect and Environmental Consultant immediately.
source removal methods which will render the HVAC system visibly clean and capable of passing cleaning verification methods (see applicable NADCA Standards) and other specified tests in accordance with all general requirements. The standard of cleanliness shall be any loose visible dust. No cleaning method, or combination of methods, shall be used which could potentially damage components of the HVAC system or negatively alter the integrity of the system.

D. Cleaning of HVAC systems shall be performed in a manner that ensures that contaminants are not spread into areas which have been cleaned, or areas which have not yet been cleaned. Cleaning shall progress in the same direction as the system airflow. Material removal shall be at the downstream end of the section through an access connection in the bottom of the duct. The portion of the system which is being cleaned must remain under a minimum negative pressure of .025 inch w.g.

E. All cleaning methods used shall incorporate the use of fan powered, high efficiency dust and particulate collection devices that are operated continuously during cleaning.

F. All vacuum devices shall be equipped with HEPA filters (99.97 percent minimum efficiency on 0.3 micron and larger particles), including hand-held vacuums.

G. All methods require mechanical agitation devices to dislodge debris adhered to interior HVAC system surfaces, such that debris may be safely conveyed to vacuum collection devices. Acceptable methods will include those which ensure compliance with Section 02 8313 and will not potentially damage the integrity of the ductwork, or system components.

H. All debris removed during cleaning shall be collected, contained, handled, and disposed of as lead waste as defined in Specification 02 8313 by means that will ensure that it is not otherwise dispersed into or onto facilities, equipment or grounds.

I. Controlling Odors: All reasonable measures shall be taken to control offensive odors and/or mist vapors during the cleaning process.

J. Component Cleaning: Cleaning methods shall be employed such that all HVAC system components must be visibly clean as defined in applicable standards (see NADCA Standards). Upon completion, all components shall be returned to their respective settings as recorded by Contractor just prior to cleaning operations.

K. Air-Volume Control Devices: Dampers and any air-directional mechanical devices inside the HVAC system shall have their position marked by Contractor prior to cleaning and, upon completion, shall be restored to their marked position. Air volume control devices damaged by the Contractor shall be replaced by the Contractor at no additional cost to the Owner.

L. Fire Dampers: When fire dampers are encountered, the fusible links shall be removed and replaced with new 165 0F units in accordance with NFPA requirements.

M. Access Panels: The Contractor shall utilize existing access panels and make additional penetrations into ductwork, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry, and inspection.

1. The Contractor shall utilize existing access panels already installed in the HVAC system whenever possible. Since opening of the access panels could potentially disturb lead, the Contractor shall place 6 mil plastic sheeting on equipment and building surfaces beneath the access panels prior to opening. Panels shall be opened slowly to minimize dust disturbance and subsequently HEPA vacuumed. When Work is complete, plastic sheeting shall be HEPA vacuumed of any visible debris, carefully folded and placed in disposal containers.

2. Additional openings to facilitate access will need to be made by the contractor. These openings will require the Contractor to cut an area of duct approximately 20 inches x 20 inches in size. The contractor shall place 6-mil plastic sheeting on equipment and building surfaces beneath the duct. Two (2) employees will make the cut. One (1) employee will be responsible for operating a HEPA vacuum to capture generated dust during cutting of the ductwork. Cut sections shall be HEPA vacuumed of visible debris.
3. Construct openings so they can be sealed with sheet metal to be installed by the Contractor in accordance with industry codes and standards, and document these openings. Submit copies of Drawings to the Architect showing locations of all existing and new openings proposed to be utilized by the Contractor at least 10 working days before start of duct cleaning Work.

4. Sheet metal covers over the openings shall not significantly hinder, restrict, or alter the air-flow within the system.

5. Sheet metal covers over the openings shall be properly insulated to prevent heat loss/gain or condensation on surfaces within the system.

6. Openings shall not compromise the structural integrity of the system.

7. Construction techniques used in the creation of openings shall conform to requirements of applicable building and fire codes, and applicable NFPA, SMACNA and NADCA Standards.

N. Air Distribution Devices (registers, grilles and diffusers): Clean all air distribution devices of visible dust and debris. All settled dust on internal and external sides of air distribution devices are contaminated with lead and shall be HEPA vacuumed and wet wiped of all visible debris and dust.

O. Air Handling Units (AHU’s), Blowers and Fans: Ensure that AHU’s, fans and blowers are thoroughly cleaned. Areas to be cleaned include, but are not necessarily limited to, blowers, fan housings, plenums, coils, scrolls, blades or vanes, shafts, baffles, dampers and drive assemblies. All visible surface contamination deposits shall be removed in accordance with NADCA Standards, this specification, and specification 02 8313. Contractor shall:
   1. Clean all internal surfaces, components and condensate collectors and drains.
   2. Assure that a suitable operative drainage system is in place prior to beginning wash down procedures.

P. Duct Systems:
   1. Create service openings in the system as necessary to accommodate cleaning of otherwise inaccessible areas. Creating these openings will disturb lead-containing dust inside the ductwork and shall be conducted as described above for access panels.
   2. Mechanically clean all duct systems to remove all visible contaminants, in such a manner that all systems are capable of passing cleaning verification testing.

Q. Cleaning of Coils: Clean coils of visible dust and debris. Drains shall be protected from clogging by cleaning operations. Prior to start of coil cleaning, Contractor shall inspect and verify proper drain function. If clogged drains are encountered, Contractor shall notify Architect and make necessary repairs to drain piping. Cleaning methods shall not cause any appreciable damage to, displacement of, inhibit heat transfer, or erosion of the coil surface or fins, and shall conform to coil manufacturer recommendations when available.

3.05 AIR HANDLER UNIT CLEANING PROCEDURE

A. At least 72 hours prior to Work commencement, notify Architect and Owner of any activity planned within the air handling units and establish a schedule of shut down times for each air handling unit. The Owner will shut down/lock-out and start up of all air handling equipment. Dust sensitive sensors may be located in the ductwork associated with each air handler. Removal and re-installation of these components will be performed by the Contractor and coordinated with the Owner.

B. Upon completion of cleaning of interior surfaces and equipment, notify Architect and request Environmental Consultant to perform visual inspection to verify the cleaning has been satisfactorily completed.

C. Outside Air Intakes:
   1. Outside Air Intakes, Inlet louvers, bird screens, dampers, turning vanes, moisture deflectors shall be cleaned thoroughly.
   2. If mechanical defects are observed, pictorially document and notify the Architect immediately. Include descriptive detail in the daily progress report.
D. Mixing Chambers:
   1. Verify and ensure proper operation of drains but do not utilize drains for disposal of cleaning residues.
   2. HEPA-vacuum and wet wipe the interior surfaces of mixing chambers, removing all dust and debris.
   3. Clean mixing dampers, including bearing frame of visible dust and debris using HEPA vacuums and wet wiping.

E. Filter Section and Canvas Connection:
   1. Remove and dispose of existing filters and Canvas Connections.
   2. Scrape debris from the filter rack area. HEPA-vacuum clean.
   3. Notify Owner when filter section is ready for installation of new filters. Owner will provide and install filter.
   4. Contractor shall provide and install new Canvas Connections.

F. Coil Sections:
   1. Remove standing water from the condensate pans or base of the plenum. Clear the drain inlets associated with each pan, ensuring proper operation prior to cleaning. Notify the Architect of any drains not properly functioning.
   2. HEPA vacuum all visible dust and debris.
   3. Take precautions not to damage fins. If fins are bent prior to cleaning, straighten fins utilizing a coil combing system after the cleaning process, or if severe straightening is required, straighten using techniques which will not further damage the coil prior to cleaning. If fin damage is severe or damage occurs during cleaning, note damage areas in Daily Progress Report and notify the Architect immediately.
   4. After HEPA vacuuming, clean the coil section using high pressure hot water. First apply hot water to one (1) side of the coil section, then apply an approved biodegradable cleaning solution. Allow time for cleaning solution to penetrate into the coil section (follow manufacturer’s recommendations). Repeat process on other side of coil section. Rinse each side. Continue process until clean water can penetrate coil section on entire coil face.

G. Fan Section:
   1. HEPA-vacuum and wet clean the fan housing to remove debris and excess grease. When the motor is within the air stream, HEPA-vacuum the motor.
   2. Hand scrape fan impellers and remove loose debris from the internal surfaces of the fan housing using HEPA vacuums. Take precautions not to damage impellers, alter blade shape or weight or affect impeller balance. Notify the Architect immediately if damage occurs.

H. Sound Attenuators, Air Handler Casings and Fresh Air Plenums/Chases:
   1. Sound attenuators shall be HEPA-vacuumed clean on all sides to remove surface debris build up. Do not water wash sound dampening systems. Take precautions not to damage surfaces.
   2. HEPA-vacuum the internal surfaces of the air handler casings to remove loosely adhering dust and debris and other contaminants that may be present.
   3. HEPA-vacuum and wet clean the internal surfaces of all fresh air plenums/chases of visible dust and debris.

3.06 AIR DISTRIBUTION SYSTEM CLEANING PROCEDURE

A. Access System Installation: Provide access into ductwork systems associated with the air handler, regardless of duct size or location. Contractor shall install sheet metal patch over all access openings created during the cleaning. Any related ductwork must not be cut into for cleaning purposes other than to install access doors or covers. The structural integrity of the ductwork shall not be altered by access system installation.

B. Pre-Cleaning Procedures:
   1. Cut an opening into the side, top, or bottom of the duct to accommodate the cleaning of the section of the duct.
a. For ducts less than 2 square feet in cross-sectional areas, access for equipment should be created between obstructions within the duct.
b. For ducts more than 2 square feet in cross-sectional areas, provide and install minimum 20 inches x 20 inches access doors every 100 feet apart for worker access. The duct-cleaning Contractor shall verify that the ductwork is capable of sustaining the weight of a worker inside the duct. Contractor must protect his/her workers from falls as required by OSHA.

C. Cleaning Procedures:
1. Ductwork:
   a. Each main duct section shall be addressed by first securing debris collection equipment to several diffuser branch ducts or to an isolated section of ductwork in that section. Take all necessary precautions to prevent dirt and debris from entering the occupant space. All ductwork must be cleaned of visible dust and debris.
   b. By agitating the loose debris on the interior surfaces, introduce the debris into the air flow produced and controlled by the collection systems. Collection systems shall be able to produce a minimum of 0.025 inch w.g. in the targeted section of duct to be cleaned. Debris shall travel through the ductwork to the point of collection.
   c. Ductwork less than 2 square feet in cross-sectional area: Insert air powered cleaning tools and contact all interior surfaces of the duct by contact cleaning. Operate the collection equipment with HEPA-Filter during cleaning to capture dislodged dirt.
   d. Ductwork of more than 2 square feet in cross-sectional area: Cleaning can be manual. Operate the collection equipment with HEPA-Filter during cleaning, to capture the dislodged dirt.
   e. Turning Vanes: Hand scrape and/or brush as necessary to remove caked on material.
   f. Contractor may choose manually cleaning methods for all interior surfaces as long as a visible dust and debris is removed.

2. Volume, Fire, and Zone Dampers:
   a. Duct mounted volume, fire and zone dampers: existing settings shall be marked, inspected and cleaned as necessary. External moving parts shall be treated with an approved dry lubricant material. After cleaning, dampers shall be repaired as necessary to ensure their intended operation and then returned to their original setting.
   b. Contractor shall indicate locations of all damaged dampers on Drawings and shall inform the Architect immediately.
   c. The Contractor shall protect all dampers from any damage. The Contractor shall be responsible for all costs for repair work necessitated by damaged caused by Contractor's activity, as determined by the Architect.

3. Duct Coils: Coils shall be cleaned by brushing and HEPA vacuuming all visible dust and debris.

4. Grilles, Registers, Diffusers (GRD): Whenever GRD are removable, they shall be removed, HEPA vacuumed and washed of visible dust and debris, dried and then replaced. When GRD are restricted by a façade or welded, they may be HEPA-vacuumed and wet wiped cleaned in place. Do not disturb damper settings.

5. Apply a penetrating encapsulant to all surfaces including walls, ceilings and support system, pipes, and ductwork. Do not encapsulate mechanical equipment, smoke/fire detection devices, or other items that would be damaged by the encapsulant. Do not apply encapsulant to the interior of the ductwork.

6. Terminal Boxes: Terminal Boxes shall be HEPA-vacuumed cleaned. After cleaning, inspect all internal components and ensure proper operation.

3.07 CLEANLINESS VERIFICATION

A. Verify cleanliness of HVAC system after cleaning and before the application of any treatment or introduction of any treatment-related substance to the HVAC system, including biocidal agents.
B. Visually inspect the HVAC system and demonstrate to the Architect that no visible contaminants are present.
   1. If no loose visible dust and debris are evident through visual inspection, the HVAC system shall be considered clean and ready for clearance inspection and testing by the Environmental Consultant.
   2. If visible loose visible dust or debris is evident through visual inspection, those portions of the system where loose visible dust or debris is present shall be re-cleaned at Contractor’s expense and subjected to re-inspection for cleanliness.

3.08 APPLICATION OF SANITIZING AGENT
   A. Sanitizing agents shall be sprayed applied to all interior system surfaces (air handling units and ductwork), excluding mechanical equipment that would be damaged by the spray.
   B. Application of sanitizing agents and coatings to control the growth of fungal or bacteriological contaminants shall only be performed after the removal of surface deposits and debris and after acceptable clearance results have been obtained.
   C. Sanitizing agents shall be applied in strict accordance with manufacturer’s instructions.

3.09 CLEAN-UP PRIOR TO RE-OCCUPANCY
   A. After work area has passed lead clearance sampling, clean-up the work area as required for turn-over to the Owner including removal of barricades, warning signs, containment materials, and protection materials from the area. Replace all movable items removed from the area to their original location.
   B. HEPA clean floors, partitions, ceilings, etc., which may have been soiled by the cleaning procedures before turnover to the Owner.

3.10 POST-PROJECT REPORT
   A. At the conclusion of this project, the contractor shall provide a report to the Architect indicating the following:
      1. Success of the cleaning project, as verified through visual inspection and wipe sampling.
      2. Areas of the system found to be damaged and/or in need of repair.
      3. “Before” and “after” cleaning test data for air handlers, ductwork and components.
      4. “Before” and “after” photographic evidence of conditions found in air handlers, ductwork and components.
      5. Marked up Contract Drawings indicating locations of Contractor installed ductwork access doors.
      6. A copy of each daily progress report.
      7. Mechanical Condition Reports (MCR) noting miscellaneous comments, recommendations, etc., concerning Contractor observations of damaged HVAC components.

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:
      2. New York State Department of Labor Rules and Regulations.
      3. Occupational Safety and Health Administration (OSHA).
      6. Local Codes and Ordinances.
      8. New York Board of Fire Underwriters.
      9. New York State Education Department “Manual of Planning Standards”.

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/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. 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 23 0515 - Mechanical 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 0515
MECHANICAL 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, ductwork 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:
   B. National Fire Protection Association:
      1. NFPA 70 - National Electrical Code.
   C. Underwriters Laboratories, Inc.:
      3. UL 1479 - Fire Tests of Through-Penetration Firestops.
   D. Mechanical Code 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 3300 - 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, jacketed cables, cable bundles, plastic pipes, sheet metal duct, and top of wall joints.

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.

D. Sleeves: 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: 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, ductwork, conduit 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 piping, ductwork, cables, etc., penetrates 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 pipe and tighten in place, in accordance with manufacturer's instructions.
   d. Interior Partitions: Seal pipe penetrations at mechanical rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

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 inch of edge of the firestop 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:
   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 firestop system manufacturer 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 firestop 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 firestop systems immediately and install new materials to produce systems complying with specified requirements.

END OF SECTION
SECTION 23 0516
EXPANSION FITTINGS AND FLEXIBLE CONNECTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Flexible pipe connectors.
B. Expansion compensators.
C. Manufactured pipe loops.

1.02 RELATED REQUIREMENTS

A. Section 23 2113 - Hydronic Piping.

1.03 REFERENCE STANDARDS

B. EJMA (STDS) - EJMA Standards; Tenth Edition.

1.04 SUBMITTALS

A. Product Data:
   1. Manufacturer's catalog sheets, specifications and installation instructions.
   2. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot (meter) and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
   3. Expansion Compensators: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

PART 2 PRODUCTS

2.01 FLEXIBLE PIPE CONNECTORS

A. Manufacturers:
   1. Flex-Hose Co., Inc.
   3. Keflex / Flex-Weld, Inc.

B. Design for a working pressure of 125 psig, when used in systems operating at pressures up to 125 psig, and for higher working pressures to correspond with the pressure in the piping for pressures over 125 psig.
   1. Furnish end fittings to correspond to the end connections of the piping in which installed.

C. Bronze Units: Fabricate of seamless flexible tin bronze tubing with a bronze wire braided outer jacketing of the same material as the tubing, silver brazed or welded to end fittings.

D. Stainless Steel Units: Fabricate of seamless flexible Type 321 steel tubing with a stainless steel wire braided outer jacketing of the same material as the tubing welded to steel end fittings.

2.02 MANUFACTURED PIPE LOOPS

A. Manufacturers:
   1. Flex-Hose Co., Inc.
   3. Approved Equal.

B. General: Manufacture pipe loops from three (3) equal length sections of annular corrugated bronze close-pitch hose with bronze over braid which will absorb or compensate for pipe movements in all 6 degrees of freedom simultaneously.

C. Design Criteria: Braided bronze loops must be suitable for operating temperatures up to 400 degrees F. Loops must be designed for pressure testing to 1-1/2 times their rated working
pressure and a minimum 4:1 (burst to working) safety factor. Each braided bronze loop must be individually leak tested by the manufacturer using a liquid dye-penetrant. Guarantee loops will be covered by the manufacturer’s 3 year full replacement warranty when installed in accordance with manufacturer’s specifications and installation instructions.

D. Fabrication: The corrugated metal hose, braids, fittings, and a copper ring-ferrule/band (material gauge not less than .032 inch) must be integrally seal-welded using a 100% circumferential oxy-acetylene process with phos-copper filler. End fittings shall be copper female sweat. Loops shall be prepared for shipment using a cut-to-length metal shipping bar, tacked securely between the elbows of the two (2) parallel legs, to maintain the manufactured length during shipping.

2.03 EXPANSION COMPENSATORS

A. Manufacturers:
   1. Flex-Hose Co., Inc.
   3. Keflex / Flex-Weld, Inc.

B. General: Provide shrouded bellows type with internal guides and limit stops.

C. Design Criteria: Design compensators for a 125 psig working pressure exterior to the bellows with a minimum compression stroke of 1-3/4 inches and 1/4 inch extension from the factory setting. Guarantee rate of life of compensators at not less than 10,000 full rated traverse cycles, when tested at 150 psig and 406 degrees F.

D. Fabrication: Compensators shall be multi-ply 18-8 chrome nickel stainless steel bellows for ferrous units and multi-ply seamless phosphor bronze for brass units. Furnish shrouds, end fittings, and internal trim of heavy carbon steel for stainless steel bellows units and brass for bronze bellows units. Furnish ferrous units of all welded construction and brass or bronze units of silver soldered (braze) construction. Provide a positive, internal anti-torque device as an integral part of each compensator and a positioning clip properly located to insure correct installation, so as to allow for full specified traverse movement.

2.04 GUIDES

A. Furnish guides designed for use with expansion compensators, the product as furnished by the compensator manufacturer or a qualified pipe hanger manufacturer as approved.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Install eliminators plumb in vertical piping and horizontally true in horizontal runs.

C. Do not use eliminators to compensate for misalignment between equipment and piping.

D. Install stainless steel units in ferrous piping and phosphor bronze units in non-ferrous piping.

E. Remove shipping bars from manufactured pipe loops and flexible pipe connectors prior to system start up.

END OF SECTION
SECTION 23 0553
MECHANICAL IDENTIFICATION

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Nameplates.
B. Tags.
C. Stencils.
D. Pipe markers.
E. Ceiling tacks.

1.02 RELATED REQUIREMENTS
A. Section 09 9000 - Painting and Coating.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. Product Data: Catalog sheets, specifications, and installation instructions for each item specified.

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 and permanent adhesive backing.
   2. Letter Height:
      a. Small hydronic and air handling equipment (i.e., pumps and small fans): 3/8 inch.
      b. Large hydronic and air handling equipment (i.e., chillers and air handlers): 3/4 inch.
   3. Name Plate Height:
      a. Small hydronic and air handling equipment (i.e., pumps and small fans): 3/4 inch.
      b. Large hydronic and air handling equipment (i.e., chillers and air handlers): 1-1/4 inch.
   4. Background Color: Black.

2.03 TAGS
A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch (40 mm) diameter.

2.04 STENCILS
A. Stencils: With clean cut symbols and letters of size as specified within this Section.
B. Stencil Paint: As specified in Section 09 9000, semi-gloss enamel, colors conforming to ANSI A13.1.

2.05 PIPE MARKERS AND ACCESSORIES
A. Snap-on Marker: One (1) piece wrap around type constructed of pre-coiled acrylic plastic with clear polyester coating, integral flow arrows, legend printed in alternating directions, 3/4” adhesive strip on inside edge, and 360 degree visibility.
B. Strap-on Marker: Strip type constructed of pre-coiled 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 inch to 1-1/4 inches:
      a. Letter size: 1/2 inch.
      b. Length of color field: 8 inches.
   2. Outside Diameter of Pipe or Insulation 1-1/2 inches to 2 inches:
      b. Length of color field: 8 inches.
   3. Outside Diameter of Pipe or Insulation 2-1/2 inches to 6 inches:
      b. Length of color field: 12 inches.
   4. Outside Diameter of Pipe or Insulation 8 inches and greater:
      a. Letter size: 2-1/2 inches.
      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.

2.06 UNDERGROUND PLASTIC PIPE MARKERS

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

2.07 PIPE SERVICE IDENTIFICATION TAGS

A. Type: No. 19 B&S gage brass, with 1/4 inch high pipe service abbreviated legend on one (1) 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.

2.08 VALVE SERVICE IDENTIFICATION TAGS

A. Type: No. 19 B&S gage brass, with 1/4 inch high pipe service abbreviated legend on one (1) 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 diameter round.

C. Fasteners: Brass "S" hook or brass jack chain of size as required for valve stem or handle to which tag is attached.

2.09 VALVE SERVICE IDENTIFICATION CHART FRAMES

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

2.10 CEILING TACKS

A. Description: Steel with 3/4 inch (20 mm) diameter color coded head.

B. Color code as follows:
   1. HVAC Equipment: Yellow.
2. Fire Dampers and Smoke Dampers: Red.

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, or stencil painting.
D. Stencils:
   1. Clean and prepare surfaces to be painted in accordance with specifications, paint manufacturer's approved product data sheets and printed label instructions.
   2. Cleaners: Use only approved products manufactured or recommended by finish paint manufacturer. Unless otherwise recommended by cleaner manufacturer, thoroughly rinse with clean water to remove surface contaminants and cleaner residue.
E. Protection: Cover and protect surfaces to be painted, adjacent surfaces not to be painted, and removed furnishings and equipment from existing paint removals, airborne sanding particles, cleaning fluids and paint spills using suitable drop cloths, barriers, and other protective devices.
   1. Schedule and coordinate surface preparations so as not to interfere with Work of other trades or allow airborne sanding dust particle to fall on freshly painted surfaces. Do not perform the Work of this Section until testing, insulation, and finish painting Work have been completed.
   2. Provide adequate natural or mechanical ventilation to allow surfaces to be prepared and painted in accordance with product manufacturer's instructions and applicable regulations.
   3. Provide and maintain "Wet Paint" signs, temporary barriers, and other protective devices as necessary to protect prepared and freshly painted surfaces from damages until Work has been accepted.

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: Install plastic nameplates on properly prepared and dry surface with adhesive and ensure permanent adhesion.
   1. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
C. Pipe and Valve Service Identification Tags:
   1. Install tags with "S" hooks and corrosion resistant chain.
D. Apply stencil painting as specified here within and in accordance with Section 09 9000.
E. Stick-On Pipe Markers:
   1. Install minimum of two (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 1” lap. Use plain banding tape on markers with integral flow arrows, and flow arrow banding tape on markers without integral flow arrows.
F. Underground Plastic Pipe Markers:
   1. Install 6” to 8” 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 Two (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.
      c. Valves in sprinkler and fire standpipe systems, except hose valves.
      d. Valves in heating, ventilating, air conditioning, and refrigeration systems.

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 inch 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 DUCTWORK IDENTIFICATION

A. Identify exposed ductwork, bare or insulated, directly connected to air handling apparatus, in the following spaces or rooms, by means of painted stenciled legends:
   1. Mechanical equipment.
   2. Steam service.
   3. Refrigeration machine.
   4. Boiler.
   5. Penthouse.

B. Locate stenciled legends to be readily visible from any point of observation. Stencil identification along center line of duct, close to equipment. Where view is unobstructed from two (2) directions, apply two (2) sets of stenciling (both sides), visible from each direction.


D. Include arrow indicating direction of air flow.

E. Ductwork Identification Legend:
   1. Outside Air: OA.
   2. Supply Air: SA.
   3. Return Air: RA.
   4. Exhaust Air: EXH.

F. Colors: Paint stenciled letters black. Where background is dark, paint stenciled letters white.

3.06 EQUIPMENT IDENTIFICATION

A. Identify uninsulated mechanical air handling equipment and fans by means of plastic nameplates:
B. Identify small fans and pumps by means of plastic nameplates:

C. Small inline pumps may be identified with tags equivalent as specified for pipe service.

D. Locations: Co-locate nameplates with manufacturer's equipment nameplates where readily visible. Where view of manufacturers nameplate is obstructed locate nameplate to be readily visible.

E. Identify insulated mechanical equipment by means of stenciled legends.
   2. Colors: Paint stenciled letters black. Where background is dark, paint stenciled letters white.
   3. Locations: Locate stencils to be readily visible from a reasonable point of view. Place identification along center line of equipment, if possible.

F. Equipment Identification Legend:
   1. Equipment identification shall match tags as scheduled on drawings.

3.07 CEILING TACKS

A. Provide ceiling tacks to locate valves, dampers, or equipment as specified above T-bar type panel ceilings.
   1. Locate in corner of panel closest to equipment.

3.08 APPLICATION OF PAINT

A. Stencil Painting: Apply with a brush or aerosol type spray can.

3.09 CLEANING

A. Clean adjacent surfaces of paint spatters resulting from the Work of this Section.

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. Sound measurement of equipment operating conditions.
E. Vibration measurement of equipment operating conditions.

1.02 REFERENCE STANDARDS


1.03 SUBMITTALS

A. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
B. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
1. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.
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. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
6. Units of Measure: Report data in I-P (inch-pound) units only.
7. Test Reports: Indicate data on AABC MN-1 forms, forms prepared following ASHRAE Std 111, or NEBB forms.
8. Include the following on the title page of each report:
   a. Name of Testing, Adjusting, and Balancing Agency.
   b. Address of Testing, Adjusting, and Balancing Agency.
   c. Telephone number of Testing, Adjusting, and Balancing Agency.
   d. Project name.
   e. Project location.
   f. Project Architect.
   g. Project Engineer.
   h. Project Contractor.
   i. Project altitude.
   j. Report date.
C. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

D. Perform cleaning and testing Work in the presence of the Owner's Representative.

E. 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.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Regulatory Requirements: Perform factory testing of factory fabricated equipment in complete accordance with the agencies having jurisdiction.

B. Perform total system balance in accordance with one of the following:
   1. AABC (NSTSB), AABC National Standards for Total System Balance.
   4. SMACNA (TAB).
   5. Maintain at least one copy of the standard to be used at project site at all times.

C. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

D. TAB Agency Qualifications:
   1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
   2. Having minimum of 3 years documented experience.
   3. Certified by one of the following:
      b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.

E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

F. Furnish AABC National Performance Guaranty for this project.

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. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of Work means acceptance of existing conditions.

3.03 PREPARATION
A. Hold a pre-balancing meeting at least 1 week prior to starting TAB work.
   1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.
C. Provide additional balancing devices as required.

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

3.05 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. At final inspection, re-check random selections of data recorded in report. Re-check points or areas as selected and witnessed by the Owner.

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. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches (12.5 Pa) positive static pressure near the building entries.

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 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.
   7. Starter size, rating, heater elements.
   8. Sheave Make/Size/Bore.
   9. Rotation.

B. V-Belt Drives:
   1. Identification/location.
   2. Required driven RPM.
   3. Driven sheave, diameter and RPM.
   4. Belt, size and quantity.
   5. Motor sheave diameter and RPM.
   6. Center to center distance, maximum, minimum, and actual.

C. 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.
10. Total operating head pressure.

D. Combustion Equipment:
1. Manufacturer.
2. Model number.
3. Serial number.
4. Firing rate.
5. Overfire draft.
6. Gas meter timing dial size.
7. Gas meter time per revolution.
8. Gas pressure at meter outlet.
13. Percent carbon dioxide (CO2).
14. Percent oxygen (O2).
15. Percent excess air.
16. Flue gas temperature at outlet.
17. Ambient temperature.
18. Net stack temperature.
20. Percent combustion efficiency.

E. Air Cooled Condensers:
1. Identification/number.
2. Location.
3. Manufacturer.
4. Model number.
5. Serial number.
6. Entering DB air temperature, design and actual.
7. Leaving DB air temperature, design and actual.
8. Number of compressors.

F. Cooling Coils:
1. Identification/number.
2. Location.
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. Saturated suction temperature, design and actual.
15. Air pressure drop, design and actual.

G. Heating Coils:
1. Identification/number.
2. Location.
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.

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.
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.
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.
10. Number of Belts/Make/Size.
11. Fan RPM.

K. Terminal Unit Data:
1. Manufacturer.
2. Type, constant, variable, single, dual duct.
3. Identification/number.
4. Location.
5. Model number.
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 09 9000 - Painting and Coating.
B. Section 23 0515 - Mechanical Firestopping.
C. Section 23 0553 - Mechanical Identification.

1.03 REFERENCE STANDARDS
H. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).

1.04 SUBMITTALS
A. Product Data: Manufacturer's catalog cuts sheets, specifications, and installation instructions for the following:
   1. Insulation materials.
   2. Jacket materials.
B. Materials Schedule: Itemize insulation materials and thicknesses for each specified application in Insulation Material Schedules in Part 3 of this Section. Where optional materials are specified, indicate the option selected.

1.05 QUALITY ASSURANCE
A. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of experience.
B. Regulatory Requirements:
   1. Insulation installed inside buildings, including duct lining materials, laminated jackets, mastics, sealants, and adhesives shall have a Fire Spread/Smoke Developed Rating of 25/50 or less based on ASTM E 84.

1.06 FIELD CONDITIONS
A. Maintain ambient temperatures and conditions required by manufacturers of insulations, adhesives, mastics, and insulation cements.
B. Maintain temperature before, during, and after installation for minimum period of 24 hours.
PART 2 PRODUCTS

2.01 FIBROUS GLASS INSULATION

A. Composed principally of fibers manufactured from rock, slag, or glass, with or without binders, and asbestos free.

B. Manufacturers:

C. Type 'A' Insulation: ASTM C 553; Flexible Blanket.
   1. 'K' (‘Ksi’) value: 0.31 at 75 degrees F (0.045 at 24 degrees C), when tested in accordance with ASTM C518.

D. Type 'B' Insulation: ASTM C 612; Rigid Board.
   1. 'K' value: 0.26 at 75 degrees F, when tested in accordance with ASTM C 518.
   2. Maximum Service Temperature: 450 degrees F.
   3. Minimum Density: 3.0 pcf or 6.0 pcf as specified.

E. Type 'C' Insulation: ASTM C 1071; Thermal and Acoustic Duct Liner Board Insulation.
   1. 'K' value: 0.27 at 75 degrees F, when tested in accordance with ASTM C 518.
   2. Maximum Service Temperature: 250 degrees F.
   4. Erosion, temperature, and fire resistant type; NFPA 90-A and 90-B.
   5. Minimum Noise Reduction Coefficients:
      a. 1/2 Inch Thickness: 0.30.
      b. 1 Inch Thickness: 0.45.
      c. 1-1/2 Inch Thickness: 0.60.

2.02 INSERTS

A. High Density Jacketed Insulation Inserts for Hangers and Supports:
   1. For Use with Fibrous Glass Insulation: ASTM C 612 Fibrous Glass Board.
      a. 'K' value: 0.26 at 75 degrees F, when tested in accordance with ASTM C 518.

2.03 JACKETS

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

2.04 ADHESIVES, MASTICS, AND SEALERS

B. Vapor Seal Adhesive (Fibrous Glass Insulation): Childers' CP-82, Epolux's Cadoprene 400, Foster's 85-75 or 85-20.
C. Vapor Barrier Mastic/Joint Sealer (Fibrous Glass Insulation): Childers' CP-30, Epolux's Cadalar 670, Foster's 95-44 or 30-35.

2.05 MISCELLANEOUS MATERIALS

A. Insulation Fasteners Manufacturers:
   1. Manufacturers:
      a. Duro-Dyne Corporation.
      b. Erico Fastening Systems, Inc.
c. Carlisle Hardcast, Inc.

2. Fastener Type: Galvanized steel, impact applied or welded with integral head, complete with self-locking insulation retaining washers.

B. Pressure Sensitive Tape for Sealing Laminated Jackets:
   1. Manufacturers:
      a. Alpha Associates.
      b. Childers.
      c. Morgan Adhesive.
   2. Tape Type: Same construction as jacket.

C. Metal Corner Angles: Galvanized steel, 2 inch x 2 inch x 28 gauge.

D. Reinforcing Membrane Manufacturers:
   1. Alpha Associates Style 59.
   2. Childers' Chil-Glas.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

A. General:
   1. Install the Work of this Section in accordance with manufacturer's printed installation instructions unless otherwise specified.
   2. All ductwork shall be thermally insulated in accordance with the New York State Energy Conservation Code and NAIMA National Insulation Standards.
   3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
   4. Insulate ducts prior to erection in place when ducts are required to be installed proximate to walls, ceilings, equipment or other ductwork which will not permit adequate space for installation of insulation after ducts are installed.

B. Fibrous Glass Board Insulation Application:
   1. Secure insulation to ductwork with insulation fasteners spaced 3" in from all corners of ducts, with intermediate fasteners at maximum 16" centers in all directions.
   2. Butt edges of insulation and fill voids with similar insulation.
   3. Seal longitudinal jacket laps continuously with vapor seal adhesive minimum 1-1/2 inch wide.
   4. Lap circumferential joints with 4 inch wide jacket material and seal laps continuously with vapor barrier adhesive or 3 feet wide pressure sensitive sealing tape.
   5. Install metal corner angles over the jacketed insulated corners. Seal exposed ends of insulation with vapor barrier mastic.
   6. Vapor seal breaks in vapor barrier jacketing, exposed surfaces of duct insulation fasteners, and metal corner angles with pressure sensitive sealing tape or coat with vapor barrier mastic.
   7. Field apply 6 oz. canvas jacket over the vapor barrier jacketed insulation where indicated on Schedule of Ductwork Insulation in this Section.
      a. Apply canvas jacket with lagging adhesive with a 2 inch lap on all seams.
      b. Use outward clinching staples for additional securement of canvas to bottom of ducts LAMINA in excess of 48 inch width.
      c. Apply heavy coat of lagging adhesive to entire canvas surface.
   8. Place trapeze hangers outside of jacketed insulated ducts.
a. Install high density insulation inserts, of thickness equal to insulation minimum of 4 inch width by the bottom dimension of the duct at points of support.
b. Continuously jacket insulated ducts and filler pieces through supports.

C. Fibrous Glass Blanket Insulation Application:
   1. Cut insulation to stretch-out dimensions as recommended by insulation manufacturer.
   2. Remove 2 inch wide strip of insulation material from the jacketing on the longitudinal and circumferential joint edges to form and overlapping flap. Install insulation with jacketing outside so flap overlaps insulation and jacketing on other end.
   3. Butt ends of insulation tightly together. Do not compress insulation at duct corners on rectangular or square ductwork.
   4. Staple joints with outward clinching staples minimum 6 inches on center and seal with pressure sensitive sealing tape.
   5. Cut off protruding ends of fasteners flush with insulation surface and seal with pressure sensitive sealing tape.
   6. Seal any tears, punctures, and penetrations of insulation jacketing with sealing tape.
   7. Insulation fasteners:
      a. Install duct insulation fasteners on bottom side of horizontal duct runs when bottom dimension of the duct is in excess of 24 inches.
      b. Install duct insulation fasteners on sides of duct risers having a dimension in excess of 24 inches.
      c. Evenly space fasteners where required maximum of 16 inches on center in all directions.

D. Duct Liner Application:
   1. Adhere insulation with adhesive for 90% coverage only where mechanical fasteners can not be used due to space or size constraints.
   2. Secure insulation with mechanical liner fasteners. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for spacing.
   4. Seal liner surface penetrations with adhesive.
   5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.03 SCHEDULE OF DUCTWORK INSULATION

A. Exhaust Ducts within 10 Feet of Exterior Openings:
   1. Type ‘A’ Flexible Blanket: Ducts up to 18” wide
      a. Minimum Thickness: 2 inch.
      b. Minimum R value: R-6
      c. Jacket Type: Type I or II
   2. Type ‘B’ Rigid Board: Ducts over 18” wide
      c. Jacket Type: Type I or Type II

B. 100% Outside Air Ducts:
   1. Concealed inside building envelope in unconditioned spaces:
      a. Type ‘A’ Flexible Blanket: Ducts up to 18” wide
         1) Minimum Thickness: 2 inches.
         3) Jacket Type: Type I or Type II.
      b. Type ‘B’ Rigid Board: Ducts over 18” wide
         1) Minimum Thickness: 1-1/2 inches.
         3) Jacket Type: Type I or Type II.
   2. Exposed inside building envelope:
a. Type ‘B’ Rigid Board.
   1) Minimum Thickness: 1-1/2 inches.
   3) Jacket Type: Type I with Canvas Outer Jacket.

C. Air Conditioning Supply and Return; Heating Supply and Return:
   1. Concealed inside building envelope in unconditioned spaces:
      a. Type ‘A’ Flexible Blanket: Ducts up to 18” wide
         1) Minimum Thickness: 2 inches.
         3) Jacket Type: Type I or Type II.
      b. Type ‘B’ Rigid Board: Ducts over 18” wide
         1) Minimum Thickness: 1-1/2 inches.
         3) Jacket Type: Type I or Type II.
   2. Exposed inside building envelope in unconditioned spaces and mechanical rooms:
      a. Type ‘B’ Rigid Board.
         1) Minimum Thickness: 1-1/2 inches.
         3) Jacket Type: Type I with Canvas Outer Jacket.
   3. Exposed inside building envelope in conditioned spaces:
      a. Uninsulated unless otherwise indicated on Drawings.

D. Air Conditioning Supply and Return; Heating Supply and Return:
   1. Inside building envelope, exposed to outside air (i.e., ventilated attic):
      a. Type ‘A’ Flexible Blanket: Ducts up to 18” wide.
         1) Minimum Thickness: 4 inches.
         2) Minimum R value: R-12.
         3) Jacket Type: Type I or Type II.
      b. Type ‘B’ Rigid Board: Ducts over 18” wide.
         1) Minimum Thickness: 3 inches.
         2) Minimum R value: R-12.
         3) Jacket Type: Type I or Type II.

END OF SECTION
SECTION 23 0719
PIPING AND EQUIPMENT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Piping insulation.
B. Equipment insulation.
C. Jackets and accessories.

1.02 RELATED REQUIREMENTS
A. Section 23 0515 - Mechanical Firestopping.
B. Section 23 0553 - Mechanical Identification.
C. Section 23 2113 - Hydronic Piping.
D. Section 23 2300 - Refrigerant Piping.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. Product Data: Manufacturer's catalog cut sheets, specifications, and installation instructions for the following:
   1. Insulation Materials.
B. Materials Schedule: Itemize insulation materials and thicknesses for each specified application in Insulation Material Schedules in Part 3 of this Section. Where optional materials are specified, indicate the option selected.

1.05 QUALITY ASSURANCE
A. Applicator Qualifications: Company specializing in performing the type of Work specified in this Section, with minimum five years of documented experience.
B. 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 E84 or UL 723.
1.06 FIELD CONDITIONS

A. Maintain ambient temperatures and conditions required by manufacturers of insulations, adhesives, mastics, and insulation cements.

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:
      b. Knauf Fiber Glass.
      c. Owens Corning Corporation.
   2. Preformed Pipe Insulation: Minimum density 3 pcf; ASTM C 547:
      a. Class 1 (Suitable for Temperatures Up to 450 degrees F): 'K' (‘Ksi’) value of 0.24 at 75 degrees F (____ at 24 degrees C).
      b. Class 2 (Suitable for Temperatures 451 to 650 degrees F): 'K' value of 0.46 at 300 degrees F.
      c. Class 3 (Suitable for Temperatures 651 to 1200 degrees F): 'K' value of 0.56 at 300 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. Flexible Elastomeric Foam Insulation:
   1. Manufacturers:
      a. Armacell Engineered Foams.
      b. Rubatex Corporation.
      c. Enviro-tec Corporation.
   2. Preformed Pipe and Fitting Insulation: ASTM C 534, Type I.
   3. FM tested and approved, meeting the following:
      a. Maximum Water Vapor Transmission: 0.10 perm-inch based on ASTM E 96, Procedure A.
      b. K of 0.27 at 75 degrees F based on ASTM C 518 or C 177.
      c. Fire Spread/Smoke Developed Rating: 25/50 or less based on ASTM E 84.
   4. Polyethylene and polyolefin insulation is not acceptable.

C. High Density Jacketed Insulation Inserts for Hangers and Supports:
   1. Manufacturers:
      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.
   3. For Use with Flexible Elastomeric Foam Insulation: Hardwood dowels and blocks, length or thickness equal to insulation thickness, other dimensions as required.
D. Cements:
   2. Fibrous Glass Hydraulic Setting Thermal Insulating and Finishing Cement: ASTM C 449/C 449M.

2.02 EQUIPMENT 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:
      b. Knauf Fiber Glass.
      c. Owens Corning Corporation.
   2. Block or Board Insulation: Minimum density 3.0 pcf and 6.0 pcf as specified; ASTM C 612:
      a. Type IA or IB (Suitable for Temperatures Up to 450 degrees F): K of 0.26 at 75 degrees F.
      b. Type II (Suitable for Temperatures 451 to 850 degrees F): K of 0.44 at 300 degrees F.
      c. Type III (Suitable for Temperatures 851 to 1000 degrees F): K of 0.44 at 300 degrees F.
      d. Type IV (Suitable for Temperatures 1001 to 1200 degrees F): K of 0.37 at 300 degrees F.
      e. Type V (Suitable for Temperatures 1201 to 1800 degrees F): K of 0.42 at 300 degrees F.

B. Flexible Elastomeric Foam Insulation:
   1. Manufacturers:
      a. Armacell Engineered Foams.
      b. Rubatex Corporation.
      c. Enviro-tec Corporation.
   2. FM tested and approved, meeting the following:
      a. Maximum Water Vapor Transmission: 0.10 perm-inch based on ASTM E96/E96M, Procedure A.
      b. K of 0.27 at 75 degrees F based on ASTM C518 or ASTM C177.
      c. Fire Spread/Smoke Developed Rating: 25/50 or less based on ASTM E84.
   4. Polyethylene and polyolefin insulation is not acceptable.

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.
   2. Type II: Reinforced aluminum foil and kraft laminate with foil facing out.
   3. Laminated vapor jackets are not required for flexible elastomeric foam insulation.

B. Premolded PVC Fitting and Piping Jackets:
   1. Constructed of high impact, UV resistant PVC.
      a. ASTM D 1784, Class 14253-C.
      b. Working Temperature: 0 to 150 degrees F.

2.04 ADHESIVES, MASTICS, AND SEALERS
B. Vapor Seal Adhesive (Fibrous Glass Insulation): Childers’ CP-82, Epolux's Cadoprene 400, Foster's 85-75 or 85-20.
C. Vapor Barrier Mastic/Joint Sealer (Fibrous Glass Insulation): Childers’ CP-30, Epolux’s Cadalar 670, Foster's 95-44 or 30-35.

D. Adhesive (Flexible Elastomeric Foam): Armstrong's 520, Childers' CP-80, Epolux's Cadoprene 488, Foster's 82-40.

E. Adhesive (Reinforcing Membrane): Childers’ Chil-Spray WB CP-56.

F. Mastic (Reinforcing Membrane): Childers' AK-CRYL CP-9.

G. Sealant (Metal Pipe Jacket): One-part silicone sealant for high temperatures; Dow Corning’s Silastic 736 RTV or General Electric’s RTV 106.

2.05 MISCELLANEOUS MATERIALS

A. Insulation Fasteners:
   2. Type: Weld pins, complete with self-locking insulation retaining washers.

B. Pressure Sensitive Tape for Sealing Laminated Jackets:
   2. Type: Same construction as jacket.

C. Wire, Bands, and Wire Mesh:
   1. Binding and Lacing Wire: Nickel copper alloy or copper clad steel.
   2. Bands: Galvanized steel, 1/2 inch wide x 0.015 inch thick, with 0.032 inch thick galvanized wing seals.
   3. Wire Mesh: Woven 20 gauge steel wire with 1 inch hexagonal openings, galvanized after weaving.

D. Reinforcing Membrane: Glass or Polyester, 10 x 10 mesh. Alpha Associates Style 59, Childers Chil-Glas, Foster’s MAST-A-FAB.

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. Piping being installed exposed to interior space shall be installed with with a PVC jacketing.

C. All piping serving as part of a heating or cooling system shall be thermally insulated in accordance with the New York State Energy Conservation Code and NAIMA National Insulation Standards.

D. 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 23 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.

E. Individual piping runs shall have consistent insulation type.

F. 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 insulation is subject to compression at points over 180 degrees apart (i.e., riser clamps, U-bolts, or trapezes, fully encircle pipe with two (2) protection shields and two (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 inches and larger.
   2. Insulation Inserts for Use with Flexible Elastomeric Foam Insulation:
      a. Where clevis hangers are used, install insulation shields with hardwood filler pieces, same thickness as adjoining insulation, inserted in undersized die cut or slotted holes in insulation at support points.
      b. Where hardwood blocks are used, contour to match the curvature of pipe, and shield.
      c. Coat dowels and blocks with insulation adhesive, and insert while still wet.
      d. Vapor seal outer surfaces of dowels and blocks with adhesive after insertion.
      e. Provide minimum two (2) dowels plugs or one filler block per hanger.

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 inches wide self-sealing longitudinal jacket laps and 3 inch wide butt adhesive backed strips, or 3 inches 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 feet.
      b. Vertical Pipe Runs: 9 feet.

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 two (2) flood coats of vapor barrier mastic, each 1/8” 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 1-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. 2 Inch Piping Size and Smaller: 4 oz./square yard unless otherwise specified.
   2. Over 2 Inch Size for Piping: 6 oz./square yard 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 inch wide longitudinal jacket laps and 3 inch wide butt strips of same material as jacket, with outward clinching staples on maximum 4 inches 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 inch 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 four (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 1-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 INSTALLATION OF FIBROUS GLASS EQUIPMENT INSULATION:
A. Secure fibrous glass block or board insulation in place with wire or galvanized steel bands.
   1. Small Areas: Secure insulation with 16 gauge wire on maximum 6” centers.
   2. Large Areas: Secure insulation with 14 gauge wire or .015 inch thick x 1/2 inch wide galvanized steel bands on maximum 10 inch centers. Stagger insulation joints.
   3. Irregular Surfaces: Where application of block or board insulation is not practical, insulate with insulating cement built-up to same thickness as adjoining insulation.
B. Stretch wire mesh over entire insulated surface and secure to anchors, with wire edges laced together.
C. Apply finishing cement a total of 1/4 inch thick. Point up joints and breaks, fill voids, and smooth entire insulation surface.
D. Neatly bevel insulation around manholes, handholes, cleanouts, ASME stamp, manufacturer’s name and catalog numbers.
E. Surface finish: Apply 6 oz. canvas with full coat of lagging cement.

3.07 INSTALLATION OF FLEXIBLE ELASTOMERIC FOAM INSULATION
A. Slit insulation and install over pipe. Seal longitudinal and butt joints with adhesive.
B. Insulate fittings and valves with miter cut sections. Use templates provided by the manufacturer and assemble the cut sections in accordance with the manufacturer's printed instructions. Insulate threaded fittings and valves with sleeved fitting covers. Overlap and seal the covers to the adjoining pipe insulation with adhesive.
C. Carefully mate and seal with adhesive all contact surfaces to maintain the integrity of the vapor barrier system.
D. Insulated Covers for Pumps: Do not extend pump insulation beyond or interfere with stuffing boxes, or interfere with adjustment and servicing of parts requiring regular maintenance or operating attention.
E. Piping Exposed to the Elements:
   1. Apply flexible elastomeric foam insulation to piping with adhesive.
   2. Apply reinforcing membrane around piping insulation with adhesive or mastic.

3.08 SCHEDULE OF PIPING AND EQUIPMENT INSULATION
A. Insulate all cold service and hot service piping, equipment, and appurtenances except where otherwise specified.
B. Hot Service Piping Insulation Schedule:
   1. Heating Water/Glycol Supply and Return:
      a. Fibrous Glass Insulation:
         1) Up to and including 1-1/2 inch pipe size - Insulation thickness = 1-1/2 inches.
         2) Larger than 1-1/2 inch pipe size - Insulation thickness = 2 inches.
   C. Cold Service Piping Insulation Schedule:
      1. Refrigerant Piping Insulation:
         a. Flexible Elastomeric Insulation:
            1) Up to and Including 1 inch pipe size - Insulation thickness = 1-1/2 inches.
            2) 1-1/4 inch and larger pipe size - Insulation thickness = 1-1/2 inches.
   D. Equipment Insulation Schedule:
      1. Insulation thickness specified above for piping also apply for flat, curved, and irregular equipment surfaces.
      2. Insulate equipment with fibrous glass board insulation with minimum density 6 pcf.
3. Insulate base mounted pumps and unitary pumps and other equipment specified serving chilled water/glycol or dual temperature systems with 3/4 inch thick sheet flexible elastomeric foam insulation.

E. Do not insulate the following hot service items:
   1. Piping inside convector, cabinet heater, and fin tube radiation enclosures.
   2. Drains from heating equipment and appurtenances that flow to waste.
   3. Water and other fluids 81 degrees F to 104 degrees F.
   5. Discharge piping from steam safety and water relief valves.
   6. Vent piping to atmosphere.
   7. Flanges and unions.
   8. Hydronic specialties: flow indicators, zone control valves, air vents, and air control fittings.
   9. Steam traps and cooling legs of steam traps.
  10. Pressure reducing valves and pilot lines.
  11. Safety, relief, and back pressure valves.
  12. Float chambers and level controllers.
  14. Vacuum pumps and vacuum pump receiving tanks.
  15. Condensate pumps and condensate pump receivers.
  16. Hot water pumps.
  17. Boiler return pumps.
  18. Fuel oil and chemical feed pumps.
  19. Condenser water pumps.
  21. Gas meters and boiler feed water meters.
  22. Equipment manholes, handholes, and cleanouts.

F. Do not insulate the following cold service items:
   1. Actual heat transfer surfaces.
   2. Flexible vibration isolators.
   3. Boiler water treatment equipment and piping.
   5. Chemical feed piping.

G. Do not insulate any equipment with a factory applied insulated steel jacket.

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. Radiant heating piping system.
   1. Pipe hangers and supports.
   2. Unions, flanges, mechanical couplings, and dielectric connections.
E. Valves:
   1. Globe or angle valves.
   2. Ball valves.
   4. Check valves.

1.02 RELATED REQUIREMENTS
A. Section 08 3100 - Access Doors and Panels.
B. Section 23 0516 - Expansion Fittings and Flexible Connections.
C. Section 23 0515 - Mechanical Firestopping.
D. Section 23 0553 - Mechanical Identification.
E. Section 23 0719 - Piping and Equipment Insulation.
F. Section 23 2114 - Hydronic Specialties.
G. Section 23 2500 - HVAC Water Treatment.

1.03 REFERENCE STANDARDS
B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
C. ASME B31.9 - Building Services Piping; 2014.
A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

B. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

C. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.

D. Provide pipe hangers and supports in accordance with ASME B31.9 unless indicated otherwise.

E. Use ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

F. Use globe valves for throttling, bypass, or manual flow control services.

G. Use plug cocks for throttling service. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.

H. Use butterfly valves in heating water systems interchangeably with gate and globe valves.

I. Use lug end butterfly valves to isolate equipment.

J. Use 3/4 inch (20 mm) ball valves with hose bibb and cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

1.05 SUBMITTALS

A. See Section 01 3300 - Submittal Procedures for submittal process.

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 catalogue 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. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and shall be specifically identified with the applicable style or series number.

E. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.06 QUALITY ASSURANCE

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

B. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.

C. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum 5 years of experience.

D. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.

E. 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.

F. Welder Qualifications: Certify in accordance with ASME BPVC-IX.

1.07 REGULATORY REQUIREMENTS
A. Conform to ASME B31.9 code for installation of piping system.
B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
C. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.
D. Perform field testing of piping systems in complete accordance with the local utilities and any other agencies having jurisdiction, New York State Mechanical Code, and ASME Code for Pressure Piping B31.

1.08 DELIVERY, STORAGE, AND HANDLING
A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
C. 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, above ground outdoors, and as approved by Architect.
      b. Use rigid joints unless otherwise indicated.
   4. Provide pipe hangers and supports in accordance with ASME B31.9 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.

2.02 HEATING WATER AND GLYCOL PIPING, ABOVE GRADE
A. Steel Pipe up to and including 2-1/2 inch ASTM A53, Schedule 40, black.
   1. Fittings: ASTM B16.3, malleable iron or Class 125 cast iron threaded.
B. Steel Pipe 3" up to and including 10 inch ASTM A53, Schedule 40, black.
   1. ASTM A 234/A 234M, wrought steel buttwelding type fittings or ASTM A 536 malleable iron mechanical coupling.
   2. Joints: AWS D1.1 welded or grooved mechanical coupling.
C. Copper Tube up to and including 2 inch: ASTM B 88 (ASTM B 88M), Type L (B), drawn.
   2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
3. Joints: Solder, lead free, 95-5 tin-antimony, or tin and silver.

2.03 RADIANT HEATING PIPING

A. Polyethylene Pipe: ASTM F876 or ASTM F877, cross-linked polyethylene, 100 psig (690 kPa) operating pressure at 180 degrees F (82 degrees C).
   1. Fittings: Brass and copper.
   2. Joints: Mechanical compression fittings.

2.04 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
B. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch (13 to 38 mm): Malleable iron, adjustable swivel, split ring.
C. Hangers for Hot Pipe Sizes 2 to 4 Inches (50 to 100 mm): Carbon steel, adjustable, clevis.
D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
E. Wall Support for Pipe Sizes to 3 Inches (76 mm): Cast iron hook.
F. Vertical Support: Steel riser clamp.
G. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
H. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
I. 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.
J. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

2.05 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe 2 Inches (50 mm) and Less:
   1. Ferrous Piping: 150 psig (1034 kPa) malleable iron, threaded.
   2. Copper Pipe: Bronze, soldered joints.
   3. Unions are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as unions and disconnect points.)
B. Flanges for Pipe 2 Inches (50 mm) and Greater:
   1. Flange Adapters for Steel Piping or Copper Tubing: Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components.
   2. Mechanical Couplings for Grooved and Shouldered Joints: Two (2) curved housing segments with continuous key to engage pipe groove, circular pressure-responsive 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. Housing Clamps: Malleable iron to engage and lock, designed to permit some angular deflection, contraction, and expansion.
   5. Gasket Material: EHP suitable for operating temperature range from -30 degrees F to 250 degrees F; EPDM suitable for operating temperature range from -30 degrees F (-34 degrees C) to 230 degrees F (110 degrees C).
   7. When pipe is field grooved, provide coupling manufacturer's grooving tools.
   8. Couplings:
a. Copper Tubing: Couplings shall be manufactured to copper-tube dimensions. (Flaring tube or fitting ends to IPS dimensions is not permitted.) Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity, coated with copper-colored enamel. Couplings shall be installation-ready, designed for direct stab installation onto roll grooved copper tube without prior field disassembly and no loose parts. Grade ‘EHP’ EPDM gasket suitable for hot water up to +250 degrees F. Victaulic QuickVic™ Style 607 coupling or approved equal.

b. Steel Piping to 12 Inches:
   1) Rigid Type: Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.
      (a) 2 Inches through 8 Inches: Installation-Ready, designed for direct stab installation without prior field disassembly and no loose parts, Grade ‘EHP’ EPDM gasket rated to +250 degrees F. Victaulic QuickVic™ Style 107H coupling or approved equal.
      (b) 10 Inches and 12 Inches: Standard rigid coupling with Grade ‘E’ EPDM gasket rated to +230 degrees F. Victaulic Style 07 coupling or approved equal.
   2) Flexible Type: For use in locations where vibration attenuation and stress relief are required, and in lieu of a flexible connector.
      (a) 2 Inches through 8 Inches: Installation-Ready, designed for direct stab installation without prior field disassembly and no loose parts, Grade ‘EHP’ EPDM gasket rated to +250 degrees F. Victaulic QuickVic™ Style 177 coupling or approved equal.
      (b) 10 Inches and 12 Inches: Standard flexible coupling with Grade ‘E’ EPDM gasket rated to +230 degrees F. Victaulic Style 77 coupling or approved equal.

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.

2.06 GLOBE OR ANGLE VALVES

A. Manufacturers:

B. Up To and Including 2 Inches (50 mm):
   1. Bronze body, bronze trim, screwed bonnet, rising stem and handwheel, inside screw with backseating stem, renewable composition disc and bronze seat, solder ends.

C. Over 2 Inches (50 mm):
   1. Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, rotating plug-type disc with renewable seat ring and disc, flanged ends.

2.07 BALL VALVES

A. Manufacturers:

B. Up To and Including 2 Inches (50 mm):
   1. Bronze one piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.
   2. Forged brass 2-piece body, chrome plated brass ball and stem, TFE seats, fluoroelastomer seals, lever handle, with hydraulic press fitting ends.

C. Over 2 Inches (50 mm):
   1. Ductile iron body, chrome plated stainless steel ball, teflon seat and stuffing box seals, lever handle, flanged ends, rated to 800 psi (5515 kPa).
   2. 800 psig (5515 kPa) CWP, ductile iron, two piece body, chrome plated steel or stainless steel ball, regular port, PTFE seats, fluoroelastomer seals, blow-out proof stem, lever handle or gear operator, with grooved ends.

2.08 BUTTERFLY VALVES

A. Manufacturers:

B. Body: Cast or ductile iron with resilient replaceable EPDM seat, (pressure responsive in sizes through 12 inches), wafer or grooved ends, extended neck.

C. Disc: Construct of aluminum bronze, stainless steel, or electroless-nickel plated ductile iron.

D. Stem: Stainless steel. (Stem shall be offset from the disc centerline to provide full 360-degree circumferential seating.)

E. Operator: 10 position lever handle.

2.09 SPRING LOADED CHECK VALVES

A. Manufacturers:

B. 300 psi CWP, ductile iron body, stainless steel spring and shaft, with EPDM or Nitrile seals, grooved ends.
   1. 14 Inches through 24 Inches, valve with AGS grooves and rated to 230 psig.

C. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

PART 3 EXECUTION

3.01 PREPARATION

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

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

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

D. Prepare piping connections to equipment using jointing system specified.

E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

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

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.
   1. Grooved Piping:
a. Pipe ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. The gasket style and elastomeric material shall be verified as suitable for the intended service as specified. A factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. Factory trained representative shall periodically visit the job site and review the product installation.

B. Route piping in orderly manner, parallel to building structure, and maintain gradient.
C. Install piping to conserve building space and to avoid interfere with use of space.
D. Group piping whenever practical at common elevations.
E. Sleeve pipe passing through partitions, walls and floors.
F. Slope piping and arrange to drain at low points.
G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 0516.

H. 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.

I. 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.

J. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Support horizontal piping as scheduled.
   3. Size hangers for outside dimension of piping insulation.
   4. Install hangers to provide minimum 1/2 inch (13 mm) space between finished piping insulation covering and adjacent work.
   5. Place hangers within 12 inches (300 mm) of each horizontal elbow.
   6. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   7. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   8. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   9. Provide copper plated hangers and supports for copper piping.

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

L. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 3100.

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

N. Install valves with stems upright or horizontal, not inverted.

3.03 PRESSURE TESTS
A. 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.
B. Take measures to protect all personnel from the potential of future of components during testing of systems.
C. Hydrostatically pressure test piping in accordance with New York State Mechanical Code Section 1208 and ASME Code for Pressure Piping B31.9 Building Services Piping Chapter IV.

D. Circulating water systems, including propylene glycol solution systems and cold water make-up piping connections to heating, ventilating, air conditioning and refrigeration systems, unless otherwise specified:
   1. Before final connections are made perform hydrostatic test at 1-1/2 times the maximum system design pressure, but not less than 100 psig, for not less than 15 minutes.
   2. After final connections are made perform hydrostatic retest at a pressure equal to maximum operating system design pressure, but not less than 30 psig, for 4 hours.

E. Equipment and Appurtenances:
   1. Hot Water Boilers: Perform hydrostatic test at 30 psig, after installation, with piping connections shut-off.
   2. Relief Valves: Increase pressure in equipment or apparatus to relief valve setting, to test opening of valves at required relief pressures.

3.04 SCHEDULES

A. Hanger Spacing for Copper Tubing.
   1. 1/2 inch (15 mm) and 3/4 inch (20 mm): Maximum span, 5 feet (1500 mm); minimum rod size, 1/4 inch (6 mm).
   2. 1 inch (25 mm) and 1-1/4 inch: Maximum span, 6 feet (1800 mm); minimum rod size, 1/4 inch (6 mm).
   3. 1-1/2 inch (40 mm) and 2 inch (50 mm): Maximum span, 8 feet (2400 mm); minimum rod size, 3/8 inch (9 mm).

B. Hanger Spacing for Steel Piping.
   1. 1/2 inch (15 mm), 3/4 inch (20 mm), and 1 inch (25 mm): Maximum span, 7 feet (2100 mm); minimum rod size, 1/4 inch (6 mm).
   2. 1-1/4 inches (32 mm): Maximum span, 8 feet (2400 mm); minimum rod size, 3/8 inch (9 mm).
   3. 1-1/2 inches (40 mm): Maximum span, 9 feet (2700 mm); minimum rod size, 3/8 inch (9 mm).
   4. 2 inches (50 mm): Maximum span, 10 feet (3.0 m); minimum rod size, 3/8 inch (9 mm).
   5. 2-1/2 inches (65 mm): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (9 mm).
   6. 3 inches (80 mm) and over: Maximum span, 12 feet (3.6 m); minimum rod size, 3/8 inch (9 mm).

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. Triple Duty Valves.
F. Balancing valves.
G. Relief valves.
H. Glycol system.

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

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

1.04 SUBMITTALS
A. Product Data: Manufacturer's catalog sheets, specifications, and installation instructions for all items specified.

PART 2 PRODUCTS

2.01 BLADDER-TYPE EXPANSION TANKS
A. Manufacturers:
B. Construction: Welded steel, tested and stamped in accordance with ASME (BPV VIII, 1); supplied with National Board Form U-1, rated for working pressure of 125 psi (860 kPa), with replaceable heavy duty butyl rubber bladder, and steel support stand.
C. Accessories: Pressure gage and air-charging fitting, tank drain; precharge to 12 psi (80 kPa).
D. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.02 AIR VENTS
A. Manufacturers:
B. Manual Type: Provide manual vent air vent valves designed to be operated manually with a screw driver or thumbscrew and 1/8 inch NPT connection.
C. Automatic Type: Provide float type automatic air vent valves with cast iron body, stainless steel float and mechanisms, pressure rated for 125 psi, with 1/2 inch NPT connections.

2.03 AIR SEPARATORS
A. In-line Air Separators:
1. Manufacturers:
2. Cast iron for sizes 1-1/2 inch (40 mm) and smaller, or steel for sizes 2 inch (50 mm) and larger; tested and stamped in accordance with ASME BPVC-VIII-1; for 125 psi (860 kPa) operating pressure.

2.04 STRainers

A. Manufacturers:
   2. Green Country Filtration.
   3. WEAMCO.
B. Size 2 inch (50 mm) and Under:
   1. Screwed brass or iron body for 175 psi (1200 kPa) working pressure, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
C. Size 2-1/2 inch (65 mm) to 4 inch (100 mm):
   1. Provide flanged iron body for 175 psi (1200 kPa) working pressure, Y pattern with 3/64 inch (1.2 mm) stainless steel perforated screen.

2.05 TRIPLE DUTY VALUES

A. Manufacturers:
   1. ITT Bell & Gossett.
   3. Taco, Inc.
B. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psi (1200 kPa) operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.06 AUTOMATIC BALANCING VALUES

A. General: Use automatic flow control valves on all heating applications of 180 GPM or less.
B. Manufacturers:
   1. ITT Bell & Gossett.
   2. Approved Equal.
C. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain, with integral automatic flow rate cartridge. EPDM O-rings.
D. Calibration: Automatically control flow within 5 percent of selected rating, over operating differential pressure range 2 to 60 psi (_____ kPa).
E. Control Mechanism: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.
F. Accessories: In-line strainer on inlet and ball valve on outlet.

2.07 BALANCING VALUES

A. Manufacturers:
   1. ITT Bell & Gossett.
   3. Taco, Inc.
B. General:
   1. Valves shall have memory stop feature to allow valve to be closed for service and re-opened to set point without disturbing balance position. Valves shall have calibrated nameplate to assure specific valves setting.
   2. Design Pressure/Temperature:
a. 3/4 Inch to 3 Inch NPT Connections: 300 psig at 250 degrees F.
b. 3/4 Inch to 2 Inch Sweat Connections: 200 psig at 250 degrees F.
c. 2-1/2 Inch to 3 Inch Flanged Connections: 175 psig at 250 degrees F.
d. 4 Inch to 12 Inch Flanged or Grooved Connections: 175 psig at 250 degrees F.

C. Valves 3/4 Inch to 2 Inch Pipe size: NPT or Sweat; Valves 2-1/2 inch to 3 inch Pipe size: NPT. Valves shall be of bronze body/brass ball construction with glass and carbon filled TFE seat rings. Valves shall have differential pressure read-out ports fitted with check valves across valve seat area. Valve body shall have 1/4 inch NPT tapped drain/purge port.

D. Valves 2-1/2 Inch to 3 Inch Pipe size: Flanged: Valves shall be of heavy duty cast iron construction with brass ball with glass and carbon filled TFE seat rings. 125 psi ANSI flanged connections shall be suitable for up to 175 psi working pressure. Valves shall have differential pressure read-out ports fitted with check valves across valve seat area.

2.08 RELIEF VALVES
A. Manufacturers:
B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.09 GLYCOL SYSTEM
A. Manufacturers:
   2. J. L. Wingert Company.
   3. ITT Bell & Gossett.
B. General: Preassembled packaged glycol feed system complete with two 1.5 gpm (@100psi) pumps, low level light and audible alarm, separate discharges and pressure switches to allow the feeding of two separate closed loop systems independently from a single tank.
C. Tank: 50 gallon polyethylene tank mounted in a four-leg carbon steel stand with upper and lower steel support bands. Tank stand shall be factory painted.
D. Panel: 120 Volt single Phase control panel with NEMA 4X enclosure consisting of the following shall be provided: H-O-A selector switch with running light and magnetic starter for feed pump. In Auto, the pump is operated by the skid-mounted differential (adjustable) pressure switch and interlocked to a low level float switch mounted in the side of the tank. Panel shall be mounted to the tank frame. All electrical components shall be wired in conduit to control panel.
E. Mixing Tank: 55 gallon (205 L) steel drum with fittings suitable for filling and hand pump for charging, rubber hose for connection of hand pump to system.
F. Storage Tank: Closed type, welded steel constructed, tested and stamped in accordance with ASME BPVC-VIII-1; 100 psi (690 kPa) rating; cleaned, prime coated, and supplied with steel support saddles. Construct with tappings for installation of accessories.
G. Expansion Tank: Diaphragm type with vent fitting with air separator, and automatic air vent.
H. Air Pressure Reducing Station: Pressure reducing valve with shut-off valves, strainer, check valve and needle valve bypass.
I. 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 (minus 40 degrees C) to 250 degrees F (121 degrees C).

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 discharge side of system circulation pump and connect to expansion tank.
F. Provide valved drain and hose connection on strainer blow down connection.
G. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.
H. 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.
I. Pipe relief valve outlet to nearest floor drain.
J. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.
K. Clean and flush glycol system before adding glycol solution. Refer to Section 23 2500.
L. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.
M. Perform tests determining strength of glycol and water solution and submit written test results.

END OF SECTION
SECTION 23 2115
HYDRONIC RADIANT HEATING SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Materials required to supply, install, and pressure test polyethylene tubing as shown on drawings or as specified herein.
B. The radiant floor heating system shall include, but not be limited to, all piping, manifolds, and valves to provide a complete and operational system.
C. The applicable installation method(s) shall comply with published installation instructions from the tubing manufacturer.

1.02 SUBMITTALS
A. Submit verification of Standard Grade Hydrostatic Design Stresses and Pressure Ratings on the tubing from Plastic Pipe Institute in accordance with TR-3. The following three standard grade ratings are required: 200°F at 80 psi, 180°F at 100 psi, 73.4°F at 160 psi.
B. Initial submittal information will include a radiant floor-tubing schedule that lists the manifolds and their respective loops. Tubing on center distances, flow rates per loop and identification of zones will also be included in the schedule information.
C. For actual construction, installation drawings of the radiant floor design tubing layout to include all required detail notes to aid in the installation of the system shall be submitted for approval as specified under terms and conditions of the Contract Document. No fabrication shall be performed until approval is obtained.

1.03 QUALITY ASSURANCE
A. All components of the hydronic radiant floor heating distribution system shall be provided through one manufacturer including, but not limited to, tubing, fittings, manifolds, and other ancillary components required to complete the installation.
B. The installing contractor shall provide, in writing, to the project engineer that the tubing furnished under this specification conforms to the material and mechanical requirements specified herein.

1.04 DELIVERY, STORAGE, AND HANDLING
A. All radiant floor heating products shall be kept clean and dry during delivery and storage.
B. All tubing shall be stored in its carton or undercover to avoid dirt or foreign material from being introduced into the tubing.
C. All radiant floor heating products will be stored together in one location to avoid lost or misplaced equipment.
D. Tubing shall not be exposed to direct sunlight for more than 30 days during installation. If construction delays are encountered, the installing contractor is responsible to provide cover to all portions of the exposed tubing.

1.05 WARRANTY
A. Tubing shall carry a 25-year non-prorated limited warranty against failure due to defects in quality or workmanship when installed by a licensed contractor.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS
A. Mr Pex Systems.
B. RehauUnlimited Polymer Solutions.
C. Uponor
D. Watts Radiant.
2.02 TUBING
A. Tubing is to be manufactured in accordance with ASTM F 876 and CAN/CSA B137.5.
B. Tubing shall not be manufactured using Siloxane material during the cross-linking process.
C. The tubing shall be homogeneous throughout and essentially uniform in color, opacity, density, and other properties. The inside and outside surfaces shall be matte or glossy in appearance. The tubing wall shall be free of cracks, holes, blisters, voids, foreign inclusions, or other defects that are apparent to the naked eye and that may affect the wall integrity.
D. Mild surface abrasions are acceptable. Gouges or notches in the tubing wall greater than 10% of the minimal wall thickness are not acceptable and are subject to rejection of that tubing loop (refer to ASTM F 876 for additional information).
E. The tubing shall have an integral oxygen diffusion barrier applied at time of manufacturing that does not exceed an oxygen diffusion rate of 0.10 grams per cubic meter per day at 104°F water temperature in accordance with German DIN 4726.
F. The tubing shall be issued a Standard Grade Hydrostatic Design Stresses and Pressure Rating in accordance with PPI TR-3 and listed in PPI TR-4.
G. Tubing manufacturing process shall be certified by an ICBO approved independent third party testing laboratory and verification agency.
H. The tubing shall be manufactured in the United States of America.

2.03 MANIFOLDS
A. Manifolds shall be manufactured of copper or brass material and shall be supplied by the respective tubing manufacturer for system compatibility.
B. Each manifold location shall have the ability to vent air manually from the system when installed at a higher elevation than the radiant panel area.
C. Manifolds installed aboveground shall be isolated from supply and return piping with valves that are suitable for isolation and balancing.

2.04 FITTINGS
A. Fittings to attach the tubing to the manifold shall be supplied by the tubing manufacturer.
B. Use of manufactured fittings are authorized.
C. All fittings used as splice connections shall be of suitable material and in accordance with the manufacturer's recommendations.
D. Fittings shall be certified to comply with the requirements of ASTM F877 and CAN/CSA B 137.5.
E. The fittings shall be manufactured in the United States of America.

2.05 SUPPLY AND RETURN PIPING TO MANIFOLDS
A. Above ground piping:
   1. Refer to Specification Section 23 2113.

PART 3 EXECUTION
3.01 GENERAL
A. During installation, all tubing shall be capped on each end to prevent foreign materials from entering the tube.
B. All tubing shall be checked for abrasions prior to installation. Tubing embedded in the slab shall be installed without joints or splices unless authorized by the tubing manufacturer.
C. The tubing shall be installed in such a manner as to effectively address the heat loss of the space. Tubing shall not be placed near heat-sensitive materials.
D. Tubing shall be properly pressure tested, in accordance with the tubing manufacturer's guidelines, prior to burial of the tubing in concrete. The tubing system shall maintain an air pressure test, under a minimum pressure of 80 psi, for a period of twenty-four (24) hours prior
to the concrete pour. Tubing shall be pressurized prior to and during the concrete pour to ensure system integrity.

E. All pressure tests shall be accomplished with air pressure. If the installing contractor prefers the use of water for pressure testing, then the installing contractor is responsible for the removal of all water from the system if ambient air temperatures approach 32 degrees F or less. If freezing temperatures are likely, then the system shall be pressurized with air only.

F. After the system has been filled with the specified media, all air shall be vented from the system. Provisions should be made for components in the mechanical room to allow system purging of air.

G. The manifold locations shall be accessible for maintenance.

3.02 CONCRETE SLAB ON GRADE INSTALLATION

A. The tubing shall be fastened to the flat mesh or reinforcing bar in accordance with the tubing manufacturer's installation recommendations.

B. Tubing on center distance(s) and loop lengths shall be specified in the submitted radiant floor design-tubing layout.

C. Tubing will be installed no closer than six (6) inches from all walls.

D. If under slab insulation is required by the design, the vertical compressive strength of the high-density extruded board insulation will be determined by the structural engineer. Required insulation resistance value (R-value) to be determined by the radiant floor design.

E. Tubing shall be installed at a consistent depth below the surface elevation as determined by the project engineer. Tubing installation will ensure sufficient clearance for all control joint cuts.

F. In areas where tubing must cross metal expansion joints that occur in the concrete, the tubing shall be installed below the metal expansion joints. Fibrous expansion joints may be penetrated depending on the tubing manufacturer's and structural engineer's recommendation.

G. Metal of PVC bend supports will be used to support the tubing departing from the slab in a 90 degree bend.

END OF SECTION
SECTION 23 2123
HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. In-line pumps.
B. Vertical in-line pumps.

1.02 RELATED REQUIREMENTS
A. Section 03 3000 - Cast-in-Place Concrete.
B. Section 23 0548 - Vibration and Seismic Controls for HVAC.
C. Section 23 0719 - Piping and Equipment Insulation.
D. Section 23 2113 - Hydronic Piping.
E. Section 23 2114 - Hydronic Specialties.

1.03 REFERENCE STANDARDS
A. NEMA MG 1 - Motors and Generators; 2014.
B. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS
A. Product Data: Manufacturer's pump characteristic performance curves with system operating point plotted. Include NPSH curve, variable speed system curves, and parallel pumping curves when applicable. Manufacturer's pump specifications, installation, and start-up instructions. Include electrical characteristics and connection requirements.
B. Contract Close Out Submittals:
   1. Operation and Maintenance Data: Include maintenance data, assembly views, lubrication instructions, and replacement parts list. Deliver two (2) copies for each type of pump to the Owner's Representative.

1.05 REGULATORY REQUIREMENTS
A. Products Requiring Electrical Connection: Listed and classified by UL and NEMA as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

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

2.02 IN-LINE PUMPS
A. Manufacturers:
   1. ITT Bell & Gossett.
   2. Armstrong Pumps, Inc.
   3. Taco, Inc.
B. General: Provide long coupled in-line circulator pumps of sizes, capacities, and characteristics as scheduled on drawings.
C. Type: Horizontal shaft, single stage, vertical split case, oil lubricated, designed for 175 psi working pressure at 225 degrees F operating temperature.

D. Casing: Cast iron, bronze fitted, with flanged pump connections and suction and discharge gauge ports.

E. Impeller: Cast bronze keyed to shaft, hydraulically and dynamically balanced.

F. Bearings: Oil-lubricated bronze.

G. Shaft: Hardened alloy steel with non-ferrous sleeve.

H. Seal: Internally flushed mechanical seal, with carbon seal rotating against a stationary ceramic seat, suitable for continuous operation at 225 degrees F (107 degrees C).

I. Drive: Self aligning flexible coupling.

J. Motor: Non-overloading at any point on pump curve, open drip-proof, oil-lubricated journal bearings, resilient mounted construction through 1 HP, rigid mounted 1-1/2 HP and over, built-in thermal overload protection on single phase motors.
  1. Motors shall be NEMA High Efficiency with minimum nominal efficiencies complying with ASHRAE Standard 90.1-2004. Efficiencies shall be determined in accordance with NEMA standard MG1.

2.03 VERTICAL IN-LINE PUMPS

A. Manufacturers:
   1. ITT Bell & Gossett.
   2. Armstrong Pumps, Inc.
   3. Taco, Inc.

B. General: Provide vertical in-line pumps of sizes, capacities, and characteristics as scheduled on drawings.

C. Type: Vertical, single stage, close coupled, radially split casing, for in-line mounting, designed for 175 psi (1200 kPa) working pressure at 225 degrees F operating temperature.

D. Casing: Cast iron, bronze fitted, with suction and discharge gauge ports, drain plug, and flanged suction and discharge.

E. Impeller: Bronze, fully enclosed, hydraulically and dynamically balanced, keyed to shaft and secured with locking capscrew.

F. Shaft: Carbon steel with replaceable bronze sleeve.

G. Seal: Internally flushed mechanical seal, with carbon seal rotating against a stationary ceramic seat, suitable for 225 degrees F (107 degrees C) continuous operating temperature.

H. Motor: Non-overloading at any point on pump curve, open drip proof with greaseable ball bearings, with lifting lug on top of motor.
  1. Motors shall be NEMA High Efficiency with minimum nominal efficiencies complying with ASHRAE Standard 90.1-2004. Efficiencies shall be determined in accordance with NEMA standard MG1.

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 written instructions with recommended clearances for maintenance.

   B. Provide line sized shut-off valves on pump discharge and suction. Provide piping and pump accessories, hangers, supports, anchors, valves, gauges, vibration isolation, and flexible metal connectors on all pumps as required for a complete system.

   C. Provide air cock and drain connection on horizontal pump casings.
D. Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer. Check and realign in presence of manufacturer's service representative. Check, align, and certify alignment of base mounted pumps prior to start-up.

E. Install in line pumps supported from piping system with access for maintenance.

F. Install base mounted pumps on concrete housekeeping base, minimum 4 inches high with anchor bolts, poured in place, set and level pump and grout in place with non-shrink grout. Refer to Section 03 3000 for grout.

G. Ensure that pumps are wired properly, grounding has been provided, and motors are rotating in correct direction prior to pump start-up.

H. Lubricate pumps before start-up. Start-up in accordance with manufacturer's written instructions.

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. Check valves.
G. Pressure regulators.
H. Filter-driers.
I. Solenoid valves.
J. Expansion valves.
K. Flexible connections.

1.02 RELATED REQUIREMENTS

A. Section 08 3100 - Access Doors and Panels.
B. Section 23 0515 - Mechanical Firestopping.
C. Section 23 0719 - Piping and Equipment Insulation.
D. Section 23 6213 - Packaged Air-Cooled Refrigerant Compressor and Condenser Units.

1.03 REFERENCE STANDARDS

A. AHRI 495 - Performance Rating of Refrigerant Liquid Receivers; 2005.
B. AHRI 710 - Performance Rating of Liquid-Line Driers; 2009.
G. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; 2013.
H. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2015.
M. ASME B31.9 - Building Services Piping; 2014.
O. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2013.
Q. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.

1.04 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

B. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.

C. Liquid Indicators:
   1. Use line size liquid indicators in main liquid line leaving condenser.
   2. If receiver is provided, install in liquid line leaving receiver.
   3. Use line size on leaving side of liquid solenoid valves.

D. Valves:
   1. Use service valves on suction and discharge of compressors.
   2. Use gage taps at compressor inlet and outlet.
   3. Use gage taps at hot gas bypass regulators, inlet and outlet.
   4. Use check valves on compressor discharge.
   5. Use check valves on condenser liquid lines on multiple condenser systems.

E. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.

F. Strainers:
   1. Use line size strainer upstream of each automatic valve.
   2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
   3. On steel piping systems, use strainer in suction line.
   4. Use shut-off valve on each side of strainer.

G. Pressure Relief Valves: Use on ASME receivers and pipe to outdoors.

H. Filter-Driers:
   1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.
   2. Use sealed filter-driers in lines smaller than 1/2 inch (13 mm) outside diameter.
   3. Use sealed filter-driers in systems utilizing hermetic compressors.
   4. Use replaceable core filter-driers in lines of 1/2 inch (13 mm) outside diameter or greater.
   5. Use replaceable core liquid-line filter-driers in systems utilizing receivers.

I. Solenoid Valves:
   1. Use in liquid line of systems operating with single pump-out or pump-down compressor control.
   2. Use in liquid line of single or multiple evaporator systems.
   3. Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.

J. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.05 SUBMITTALS

A. See Section 01 3300 - Submittal Procedures, for submittal process.
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.

D. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Test Reports: Indicate results of leak test, acid test.

F. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.

G. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.

H. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum five years of documented experience.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.

C. Welders Certification: In accordance with ASME BPVC-IX.

D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

2.02 PIPING

A. Copper Tube: ASTM B280, H58 hard drawn or O60 soft annealed.
   2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.

B. Copper Tube to 7/8 inch (22 mm) OD: ASTM B88 (ASTM B88M), Type K (A), annealed.

C. Pipe Supports and Anchors:
   1. Conform to ASME B31.5.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch (13 to 38 mm): Malleable iron adjustable swivel, split ring.
   3. Hangers for Pipe Sizes 2 Inches (50 mm) and Over: Carbon steel, adjustable, clevis.
   5. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
   7. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
   8. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.03 MOISTURE AND LIQUID INDICATORS

A. Manufacturers:
   3. Substitutions: See Section 01 6000 - Product Requirements.
B. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F (93 degrees C) and maximum working pressure of 500 psi (3450 kPa).

2.04 VALVES
A. Manufacturers:

B. 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 (3450 kPa) and maximum temperature of 275 degrees F (135 degrees C).

C. 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 (3450 kPa) and maximum temperature of 275 degrees F (135 degrees C).

D. Ball Valves:
1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi (3450 kPa) and maximum temperature of 300 degrees F (149 degrees C).

E. 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 (3450 kPa).

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 (2960 kPa).

2.06 CHECK VALVES
A. Manufacturers:
3. Substitutions: See Section 01 6000 - Product Requirements.

B. Globe Type:
1. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum temperature of 300 degrees F (149 degrees C) and maximum working pressure of 425 psi (2930 kPa).

C. Straight Through Type:
1. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seal; for maximum working pressure of 500 psi (3450 kPa) and maximum temperature of 200 degrees F (93 degrees C).

2.07 PRESSURE REGULATORS
A. Manufacturers:
3. Substitutions: See Section 01 6000 - Product Requirements.

B. Brass body, stainless steel diaphragm, direct acting, adjustable over 0 to 80 psi (0 to 550 kPa) range, for maximum working pressure of 450 psi (3100 kPa).

2.08 FILTER-DRIERS

A. Manufacturers:
3. Substitutions: See Section 01 6000 - Product Requirements.

B. Performance:
1. Flow Capacity - Liquid Line: As indicated in schedule, minimum, rated in accordance with AHRI 710.
2. Pressure Drop: 2 psi (14 kPa), maximum, when operating at full connected evaporator capacity.

C. 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.

D. Construction: UL listed.
1. Replaceable Core Type: Steel shell with removable cap.
2. Sealed Type: Copper shell.
3. Connections: As specified for applicable pipe type.

2.09 SOLENOID VALVES

A. Manufacturers:
3. Substitutions: See Section 01 6000 - Product Requirements.

B. Valve: AHRI 760 I-P, pilot operated, copper, brass or steel body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psi (3450 kPa).

C. Coil Assembly: UL 429, UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.

2.10 EXPANSION VALVES

A. Manufacturers:
3. Substitutions: See Section 01 6000 - Product Requirements.

B. 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.

C. 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 (6 degrees C) superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.11 FLEXIBLE CONNECTORS

A. Manufacturers:

B. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches (230 mm) long with copper tube ends; for maximum working pressure of 500 psi (3450 kPa).

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. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches (100 mm).
   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.
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 (13 mm) space between finished covering and adjacent work.
   4. Place hangers within 12 inches (300 mm) 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 23 0719.
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. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
Q. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
R. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
S. Fully charge completed system with refrigerant after testing.
T. Provide electrical connection to solenoid valves. Refer to Section 26 2717.
U. For refrigeration systems with multiple circuits, provide refrigerant piping in quantity and dimension for each circuit as required by the manufacturers written instructions.

3.03 FIELD QUALITY CONTROL
   A. See Section 01 4000 - Quality Requirements, for additional requirements.
   B. Test refrigerant piping in accordance with New York State Mechanical Code Section 1108 and ASME Code for Pressure Piping B31.5 Refrigerant Piping and Heat Transfer Components Chapter VI.
   C. Test refrigeration system in accordance with ASME B31.5.
   D. Pressure test system with dry nitrogen to 200 psi (1380 kPa). Perform final tests at 27 inches (92 kPa) vacuum and 200 psi (1380 kPa) using halide torch. Test to no leakage.

3.04 SCHEDULES
   A. Hanger Spacing for Copper Tubing.
      1. 1/2 inch (13 mm), 5/8 inch (16 mm), and 7/8 inch (22 mm) OD: Maximum span, 5 feet (1500 mm); minimum rod size, 1/4 inch (6.3 mm).
      2. 1-1/8 inch (29 mm) OD: Maximum span, 6 feet (1800 mm); minimum rod size, 1/4 inch (6.3 mm).

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Metal ductwork.
B. Duct cleaning.

1.02 RELATED REQUIREMENTS
A. Section 09 9000 - Painting and Coating.
B. Section 23 0515 - Mechanical Firestopping.
C. Section 23 0593 - Testing, Adjusting, and Balancing.
D. Section 23 0713 - Duct Insulation.
E. Section 23 3300 - Ductwork Accessories.
F. Section 23 3600 - Air Terminal Units.
G. Section 23 3700 - Air Outlets and Inlets.

1.03 REFERENCE STANDARDS
E. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).

1.04 SUBMITTALS
A. Shop Drawings:
   1. Layout of ductwork systems shall be submitted for review. Coordinate layout with existing conditions and work of other trades, note areas in which it may be necessary to deviate substantially from layout shown on the Contract Drawings. Show relocation of ductwork and changes in size of ducts. Minor transitions in ductwork to accommodate field conditions need not be submitted unless duct area is not maintained.
   2. Layouts of mechanical equipment rooms and penthouses.
   3. Details of intermediate structural steel members required to span main structural steel for the support of ductwork.
   4. Method of attachment of duct hangers to building construction.
   5. Coordinate Shop Drawings with related contracts prior to submission. Coordinate any changes with related trades prior to construction.
B. Product Data: Material, gage, type of joints, sealing materials, and reinforcing for each duct size range, including sketches or SMACNA plates for joints, method of fabrication, and reinforcing.

1.05 QUALITY ASSURANCE
A. SMACNA: Gages of materials, fabrication, reinforcement, sealing requirements, installation, and method of supporting ductwork shall be in accordance with the following SMACNA manuals, unless otherwise shown or specified.
   1. HVAC Duct Construction Standards.
   2. Round Industrial Duct Construction Standard.
B. Unless otherwise shown or specified follow Hood Design Data and Construction Guidelines for Local Exhaust Systems from the ACGIH Industrial Ventilation Manual.
C. Conform to the applicable requirements of NFPA 90A, 90B, 91, 96, and 101.
D. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum five years of experience.

PART 2 PRODUCTS
2.01 DUCT ASSEMBLIES
A. Regulatory Requirements: Construct ductwork to NFPA 90A standards.

2.02 MATERIALS
A. Sheet Metal:

B. Flexible Duct: Where indicated only, provide flexible duct as follows:
   1. Manufacturers:
      a. Flexmaster, Type 3.
      b. Clevaflex USA, Inc.
      c. Thermaflex.
   2. Vapor Barrier: Black polyethylene vapor barrier film.
   4. Aluminum foil tri laminate, fiberglass and aluminized polyester, mechanically locked.
   5. Factory wrapped exterior fiberglass insulation blanket. 'K' value of 0.23.
   6. Outer jacket of black fire retardant polyethylene material.
   7. UL listed per UL 181, Class 1 Air Duct.
   8. Maximum Velocity: 4000 fpm (20.3 m/sec).
   9. Temperature Range: -20 degrees F to 175 degrees F (-28 degrees C to 79 degrees C).

C. Duct Hangers:
   1. Strap Hangers: Same material as ductwork, except that hangers for stainless steel ducts in unfinished spaces may be galvanized steel.
   2. Rod Type Hangers: Mild low carbon steel, unless otherwise specified; fully threaded or threaded each end, with two (2) removable nuts each end for positioning and locking rod in place. Shop coat with primer unless stainless steel or galvanized.

2.03 FABRICATION - GENERAL
A. Fabricate ductwork from galvanized sheet metal, except as follows:
B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
C. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).

2.04 FABRICATION - SHOP
A. Shop fabricate ductwork in 4, 8, 10, or 12 foot lengths unless otherwise required to complete run. Pre-assemble work in shop to the greatest extent possible to minimize field assembly. Match-mark sections for coordinated installation.
B. Fabricate duct fittings to match adjoining ducts and comply with duct requirements. Fabricate radius elbows with centerline radius equal to one and one half times the associated width.
C. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible.

2.05 FABRICATION - FACTORY
A. Manufacturers:
   1. Metal-Fab, Incorporated.
   2. SEMCO Incorporated.
B. General: At installer’s option, provide factory fabricated spiral, round, or oval ductwork and fittings in lieu of shop fabricated ductwork and fittings. Gauges according to Tables 3-2 and 3-3 in SMACNA Duct Construction Standards Manual.

C. Round Elbows:
1. Up to and including 14 inch diameter: One piece construction 90 degree and 45 degree.
2. Over 14 inch diameter: 5 gore 90 degree and 3 gore 45 degree construction with machine formed seam joint.

D. Divided flow fittings: 90 degree tees constructed with turning vanes saddle tap spot welded and bonded to duct fitting body.

2.06 FABRICATION - STAINLESS STEEL DUCTWORK

A. Use minimum No. 18 gage for exhaust ducts connected to cooking equipment hoods. Use minimum No. 20 gage for exhaust ducts connected to other hoods.

B. Use stainless steel reinforcing members for ducts in finished spaces and galvanized steel in unfinished spaces.

C. Longitudinal Seams for Dishwashing and Other Scullery Equipment Exhaust Ductwork:
1. Form double corner seams or Pittsburg lock seams.
2. Fabricate elbows and transitions with Pittsburg lock seams.
3. Fabricate double compounded elbows and other complex fittings with double corner seams.
4. Locate seams in horizontal ducts at top corners or ducts, unless otherwise approved in writing.
5. Locate seams in vertical ducts at rear corners of ducts.

2.07 REGISTERS OR GRILLES INSTALLED IN EXPOSED DUCTWORK

A. Frames are not required for registers and grilles installed directly in uninsulated exposed ductwork.

B. Cut openings in ducts, forming a double thickness of metal to attach registers or grilles with sheet metal screws. Bend back edges of openings into duct on all four (4) sides a minimum of 1 inch to provide double thickness. Provide felt or sponge rubber gasketing on all four (4) sides of duct openings for supply grilles and supply registers.

2.08 DIFFUSERS INSTALLED IN EXPOSED DUCTWORK

A. Frames are not required for diffusers installed directly in uninsulated exposed ductwork.

B. Cut and form openings in ducts to accommodate the specified volume control damper and adjustable equalizing grid assembly. Reinforce openings as required and approved. Provide felt or sponge rubber gasketing around duct opening for supply diffuser assemblies.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.

C. Install ductwork to allow maximum headroom. Properly seam, brace, stiffen, support, and render ducts mechanically airtight. Adjust ducts to suit job conditions. Dimensions may be changed as approved providing cross sectional area is maintained.

D. Pitch horizontal ducts connected to hoods downward toward hood not less than 1 inch in 10 feet.

E. Provide necessary transformation pieces and flexible fabric connections for ductwork connected to air handling equipment or air inlet and outlet devices.

F. Transition duct sizes gradually, not exceeding 30 degrees expanding and 45 degrees contracting tapers unless otherwise required to complete run.
G. Spiral or round ductwork may be substituted for rectangular or square, as approved, providing cross-sectional area is maintained and adequate clearance is verified in the field.

H. Connect terminal units to supply ducts directly or with one foot (300 mm) maximum length of flexible duct. Do not use flexible duct to change direction.

I. Connect diffusers to low pressure ducts directly or with 3 feet maximum length of flexible duct held in place with strap or clamp.

J. Connect flexible ducts to metal ducts with draw bands and adhesive.

3.02 SEALING SEAMS, JOINTS, AND PENETRATIONS
A. Seal ductwork in accordance with the SMACNA Manual except for the following:
   1. Ductwork Specified to be Insulated: Conform with Seal Class A for all pressure classes.
   2. Cooking equipment Exhaust Ductwork: Conform with NFPA 96.
   3. Horizontal Ductwork for Dishwashing and Other Scullery Equipment Exhausts:
      a. Continuously solder transverse joints vaportite along bottom and up both sides 2 inches minimum.
      b. Continuously solder longitudinal seams vaportite if seams are approved to be located at bottom of duct.

3.03 HANGERS FOR DUCTS UNDER 2 INCHES W.G.
A. Install hangers for ducts as specified in the SMACNA Manual, with the following exceptions:
   1. Rectangular ducts up to 42 inches wide, not having welded or soldered seams, and supported from overhead construction; extend strap hangers down over each side of the duct and turn under bottom of duct a minimum of 2 inches. Secure hanger to duct with three (3) full thread sheet metal screws, one in the bottom and two (2) in the side of duct.
   2. Rectangular ducts 43 inches wide and over, and all sides of duct with welded or soldered seams, and supported from overhead construction; use trapeze hangers.
   3. Prime coat plain steel rods threaded at site immediately after installation with metal primer.

3.04 HANGERS FOR DUCTS OVER 2 INCHES W.G.
A. Install hangers for ducts as specified in the SMACNA Manual.
B. Prime coat plain steel rods threaded at site immediately after installation with metal primer.

3.05 CLEANING
A. Clean duct system internally of dust and debris unit-by-unit as installed. Clean external surfaces of foreign substances which might cause corrosive deterioration or where ductwork is to be painted.
B. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.
C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

3.06 DUCT SYSTEM CLASSIFICATIONS
A. Metal and Flexible Duct:
   1. Supply Ducts:
      a. SMACNA Pressure Class: + 2 inch WG.
      b. SMACNA Seal Class: ‘B’.
      c. SMACNA Leakage Class:
         1) Round Duct: Class 6 (Max 6 cfm/100 square feet of duct @ 1 inch WG).
         2) Rectangular Duct: Class 12 (Max 12 cfm/100 square feet of duct @ 1 inch WG).
   2. Return Ducts:
      a. SMACNA Pressure Class: - 1 inch WG.
      b. SMACNA Seal Class: ‘B’.
      c. SMACNA Leakage Class:
         1) Round Duct: Class 6 (Max 6 cfm/100 square feet of duct @ 1 inch WG).
2) Rectangular Duct: Class 12 (Max 12 cfm/100 square feet of duct @ 1 inch WG).

3. Exhaust Ducts:
   a. SMACNA Pressure Class: + 1 inch WG / - 1 inch WG.
   b. SMACNA Seal Class: 'B'.
   c. SMACNA Leakage Class:
      1) Round Duct: Class 6 (Max 6 cfm/100 square feet of duct @ 1 inch WG).
      2) Rectangular Duct: Class 12 (Max 12 cfm/100 square feet of duct @ 1 inch WG).

B. Kitchen and Industrial Duct:
   1. SMACNA Pressure Class: + 2 inch WG / - 2 inch WG.
   2. SMACNA Seal Class: 'A'.
   3. SMACNA Leakage Class:
      a. Round Duct: Class 3 (Max 3 cfm/100 square feet of duct @ 1 inch WG).
      b. Rectangular Duct: Class 6 (Max 6 cfm/100 square feet of duct @ 1 inch WG).

END OF SECTION
SECTION 23 3300
DUCTWORK ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Air turning devices/extractors.
   B. Backdraft dampers.
   C. Duct access doors.
   D. Fire dampers.
   E. Flexible duct connections.
   F. Volume control dampers.
   G. Automatic air dampers.

1.02 RELATED REQUIREMENTS
   A. Section 23 3100 - Ductwork.
   B. Section 23 3600 - Air Terminal Units.

1.03 REFERENCE STANDARDS
   D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).
   E. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.

1.04 SUBMITTALS
   A. Product Data: Catalog sheets, diagrams, standard schematic drawings, and installation instructions for each manufactured product.
      1. UL ratings, leakage, pressure drop, and maximum pressure data.
      2. Indicate materials, construction, dimensions, and installation details.
      3. Verify conformance to NFPA, UL, BSA or MEA, CSFM, and applicable building code.
      4. Include damper pressure drop data based on tests and procedures performed in accordance with AMCA 500.

1.05 QUALITY ASSURANCE
   A. Regulatory Requirements:
      1. Unless otherwise shown or specified, comply with the applicable requirements of the following:
         a. SMACNA: Gages of materials, fabrication, sealing, and installation shall be in accordance with the SMACNA Manuals.
            1) HVAC Duct Construction Standards.
            2) Round Industrial Duct Construction Standards.
            3) Rectangular Duct Construction Standards.
         c. AMCA: Certify damper and/or louver ratings in accordance with AMCA 511.
         e. UL: Standards Nos. UL181 and UL555.
      B. Warranty: Dampers shall be warranted against manufacturing defects for a period of 5 years.
1.06 DELIVERY, STORAGE, AND HANDLING
   A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES
   A. Manufacturers:
   B. Manufactured Turning Vanes: Construct of 1-1/2 inch wide curved blades set at 3/4 inch OC supported with bars perpendicular to blades set to 2 inches OC, and set into side rails suitable for mounting in ductwork.
      1. Weld, screw, or rivet rails to ductwork.

2.02 BACKDRAFT DAMPERS
   A. Manufacturers:
   B. Gravity Backdraft Dampers, Size 18 by 18 inches (450 by 450 mm) or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.
   C. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch (150 mm) 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 DUCT ACCESS DOORS
   A. Manufacturers:
   B. Prefabricated or Fabricated at Site: Minimum 12 inches x12 inches, of same material and finish as duct unless otherwise shown or specified.
      1. For uninsulated duct designed for under two inches water gage: Fabricate single panel door of same gage as duct, with all edges folded, size door to overlap opening perimeter by one inch.
      2. For insulated duct and duct designed for two inches water gage and over: Fabricate hollow metal door in accordance with the SMACNA Manual. Fill void in doors for insulated duct with thermally equivalent insulation.
         a. Exception: Where access doors are required by NFPA 96 in cooking equipment exhaust ductwork, gasket with Fibrefrax Grade 110 paper by Carborundum Co.
   C. Access Door Hardware:
      1. Piano Hinges: Galvanized steel with brass pins, continuous type, full height of door.
      2. Butt Hinges: Galvanized steel with brass pins, approximately 2 inches x 1-1/2 inches wide for doors over 24 inches and higher.
      3. Sash Locks: Galvanized, cadmium plated, or aluminized steel or cast aluminum.

2.04 FIRE DAMPERS
   A. Manufacturers:

B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

C. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1.0 inch (250 Pa) pressure class ducts up to 12 inches (300 mm) in height.

D. Rating: Not less than 1-1/2 hour fire rating for all floors/partitions with less than 3 hour fire rating.
   1. Class II: Maximum leakage rate 20 cubic feet per minute at 4 in. wg. differential pressure.

E. Fusible Links: UL 33, separate at 160 degrees F (71 degrees C), vibration proof with adjustable link straps for combination fire/balancing dampers, secured with "S" hooks or stainless steel bolts and lock nuts.

2.05 FLEXIBLE DUCT CONNECTIONS

A. Static Pressures under 6 inches water gage: Woven Fiberglass fabric with Hypalon coating.

B. Factory prefabricated and pre-assembled connectors of fabric materials specified above are acceptable with minimum 24 gage galvanized steel edges as required by free fabric length.

C. Fabricate in accordance with SMACNA (DCS) and as indicated.

D. Flexible Duct Connections: Fabric crimped into metal edging strip.

2.06 VOLUME CONTROL DAMPERS

A. Manufacturers:

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Single Blade Dampers: Fabricate for duct sizes up to 6 by 30 inch (150 by 760 mm) or 12 inch diameter.

D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 by 72 inch (200 by 1825 mm). Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

E. End Bearings: Provide two piece synthetic end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

F. Quadrants:
   1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.

2.07 AUTOMATIC AIR DAMPERS

A. Manufacturers:
   1. American Warming and Ventilating.
   2. Ruskin.

B. Damper shall be same size as corresponding louver or duct and be suitable for mounting directly to the louver, flanged wall sleeve, or duct flange.

C. Type: Airfoil opposed blade low leakage control damper. Maximum leakage rate 6 cfm/square feet at 4 inch wg.

D. Frame: 5 inch x 1 inch 16 gage galvanized steel hat channel with reinforced corners and welded joints.

E. Blades: Airfoil shaped, galvanized steel double skin construction equivalent to 14 gage. Mounted on 1/2 inch diameter plated steel axles with synthetic sleeve type bearings.
F. Linkage: Side linkage out of airstream concealed in frame. Weld actuator bracket to frame.

G. Seals: Extruded silicone rubber blade seals. Flexible metal compression type jamb seals.

H. Actuator:
   1. Positive positioning, 24 volt actuator with spring return, furnished and sized by damper manufacturer.
   3. Actuator shall fail closed upon loss of electric power.

2.08 GASKET MATERIAL
A. Registers, Grilles, and Diffusers Installed in Exposed, Uninsulated Ductwork: 1/4 inch thick felt or sponge rubber material, of width as required by flange.

B. Flanged Joints in Ducts: 1/8 inch thick reinforced inert plastic of the self-conforming type, of same width as flange.
   1. Exception: Where flanged connections in cooking equipment exhaust ductwork is allowed by NPA 96, make up joints with Fibrefrax Grade 110 Paper by Carborundum Co.

2.09 SEALANTS

B. U.L. Listed adhesives (liquid or mastic), scrim, tapes, or combinations thereof, as required for pressure class; suitable for system operating temperatures; compatible with media conveyed within, insulation (if any), and ambient conditions.

PART 3 EXECUTION
3.01 INSTALLATION - GENERAL
A. Unless otherwise shown or specified, install the Work of this Section in accordance with the manufacturer's printed installation instructions and the SMACNA Manual.

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 minimum 8 by 8 inch (200 by 200 mm) size for hand access, 18 by 18 inch size for shoulder access, and as indicated. Provide 4 by 4 inch (100 by 100 mm) for balancing dampers only. Review locations prior to fabrication.

D. Provide fire 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 two (2) duct widths from duct take-off, where possible.

H. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

3.02 INSTALLATION - FLEXIBLE FABRIC CONNECTORS
A. Make ductwork connections to air handling equipment with flexible fabric connectors. Install connectors with sufficient slack to prevent vibration transmission.

B. Free Fabric Length: Install fabric connectors a minimum of three inches in length for ducts having a maximum diameter of 18 inches, or maximum side dimension of 30 inches, and a
minimum of 5 inches in length for duct diameters over 18 inches or side dimensions over 30 inches.

C. Secure fabric connectors to fans, casings, and ducts as follows:
   1. Round Connectors: Secure with No. 12 USS gage x 1 inch wide galvanized steel draw bands. Secure bands with bolts and nuts.
   2. Rectangular Connectors: Secure with 1 inch x 1/8 inch thick flat galvanized steel bars, with screws or bolts on maximum 8 inch centers, or with approved sheet metal slip joints. Tightly crimp fabric into sheet metal joint and secure complete joint with sheet metal screws on maximum 6 inch centers.

D. Fabric connectors may be factory pre-fabricated pre-assembled units, with minimum No. 24 USS gage metal edges, secured to fabric with double lock seams.

E. Do not paint fabric connectors.

3.03 INSTALLATION - ACCESS DOORS

A. Install gasketed access doors in ductwork at each of the following:
   1. Major changes of direction in horizontal ducts connected to cooking equipment hoods.
   2. Motor operated dampers.
   3. Fire dampers.
   4. Filters.
   5. Coils.
   6. Fans.
   7. All locations where operating parts of any kind are installed and elsewhere as indicated.

END OF SECTION
SECTION 23 3400
FANS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Power roof exhausters.
   B. Centrifugal in-line fans.

1.02 RELATED SECTIONS
   A. Section 23 0548 - Vibration and Seismic Controls.
   B. Section 23 3100 - Ductwork.
   C. Section 23 3300 - Ductwork Accessories.

1.03 REFERENCES
   D. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2003.
   F. UL 705 - Power Ventilators; Underwriters Laboratories Inc.; 2004.

1.04 SUBMITTALS
   A. Product Data: Manufacturer's catalog sheets, standard schematic drawings, specifications, and installation instructions for each size unit and curb.
      1. Provide fan curves with specified operating point clearly plotted.
   B. Detailed Dimensional Data: If roof curb is not the product of the fan manufacturer, provide detailed dimensional data confirming the fan and curb match exactly.
   C. Contract Closeout Submittals:
      1. Operation and Maintenance Data: Deliver 2 copies covering the installed products to the Owner's Representative.

1.05 QUALITY ASSURANCE
   A. Regulatory Requirements:
      1. Fans shall be licensed to bear the AMCA seal.
      2. All electrical components shall be UL listed.

PART 2 PRODUCTS

2.01 POWER ROOF EXHAUSTERS
   A. Manufacturers:
      1. PennBarry.
      2. Loren Cook Company.
   B. General: Powered roof exhausters shall be of the electric motor centrifugal fan type, V-belt or direct drive as scheduled on drawings. Fans shall be enclosed in a storm proof aluminum housing, properly braced and stiffened to form a rigid unit.
C. Housing: Fabricate from spun aluminum with bolted and welded construction utilizing corrosion resistant fasteners. Top cap shall be of two piece construction with stainless steel quick release latches to permit access to motor compartment. Provide structural reinforcing members to support fan wheel, motor and bearings, and vibration eliminating devices to prevent transmission of vibration to housing.

D. Fan Assembly:
   1. Fan Wheel: Non-overloading backward inclined, spark-resistant centrifugal type, fabricated from aluminum balanced at the factory in accordance with AMCA Standard 204-96.
   2. Drive Assembly: Direct or Belt drive as indicated on Drawings.
      a. Direct Drive: Electric motor direct drive.
      b. Belt Drive: Electric motor driven V belt drive, with cast iron or steel pulleys, sized for 150% of rated horsepower at maximum speed. Provide motor pulley of the variable pitch type, factory set at the design fan RPM at mid-position.
   3. Bearings: Heavy duty regreasable ball type in a cast iron pillow block housing designed specifically for air handling equipment and selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
   4. Motor: Heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase, and enclosure. Factory installed wiring shall be in a flexible metal conduit or integral conduit chase.

E. Damper: Automatic self-closing back draft type, with spring actuated return. Fabricate frame and blades from aluminum, with bearings of bronze or nylon. Damper blades shall be coupled together with tie rods at each end and shall have felted edges.

F. Nameplate: Engraved aluminum indicating manufacturer's model number, serial number, and equipment name to match unit tag as identified on drawings.

G. Accessories:
   1. Disconnect Switch: Factory installed and wired non-fused disconnect switch, located under fan housing.
   2. Birdscreen: Aluminum wire mesh birdscreen on discharge openings.
   4. Damper: Provide automatic air damper in lieu of gravity damper were indicated on drawings. Include line voltage motor drive, power open, spring return.
   5. Speed Control: On direct drive models, provide factory installed and wired solid state variable speed controller.

2.02 CENTRIFUGAL IN-LINE FANS

A. Manufacturers:
   1. PennBarry.
   2. Loren Cook Company.

B. General:
   1. Fans shall be of size, arrangement, type, capacity, motor location, discharge location, rotation and constructed for Class 1 operating limits, unless otherwise indicated. Fans shall be non-overloading, backward curved type.
   2. Backward Curved Fans:
      a. General: Fabricate housings from heavy gage galvanized sheet steel, properly reinforced and supported to prevent breathing and vibration at all speed. Blades, shrouts and center plates shall be fabricated from sheet steel, with the blades die formed and welded or riveted in place. Provide close grained cast iron hubs, securely riveted to the center plate. Shafts shall be steel, accurately turned, of ample diameter to prevent whipping, with precision bearings of the self-aligning, grease packed pillow
b. Fan Housings: Fabricate scrolls, sides and inlet cones from sheet steel, with angle bracing on housings. Provide a clean out door in scroll. Access doors shall be pan type, with inner surface flush with scroll and the rim secured to the frame on the scroll with hand grip bolts. Raised frame on scroll and door shall be suitable for installation of insulation, when specified.

3. Fan Shafts: Fabricate shafts from hot rolled or forged steel, extended on bearing end, to permit mounting of fan pulley, with end of shaft countersunk. Fan shafts shall be turned, ground, polished, and rust protected.

4. Bearings: Ball, roller or taper grease packed type, as required, rated for a minimum L50 life exceeding 200,000 hours. Provide with pressure type lubricating fittings, extend lubricating fittings to accessible locations.

5. Drive Assembly: Electric motor driven V-belt drive assembly, with belts having a service factor which is 50% greater than the rated HP of the motor. Provide cast iron or steel adjustable pulleys, with keyed hub, securely attached to shaft. Mount driving motor on rails for ease in adjustment of belt tension.

6. Motors shall be heavy duty ball bearing open drip proof motors. Motors shall be high efficiency with minimum nominal efficiencies in accordance with ASHRAE standard 90.1-2004. Efficiencies shall be demonstrated in accordance with NEMA standard MGI.

7. Guards: Provide belt drive with an expanded metal or sheet metal guard, of substantial construction to comply with all safety codes. Floor supported guards shall have the legs securely fastened to the floor, as directed and approved. Guards supported from the fan shall be securely bolted thereto. Guards shall be easily removable for access to belts and pulleys, and shall be provided with covered test openings, to permit RPM readings of fan and motor, without removal of belt guard.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
1. Install fans and accessories in complete accordance with manufacturer's printed installation instructions and the requirements of the Contract Documents.
2. Provide sheaves required for final air balance.
3. Provide backdraft dampers on inlet to roof and wall exhausters.
4. Provide backdraft dampers on outlet from cabinet and ceiling exhauster fans and as indicated.
   a. Provide automatic air dampers in lieu of gravity damper were indicated on drawings. Include line voltage motor drive, power open, spring return.

B. Power Roof Exhausters:
1. Furnish roof curbs to Roofing Contractor for installation with Manufacturer's printed installation instructions.
2. Secure roof exhausters with cadmium plated steel or stainless steel lag screws to roof curb.
3. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.

C. Centrifugal In-line and Duct Fans:
1. Install fans with vibration isolation.
2. Install flexible connections specified in Section 23 3300 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch (25 mm) flex between ductwork and fan while running.
3. Provide inlet air screens on fans not indicated to have an inlet duct connection. If fan has inlet bearing, mount screen inside bearing.

END OF SECTION
SECTION 23 3516
VEHICLE AND WELDING EXHAUST SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Fume exhaust fans.
B. Vehicle exhaust reels.
C. Ductwork and duct accessories.

1.02 RELATED REQUIREMENTS
A. Section 26 2717 - EQUIPMENT WIRING: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS
E. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).
F. SMACNA (RIDC) - Rectangular Industrial Duct Construction Standards; 2007.
G. SMACNA (ROUND) - Round Industrial Duct Construction Standards; 1999.

1.04 SUBMITTALS
A. Product Data: Provide manufacturer's catalog sheets, standard schematic drawings, specifications, and installation instructions for each size unit.
   1. Provide fan curves with specified operating point clearly plotted.
B. Shop Drawings: Indicate dimensions, sizes, weights and point loadings, and locations and sizes of field connections.
C. Contract Closeout Submittals:
   1. Operation and Maintenance Data: Include instructions for fan lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 QUALITY ASSURANCE
A. Fan Performance Ratings: Determined in accordance with AMCA 210 and labeled with AMCA Certified Rating Seal.
B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 FUME EXHAUST FANS
A. Manufacturers:
   1. PlymoVent Corporation
   2. Greenheck.
   3. Loren Cook Company.
B. The fans shall be manufactured to AMCA Class B spark resistant construction standards with a built-up backward incline impeller. The fan housing shall be steel and shall be powder coated yellow inside and outside. The housing shall be made in two parts, which are bolted together. The discharge orientation may be changed by unbolting the motor mounting plate from the housing and turned to the proper orientation. The fan shall be of a direct drive design with the
fan housing bolted directly to the face of the motor. All motors shall be high efficiency TEFC type suitable for indoor and outdoor installations. All fans shall be AMCA tested.

C. Fan Starter Control Box

1. Control boxes are UL approved/listed and are built specifically for a motor horsepower, voltage and electrical phase to suit each application. Consult fan schedule for fan motor requirements.
   a. The control box uses a NEMA 12 enclosure with a unique key lock on the door.
   b. Inside the control box there is a multi-voltage transformer. This transformer (primary power 208-volt, 3 Phase) has secondary output voltage of 24 volts.
   c. Included in the control box is an Allen Bradley motor starter contactor with a 24v magnetic coil sized to match motor HP, voltage and electrical phase.
   d. Coupled to the contactor is an adjustable motor overload with reset. The contactor and overload are designed for specific horsepower, voltage and phase of the fan motor used with this control box.
   e. Fuses are included for the primary and secondary electrical voltage circuits.
   f. A label inside the door list the operating parameters of the control box for each application.
   g. Activation of the motor starter is via completion of a 24-volt circuit. The switch shall be a MSR-24/2 Micro Switch located on the hose reel. Single throw, double pole. Micro Switch for fan start/stop. Low Voltage Wiring to each Hose Reel
   h. SA-Switch Simple On-Off Switch, 1PH, 30 Amps in a NEMA 4 enclosure- field connect to control box for local fan start/stop.

2.02 VEHICLE EXHAUST TUBING REELS

A. Manufacturers:
   1. Car-Mon Products, Inc.
   3. Ventaire.

B. General: Provide spring operated tubing storage reel designed for removal of vehicle exhaust. Furnish unit complete with 33 ft. of 5" diameter tubing, power actuator, and tailpipe adapter.

C. Hose reel Construction and Components:

1. All steel components shall be electro zinc plated steel except for the hose storage drum end plates, which will be powder coated yellow.
2. Provide four angle clips, one at each corner for mounting reel to walls or building steel.
3. Spring cassette must be a sealed enclosure to prevent the coiled spring from coming out of the enclosure if the spring ever needs to be exchanged. Spring cassette must be on the outside of the reel assembly (not in-between the hose reel side bracket and rotating drum) and held to the reel with three bolts.
4. Spring shall be a single, two-inch wide heavy-duty coil spring with a total lifting capacity of 40 lbs.
5. Provide two adjustable side support tie bars that both connects the side plates together and acts as the hose stop bar. Field adjust location of bar to match hose diameter used.
6. Provide two steel hose guides bolted to the rotating drum of hose reel. Plastic tubing type hose guides are unacceptable.
7. Access slot in hose reel drum shall be covered with a sheet metal cover made from the same thickness steel as the drum. Cover any exposed edges of drum access slot with a heavy molded trim channel that covers the entire access edge.
8. Provide, as part of the hose reel assembly, a rubber hose stop collar. This collar is installed around the hose and adjusted to control the amount of hose that hangs down off the reel when the hose is recoiled.
9. Hose reel must contain a latch and lock feature that allows an operator to pull the hose down to a convenient position and the reel will stay there until the hose is recoiled by pulling out a little more hose.
10. Hose reel must be designed to allow for future conversion from a spring recoil type reel to a motor activated reel via removal of the spring cassette and addition of the motor drive without complete disassembly of the reel.

11. Hose reel damper design to open on clockwise revolution and close on complete counterclockwise revolutions. Damper housing to be galvanized steel.

D. 1. Provide 5" diameter by 33 feet long exhaust hose. This hose shall be rated for a continuous operating temperature of 570 degrees F with a maximum spike temperature resistance of 650 degrees F.

E. Hose shall be constructed of a single ply, high temperature resistance Hypalon-coated polyester fabric that is mechanically joined together with an external galvanized metal helix. No glue or adhesives shall be used in the construction of the hose.

F. The external helix shall be covered with a tough, heat resistant plastic covering. This covering shall provide protection to both the hose and operator by protecting the hose from abrasion and acting as a heat protector for the operator. This protective wear band shall be yellow in color to provide additional visibility for the hose.

G. This hose shall have a smooth inner bore to lessen pressure loss.

H. The hose fabric shall not contain any asbestos or glass fibers.

I. Technical Data: Spring Recoil Hose Reel w/ Mechanical Damper, 33.5" wide drum, suitable for 5" hoses, 33' long max.

J. Connect hose to Hose Reel, nozzle or duct fitting with stainless steel Bridge Clamps made specifically for use with external helix hoses.

K. Stainless steel cone nozzle Tailpipe adaptor
   1. Stainless steel cone nozzle w / Vise Grip, 5" high temperature resistance 1200 DEG F with hose connection tapering up to 7" at open end. Nozzle 20 Gauge 304 Stainless Steel Cone nozzle with Locking Vise Grip.

2.03 DUCTWORK AND DUCT ACCESSORIES

A. All ductwork, fittings and joints must be securely fastened and sealed as required by the International Mechanical Code and the Uniform Mechanical Code.

B. The ductwork will connect the radial exhaust blower to the multiple hose assemblies with round spiral industrial duct, as defined in SMACNA Industrial Duct Construction to prevent deflection under use.

C. Duct gauge will be a minimum 22-gauge galvanized sheet metal round spiral as outlined and required in International Mechanical Code.

D. Ductwork will be of the taper design to maintain constant velocities without the need for dampers to balance the system. Any and all elbows-Branches, Reducing & non- Reducing lateral branches will be 20 gauge. NOTE Saddle taps to Duct are not acceptable,

E. All non-welded joints will be sealed with a mechanical Teflon collar to provide a positive leak proof seal to fulfill the International Mechanical Code and Uniform Mechanical Code that "all joints must be securely fastened and sealed" to comply with conveying of hazardous material requirements. Ductwork joints that do not conform to the above do not fulfill the International Mechanical Code and Uniform Mechanical Code for conveying hazardous material.

F. A hinged back draft damper/exhaust rain cap will be provided for protection from rain and other inclement weather.

PART 3 EXECUTION

3.01 INSTALLATION

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

B. Install fans with resilient mounting.
C. Install flexible connections at fan inlet and discharge. Ensure metal bands of connectors are parallel with minimum 1 inch (25 mm) flex between ductwork and fan while running.

D. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Diffusers.
   B. Registers/grilles.
   C. Louvers.

1.02 RELATED REQUIREMENTS
   A. Section 23 3100 - Ductwork.
   B. Section 23 3300 - Ductwork Accessories.

1.03 REFERENCE STANDARDS
   C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).

1.04 SUBMITTALS
   A. Product Data: Catalog sheets, diagrams, standard schematic drawings, and installation instructions for each manufactured product.
   B. Schedule of Outlets and Inlets: Indicate type keyed to contract drawings, application, size, airflow, pressure drop, and noise level.

1.05 QUALITY ASSURANCE
   A. Regulatory Requirements:
      1. Unless otherwise shown or specified comply with the applicable requirements of the following:
         a. SMACNA: Gages of material, fabrication, sealing, and installation shall be in accordance with the SMACNA Manuals.
            1) HVAC Duct Construction Standards.
            2) Round Industrial Duct Construction Standard.
            3) Rectangular Industrial Duct Construction Standard.
         c. UL: Standards No. UL181, UL555, and UL555S.
         d. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
         e. Test and rate louver performance in accordance with AMCA 500-L.

1.06 MAINTENANCE
   A. Special Tools:
      1. One bar deflection key for every five supply grilles or diffusers.
      2. Two keys or socket wrenches for each type of damper adjustment screw or device on manual damper regulators.
      3. One tool for each type and size security fastener.

PART 2 PRODUCTS

2.01 SUPPLY AIR OUTLETS:
   A. Manufacturers:
      1. Price Industries.
      2. Titus.
   B. Type 'S1':
      1. Model: Krueger PLQ.
2. Description: Steel - Square ceiling diffuser with round neck and square face plaque. The diffuser backpan shall be one piece stamped construction and corporate 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. Border: Provide appropriate border to accommodate mounting per ceiling type.
5. Finish: #44 British White.

C. Type 'S2':
   1. Model: Krueger 880.
   2. Description: Steel - Double deflection with the sets of fully adjustable deflection blades spaced at 3/4" on center. Front blades shall be parallel to short dimension.

2.02 RETURN/EXHAUST AIR INLETS:

A. Manufacturers:
   1. Price Industries.
   2. Titus.

B. Type 'R1':
   2. Description: Aluminum 1/2"x1/2"x1" grids (egg crate core) with extruded aluminum border. Sized per schedule on drawings.
   3. Border: Type F23 for lay-in installation, Type f22 for surface mount. Panel mounting shall not be allowed.

C. Type 'R2'
   1. Model: Krueger S80
   2. Description: Steel 35 degree deflection fixed louver type blades spaced at 3/4" on center.

2.03 LOUVERS

A. Manufacturers:
   1. Greenheck.
   2. Louvers and Dampers/Mestek Inc..
   3. Ruskin.

B. Type: Stationary type louver with welded construction and drainable blades mounted in a 4 inch louver frame. Each stationary blade shall incorporate an integral downspout so water drains to blade end, then down the downspouts and out at the louver sill.

C. Blades: Position blades at 45 degree angle at 4 inch on centers.

D. Material: 6063T5 Extruded aluminum 0.081 inch nominal thickness.


F. Finish: Louver shall be supplied with standard mill finish.

G. Finish: Louver shall be supplied with a baked enamel finish, color to be selected by Architect.

PART 3 EXECUTION
3.01 INSTALLATION

A. Unless otherwise specified, install the Work of this Section in accordance with manufacturer's printed installation instructions and the appropriate SMACNA Manual.
B. Coordination: Coordinate location of outlets and inlets with other trades. Make necessary minor adjustments in position to conform with architectural features, symmetry, sprinkler/smoke heads, and lighting arrangement.
   1. Locate outlets and inlets to conform to reflected ceiling plans.
   2. Arrange and locate duct taps to accommodate proper placement of outlets and inlets.

C. Install diffusers to ductwork with air tight connection.

D. 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.

END OF SECTION
PART 1: GENERAL

1.01 RELATED DOCUMENTS
   A. Conditions of the Contract and portions of Division One of this Project Manual apply to this
      Section as though repeated herein.

1.02 SUMMARY
   A. Section Includes:
   B. Spring Operated Hose Reel Hose Storage System, Plymovent SER-850 Spring recoil hose reel.

1.03 SYSTEM DESCRIPTION
   A. Hose Reel Storage System.
   B. Supports.
   C. Hose
   D. Tailpipe adaptors
   E. Fan
   F. Control box

1.04 SUBMITTALS
   A. Product Data: Indicate manufacturer’s model number, technical data, accessories,
      requirements for access, maintenance, weights and service-connections including dimensions.

1.05 RELATED REQUIREMENTS
   A. NIOSH Pocket Guide to Chemical Hazards
   B. Underwriters Laboratory (UL)
   C. National Fire Protection Agency (NFPA)
      1. National Electric Code (NEC)
      2. NFPA 1500
         a. Air Movement (AMCA)
         b. International Mechanical Code (IMC)
         c. Uniform Mechanical Code (UMC)
         d. American National Standards Institute (ANSI)
         e. American Society of Mechanical Engineers (ASME)
         f. Vehicle Exhaust System Certified Bidder will provide one (1) automatic start control
            panel listed by UL in accordance with underwriters’ laboratories standard UL-508.
         g. Vehicle Exhaust System Certified Bidder will provide and install one (1) non-sparking
            radial exhaust blower.
         h. The pneumatic system shall virtually under no circumstances allow exhaust leakage
            or bypass to the nozzle.

1.06 QUALITY ASSURANCE
   A. The manufacturer must be ISO 9001:2000, UL and CUL Certified and have their Exhaust
      Blowers certified by the Air Movement and Control Association (AMCA) to ensure quality,
      consistency and reliability of products. Certification documents shall be provided and attached
      to the bid proposal. All workmanship, manufacturing procedures, airflow design and materials
      shall be performance guaranteed.

1.07 MANUFACTURER QUALIFICATIONS
   A. Equipment and materials provided for the system installation(s) shall be manufactured and
      provided by the supplier of primary exhaust removal system (Equipment Manufacturer) and be a
      standard product of manufacturer currently engaged in the manufacture of Vehicle Exhaust
Extraction Systems. Where the requirement calls for a packaged exhaust system to be provided, all items shall be the product of the manufacturer. The product offering is to be a product that has been offered before a minimum period of twenty-five (25) years.

PART 2: PRODUCTS

2.01 MANUFACTURER

A. PlymoVent Group: www.plymovent.com
B. Ventair
C. Car-Mon Products, Inc.

2.02 MANUFACTURED HOSE REEL UNITS

A. Spring Operated Hose Reel Hose Automatic Drum Storage System. QUANITY Three (3)
B. Model: SER-850-125 AD for 5-inch diameter hose. Spring Recoil Hose Reel, 23.6” wide drum, suitable for 5” hoses, 33’ long max.
C. Hose Reel Construction and Components:
   1. All steel components shall be electro zinc plated steel except for the hose storage drum end plates, which will be powder coated yellow.
   2. Provide four angle clips, one at each corner for mounting reel to walls or building steel.
   3. Spring cassette must be a sealed enclosure to prevent the coiled spring from coming out of the enclosure if the spring ever needs to be exchanged. Spring cassette must be on the outside of the reel assembly (not in-between the hose reel side bracket and rotating drum) and held to the reel with three bolts.
   4. Spring shall be a single, two-inch wide heavy-duty coil spring with a total lifting capacity of 40 lbs.
   5. Provide two adjustable side support tie bars that both connects the side plates together and acts as the hose stop bar. Field adjust location of bar to match hose diameter used.
   6. Provide two steel hose guides bolted to the rotating drum of hose reel. Plastic tubing type hose guides are unacceptable.
   7. Access slot in hose reel drum shall be covered with a sheet metal cover made from the same thickness steel as the drum. Cover any exposed edges of drum access slot with a heavy molded trim channel that covers the entire access edge.
   8. Provide, as part of the hose reel assembly, a rubber hose stop collar. This collar is installed around the hose and adjusted to control the amount of hose that hangs down off the reel when the hose is recoiled.
   9. Hose reel must contain a latch and lock feature that allows an operator to pull the hose down to a convenient position and the reel will stay there until the hose is recoiled by pulling out a little more hose.
   10. Hose reel must be designed to allow for future conversion from a spring recoil type reel to a motor activated reel via removal of the spring cassette and addition of the motor drive without complete disassembly of the reel.
   11. Hose reel damper design to open on clockwise revolution and close on incomplete counterclockwise revolutions. Damper housing to be galvanized steel.
      a. Exhaust Hose Quantity Three
         1) EF2 hose is a fabric hose that withstands high heat when extracting exhaust from spark ignition engines or diesel engines. The hose is especially suitable when working with trucks or construction machines that produce hot exhaust. EF2 is flame-resistant due to a specially coated, high temperature fabric.
      D. Provide Plymovent Type EF 5” diameter by 33 feet long exhaust hose. This hose shall be rated for a continuous operating temperate of 570 degrees F with a maximum spike temperature resistance of 650 degrees F.
      E. Hose shall be constructed of a single ply, high temperature resistance Hypalon-coated polyester fabric that is mechanically joined together with an external galvanized metal helix. No glue or adhesives shall be used in the construction of the hose.
F. The external helix shall be covered with a tough, heat resistant plastic covering. This covering shall provide protection to both the hose and operator by protecting the hose from abrasion and acting as a heat protector for the operator. This protective wear band shall be yellow in color to provide additional visibility for the hose.

G. This hose shall have a smooth inner bore to lessen pressure loss.

H. The hose fabric shall not contain any asbestos or glass fibers.

I. Technical Data: Spring Recoil Hose Reel w/ Mechanical Damper, 33.5" wide drum, suitable for 5" hoses, 33" long max.

J. Connect hose to Hose Reel, nozzle or duct fitting with stainless steel Bridge Clamps made specifically for use with external helix hoses.

2.03 STAINLESS STEEL CONE NOZZLE TAILPIPE ADAPTOR QUANTITY THREE

A. STPAV-5 Stainless steel cone nozzle w/ Vise Grip, 5" STPAV HIGH TEMPERATURE RESISTANCE 1200 DEG F 0000102925 WITH hose connection tapering up to 7" at open end. Nozzle 20 Gauge 304 Stainless Steel Cone nozzle with Locking Vise Grip.

2.04 2.05 PLYMOVENT MANUFACTURED “FUA” SERIES FANS - FAN HOUSING POWDER COATED LIGHT GRAY. NEMA FAN. QUANTITY ONE

A. The “F” Series FUA-4700 536-NEMA fans include FUA models shall be manufactured to AMCA Class B spark resistant construction standards with a built-up backward incline impeller. The fan housing shall be steel and shall be powder coated yellow inside and outside. The housing shall be made in two parts, which are bolted together. The discharge orientation may be changed by unbolting the motor mounting plate from the housing and turned to the proper orientation. The fan shall be of a direct drive design with the fan housing bolted directly to the face of the motor. All motors shall be high efficiency TEFC type suitable for indoor and outdoor installations. All fans shall be AMCA tested. F Series fan, FUA-4700 536-NEMA F SERIES FAN, 3 HP, 3450 RPM, 208-230 / 460V, 3 PHASE, 60 HZ, TEFC MOTOR, CLASS B CENTRIFUGAL FAN, GRAY FAN HOUSING.

2.05 2.06 PLYMOVENT MANUFACTURED FAN STARTER CONTROL BOX QUANTITY ONE

A. Provide one Plymovent SA-24 Control Box (one per fan) to remotely start/stop the fan via a remotely located switch. A-24 control box for 3HP, 208-230volt, three phase motor, rated for 4A, with transformer, contactor, overload and fuses. NEMA 12 enclosure.

B. All SA-24 control boxes are UL approved/listed and are built by Plymovent specifically for a motor horsepower, voltage and electrical phase to suit each application. Consult fan schedule for fan motor requirements.

1. The SA-24 control box uses a NEMA 12 enclosure with a unique key lock on the door.
2. Inside the control box there is a multi-voltage transformer. This transformer (primary power 208-volt, 3 Phase) has secondary output voltage of 24 volts.
3. Included in the control box is an Allen Bradley motor starter contactor with a 24v magnetic coil sized to match motor HP, voltage and electrical phase.
4. Coupled to the contactor is an adjustable motor overload with reset. The contactor and overload are designed for specific horsepower, voltage and phase of the fan motor used with this control box.
5. Fuses are included for the primary and secondary electrical voltage circuits.
6. A label inside the door list the operating parameters of the SA-24 control box for each application.
7. Activation of the motor starter is via completion of a 24-volt circuit. The switch shall be a MSR-24/2 Micro Switch located on the hose reel. Single throw, double pole. Micro Switch for fan start/stop (through a SA-24). Low Voltage Wiring to each Hose Reel
8. SA-Switch Simple On-Off Switch, 1PH, 30 Amps in a NEMA 4 enclosure- field connect to SA-24 control box for local fan start/stop. Low Voltage Wiring to SA-24 Box.
2.06 DUCTWORK
   A. All ductwork, fittings and joints must be securely fastened and sealed as required by the International Mechanical Code and the Uniform Mechanical Code.
   B. The ductwork will connect the radial exhaust blower to the multiple hose assemblies with round spiral industrial duct, as defined in SMACNA Industrial Duct Construction to prevent deflection under use.
   C. Duct gauge will be a minimum 22-gauge galvanized sheet metal round spiral as outlined and required in International Mechanical Code.
   D. Ductwork will be of the taper design to maintain constant velocities without the need for dampers to balance the system. Any and all elbows-Branches, Reducing & non- Reducing lateral branches will be 20 gauge. NOTE Saddle taps to Duct are not acceptable,
   E. All non-welded joints will be sealed with a mechanical Teflon collar to provide a positive leak proof seal to fulfill the International Mechanical Code and Uniform Mechanical Code that “all joints must be securely fastened and sealed” to comply with conveying of hazardous material requirements. Ductwork joints that do not conform to the above do not fulfill the International Mechanical Code and Uniform Mechanical Code for conveying hazardous material.
      1. A hinged back draft damper/exhaust rain cap will be provided for protection from rain and other inclement weather.

2.07 FABRICATION
   A. Shop Assembly: Shop assemble hose reel to greatest extent possible for ease of shipment. Provide each hose reel with an adapter assembly to adapt the hose reel to the desired hose diameter. This adaptor kit includes the Hose Stop Collar used to limit how much hose hangs down from the reel when the hose is recoiled.

PART 3: EXECUTION

3.01 EXAMINATION
   A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, service-utility connections, and other conditions affecting installation and performance of food service equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION
   A. Install system level and plumb, and in accord with manufacturer’s written instructions, original design and referenced standards.
   B. Hose reels must be mounted securely from the building steel or suitable structure.

3.03 ADJUSTING
   A. Adjust system for proper operation. Replace any parts that prevent the system from operating properly.

3.04 CLEANING
   A. Remove all debris caused by installation of the system. Clean all exposed surfaces to as fabricated condition and appearance.

3.05 DEMONSTRATION
   A. Provide the end user a minimum of one hour of hands-on demonstration and operation of the system.

3.06 PROTECTION
   A. Provide protection of the completed installation until completion of the project. Repair any damage at no additional cost to owner.

3.07 WARRANTY
   A. 3 Year Warranty: Standard Product
1. 3 Year Warranty will be granted on Plymovent Standard Product

B. 1 Year Warranty: Exhaust Hoses, Electrical Motors and Components (excluding Fuses)

END OF SECTION
SECTION 23 5100
BREECHINGS, CHIMNEYS, AND STACKS

PART 1  GENERAL
1.01  SECTION INCLUDES
   A. Double wall metal stacks.
   B. Modulating Combustion Air System

1.02  RELATED REQUIREMENTS

1.03  REFERENCE STANDARDS
   A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or
      Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2017.
   B. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel
      Sheet, Strip, Plate, and Flat Bar; 2010.
   C. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon,
      Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and
      Ultra-High Strength; 2017.
   E. NFPA 82 - Standard on Incinerators and Waste and Linen Handling Systems and Equipment;
      2014.
   G. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).
   H. UL 103 - Factory-Built Chimneys for Residential Type and Building Heating Appliances; Current
   J. UL 641 - Type L Low Temperature Venting Systems; Current Edition, Including All Revisions.
   K. UL 959 - Medium Heat Appliance Factory Built Chimneys; Current Edition, Including All
      Revisions.

1.04  DEFINITIONS
   A. Breeching: Vent Connector.
   B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.
   C. Smoke Pipe: Round, single wall vent connector.
   D. Vent: That portion of a venting system designed to convey flue gases directly outdoors from a
      vent connector or from an appliance when a vent connector is not used.
   E. Vent Connector: That part of a venting system that conducts the flue gases from the flue collar
      of an appliance to a chimney or vent, and may include a draft control device.

1.05  DESIGN REQUIREMENTS
   A. Factory built vents and chimneys used for venting natural draft appliances shall comply with
      NFPA 211 and be UL listed and labeled.

1.06  SUBMITTALS
   A. See Section 01 3300 - Submittal Procedures, for submittal process.
   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.
D. Manufacturer's Instructions: Include installation instructions, and indicate assembly, support details, and connection requirements.

E. Manufacturer's Certificate: Certify that refractory lined metal stacks meet or exceed specified requirements.

1.07 QUALITY ASSURANCE

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

1.08 REGULATORY REQUIREMENTS

A. Conform to applicable code for installation of natural gas burning appliances and equipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Enervex Inc.: www.enervex.com
B. AMPCO by Hart & Cooley, Inc; Model VSI: www.ampcostacks.com

2.02 BREECHINGS, CHIMNEYS, AND STACKS - GENERAL REQUIREMENTS

2.03 DOUBLE WALL METAL STACKS (PRIMARY SCHOOL)

A. Provide double wall metal stacks, tested to UL 103 and UL listed, for use with building heating equipment, in compliance with NFPA 211.

B. Fabricate with 1 inch minimum air space between walls. Construct inner jacket of 24 gage ASTM A666, Type 304 stainless steel. Construct outer jacket of aluminum coated steel 24 gage for sizes 10 inches to 24 inches (250 mm to 600 mm) and 20 gage (0.9 mm) for sizes 28 inches to 48 inches (700 mm to 1200 mm).

2.04 DOUBLE WALL METAL STACKS (BUS GARAGE)

A. Provide double wall metal stacks, tested to UL 103 and UL listed, for use with building heating equipment, in compliance with NFPA 211.

B. Fabricate with 1 inch minimum air space or high temperature ceramic-fiber insulation between walls. Construct inner jacket of 20 gauge ASTM A666, Type AL29-4C or 316L-PCM stainless steel. Construct outer jacket of Type 304 stainless steel with a minimum thickness of 24 gauge. Similar to Security Chimney – Secure Seal, Heat-Fab – Saf-T Vent CI Plus or Enervex - PowerStack.”

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 54.

C. Provide all modular straight sections, fittings, supports, guides, expansion joints, guy sections, guy tensioners, roof thimbles, roof flashings, storm collars and stack cap terminations as required to provide a complete system per the manufacturer's installation instructions.

D. The vertical stack termination shall be no less than two feet above any portion of the building within ten feet of the stack penetration (see NFPA-211).

E. 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.

F. Level and plumb chimney and stacks.

G. Clean breechings, chimneys, and stacks during installation, removing dust and debris.

END OF SECTION
SECTION 23 5216
CONDENSING BOILERS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Boilers.
B. Controls and boiler trim.
C. Hot water connections.
D. Fuel connection.
E. Collector, draft hood, and chimney connection.

1.02 RELATED SECTIONS
A. Section 23 2113 - Hydronic Piping.
B. Section 23 2114 - Hydronic Specialties.
C. Section 23 5100 - Breechings, Chimneys, and Stacks.

1.03 REFERENCES
C. 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; 2004.
E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2003.
I. Part 4 of Title 12 Rules and Regulations of the State of New York Industrial Code Rule No. 4 (12NYCRR4).

1.04 PERFORMANCE REQUIREMENTS
A. Performance rating shall be in accordance with Hydronics Institute Testing and Rating Standard for Commercial Boilers.

1.05 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.
C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE
A. Regulatory Requirements:
1. Boiler shall be constructed, tested and stamped in accordance with the ASME Code for Low Pressure Heating Boilers, bearing the 'H' stamp for 160 psig working pressure.
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.

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

1.07 WARRANTY

A. (Lochinvar) The complete heat exchanger assembly shall carry a 10 year limited warranty against failure due to condensate corrosion, thermal stress, material defects, or workmanship. The burner shall carry a complete 5 year warranty.

PART 2 PRODUCTS

2.01 HIGH EFFICIENCY HOT WATER BOILER

A. Manufacturers:
   1. Aerco International, Inc.
   2. Lochinvar Corporation.
   3. Fulton
   4. Substitutions: See Section 01 6000 - Product Requirements

B. Construction:
   1. The Boiler shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. A burner/flame observation port shall be provided for observing the burner flame and combustion chamber. The burner shall be a premix design constructed of high temperature stainless steel with a woven Fecralloy outer covering to provide smooth operation at all modulating firing rates. The Boiler shall be supplied with a negative pressure regulation gas valve and be equipped with a pulse width modulation blower system to precisely control the fuel/air mixture to the burner. The Boiler shall operate in a safe condition with gas supply pressures as low as 4 inches of water column. The burner flame shall be ignited by direct spark ignition with flame monitoring via a flame sensor.

C. Modulating Air/Fuel Valve and Burner:
   1. The Boiler burner shall be capable of a 10 to 1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall not operate above 7.5% oxygen level or 55% excess air. The burner shall produce less than 20 ppm of NOx,
under standard calibration, corrected to 3% excess oxygen when firing on natural gas. The burner shall be metal fiber mesh covering a stainless steel body with spark or proven pilot ignition and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and fuel input. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment. A variable speed cast aluminum pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.

D. Pressure Vessel/Heat Exchanger:
   1. The boiler shall be capable of handling return water temperatures down to 40 F without any failure due to thermal shock or fireside condensation. The heat exchanger shall be constructed of 439 stainless steel fire tubes and tubesheets, with a one-pass combustion gas flow design. The fire tubes shall be 1/2" or 5/8" OD, with no less than 0.049" wall thickness. The upper and lower stainless steel tubesheet shall be no less than 0.25" thick. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 150 psig. Access to the tubesheets and heat exchanger shall be available by burner and exhaust manifold removal. Minimum access opening shall be no less than 8-inch diameter. The pressure vessel shall have a maximum water volume of 55 gallons. The boiler water pressure drop shall not exceed 3 psig at 261 gpm. The boiler water connections shall be 4" flanged 150 lb. ANSI rated. The pressure vessel is constructed of SA53 carbon steel, with a 0.25 in. thick wall and 0.50 in. thick upper head. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases. The heat exchanger shall be constructed of 439 stainless steel fire tubes and tube sheets with a one-pass combustion gas flow design. The fire tubes shall be 5/8 in. OD with no less than 0.065 in. wall thickness. The upper and lower stainless steel tube sheets shall be no less than 0.313 in. thick. The pressure vessel shall be constructed of ASME SA53 carbon steel, with a 0.25 inch thick wall and 0.50-inch thick upper head. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.

E. Boiler Venting:
   1. Vent system with Vertical rooftop Exhaust and Horizontal sidewall Air Intake with the combustion air intake in a different pressure zone. The flue shall be Category IV approved material constructed of Stainless Steel. A separate pipe shall supply combustion air directly to the boiler from the outside in a different pressure zone from that of the exhaust vent. The boiler’s total combined air intake length shall not exceed 100 equivalent feet. The boiler’s total combined exhaust venting length shall not exceed 100 equivalent feet.

F. Boiler Controls:
   1. The boiler controls shall be Underwriters Laboratories Recognized.
   2. The Boiler shall utilize a 24 VAC control circuit and components. The control system shall have a factory installed display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. The Boiler shall be equipped with a temperature/pressure gauge; high limit temperature control with manual reset; ASME certified pressure relief valve set for 30 psi (standard); outlet water temperature sensor with a dual thermistor to verify accuracy; system supply water temperature sensor; outdoor air sensor, flue temperature sensor with dual thermistor to verify accuracy; low water cut off with manual reset, blocked drain switch and a condensate trap for the heat exchanger condensate drain.
   3. Each boiler shall incorporate two low level cut-offs, an electric type low water level cutoff with test, manual reset and dual over-temperature protection and also an auxiliary low level cut-off 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.

G. Boiler Management System (BMS):
   1. The Boiler Manufacturer shall supply as part of the boiler package a completely integrated Boiler Management System Programmer to control all operation and energy input of the multiple boiler heating plant. Each boiler shall have integrated Boiler Sequencing Technology (BST), capable of multi-unit sequencing with lead-lag functionality and parallel operation. The system will incorporate the following capabilities:
      a. Efficiently sequence 2-to-8 units on the same system to meet load requirement.
      b. Integrated control and wiring for seamless installation of optional isolation valve. When valves are utilized, the system shall operate one motorized valve per unit as an element of load sequencing. Valves shall close with decreased load as units turn off, with all opening under no-load conditions.
      c. Automatically rotate lead/lag amongst the units on the chain and monitor run hours per unit and balance load in an effort to equalize unit run hours.
      d. Option to manually designate lead and last boiler.
      e. Designated master control, used to display and adjust key system parameters.
      f. Automatic bump-less transfer of master function to next unit on the chain in case of designated master unit failure; master/slave status should be shown on the individual unit displays.
   2. The controller shall have the ability to vary the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant. The ACS shall control the boiler outlet header temperature within +2°F. The controller shall be a PID type controller and uses Ramp Up/Ramp Down control algorithm for accurate temperature control with excellent variable load response. The ACS controller shall provide contact closure for auxiliary equipment such as system pumps and combustion air inlet dampers based upon outdoor air temperature.
   3. When set on Internal Setpoint Mode, temperature control setpoint on the ACS shall be fully field adjustable from 50°F to 190°F in operation. When set on Indoor/Outdoor Reset Mode, the ACS will operate on an adjustable inverse ratio in response to outdoor temperature to control the main header temperature. Reset ratio shall be fully field adjustable from 0.3 to 3.0 in operation. When set on 4ma to 20ma Temperature Control Mode, the ACS will operate the plant to vary header temperature setpoint linearly as an externally applied 4-20 ma signal is supplied.
   4. Provide BACNET interface for connection into existing building controls system.

H. Fuel Supply Requirements:
   1. Each boiler shall require a minimum natural gas pressure of 7” W.C. (FM gas train) 7.4” W.C. (IRI gas train) at 2,000 scfh (full load rated capacity).

PART 3 EXECUTION

3.01 INSTALLATION

A. Install boiler in accordance with manufacturer's printed instructions.
B. Provide framed glass holder for NYS Department of Labor certificate of inspection, and post near the boiler prior to operation of the boiler.
C. Attach to boiler, identification number assigned by NYS Department of Labor Commissioner.
D. Each boiler shall be provided with an individual supply gas regulator for proper gas regulation for each gas supply as close to the boiler inlet connection as possible.
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. The vent system must conform with all manufacturer’s recommendations and shall utilize UL listed stainless steel AL-29-4C Positive Pressure.

I. Pipe relief valves and condensate drain to nearest floor drain.

J. Coordinate for electrical connections by 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.

END OF SECTION
SECTION 23 5233
WATER-TUBE BOILERS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Packaged water-tube boilers.
B. Electrical power.

1.02 RELATED REQUIREMENTS
A. Section 03 3000 - Cast-in-Place Concrete.
B. Section 23 5100 - Breechings, Chimneys, and Stacks.
C. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables.
D. Section 26 0526 - Grounding and Bonding for Electrical Systems

1.03 REFERENCE STANDARDS
B. ASME B31.9 - Building Services Piping; 2014.
C. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2015.
D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.
C. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start up instructions.
D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 WARRANTY
A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Manufacturer will repair or replace pressure vessel components, casing of boilers that fail, due to materials or workmanship within five years from date of Substantial Completion, pro rata.
   1. Thermal Shock: 20 years from date of Substantial Completion.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Protect boilers from damage by leaving factory inspection openings and shipping packaging in place until final installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Bryan Steam Corporation; _________: www.bryanboilers.com/
B. Cleaver-Brooks; _________: www.cleaver-brooks.com/
C. Substitutions: See Section 01 6000 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS
A. ASME Compliance: Fabricate and label boilers to comply with ASME BPVC.
2.03 PACKAGED WATER-TUBE BOILERS

A. Factory-fabricated, hot water, water-tube boiler on a skid mounted steel base including insulation, jacketing, venting, supply and return connections, and controls.

B. Pressure Vessel: Vertical steel tubes and drums.
   1. Accessible head plates at both ends.
   2. Inspection openings or couplings in headers.
   3. Drain tappings, both drums, for surface and mud removal.
   4. Limit tube configurations to two.
   5. Accessible inspection ports in drum, mud legs, and tube manifolds.
   6. Membrane water-wall design.

C. Combustion Chamber:
   1. Pour Refractory: 2 1/2 inch (64 mm), 2700 deg F (1482 deg C) minimum.
      a. Lap joints 2 inch (50 mm) thick.
   2. Fiber-blanket joint seals on side walls.
   3. Observation ports in front and back.

D. Casing:
   1. Insulation Surrounding Pressure Vessel and Combustion Chamber:
      a. Refractory Thickness: 2 inch (50 mm).
      b. Insulating Board Thickness: 1 inch (25 mm).
      c. Galvanized-steel membrane.
      d. Mineral-fiber Insulation: 2 inch (50 mm).
   2. Flue Connection: Aluminized steel.
   4. Steel mounting base.
   5. Control Compartment Enclosure: NEMA 250, Type 1A.

E. Trim for Hot Water:
   2. Comply with ASME B31.9.
   3. Aquastat Controllers: Operating, firing rate, and high limit.
   4. Two (2) Safety Relief Valves: ASME rated.
   5. Pressure and Temperature Gauge: Minimum 3 1/2 inch (89 mm) diameter,
   7. High limit safety controller
   8. Low water cutoff

2.04 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

B. Single-Point Field Power Connection: Factory installed switches, controllers, transformers, and other devices will have a single-point field connection.
   1. Enclosure: NEMA 250, Type 1.
   2. Wiring: Numbered and color-coded matching wiring diagram.
   3. Factory wiring exterior of an enclosure to be in a metal raceway.
   4. Field power interface shall be to lugs.
   5. Branch power circuit to each motor and controls with disconnect switch or circuit breaker.
PART 3 EXECUTION

3.01 INSTALLATION
   A. Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 3000.
   B. Gas-Fired Boilers: Install according to NFPA 54.
   C. Assemble boiler tubes in sequence and seal each tube joint.
   D. Assemble and install boiler trim.
   E. Install necessary control wiring and electrical devices requiring field installation.

3.02 CONNECTIONS
   A. Drawings indicate general arrangement of piping, fittings, and specialties.
   B. Piping installation must not impede service and maintenance of boiler.
   C. Hot-water to supply and return tappings with shutoff valve with union or flange connections. Install piping from safety relief valves to nearest floor drain.
   D. Equipment drain connection to nearest floor drain. Pipe size same as connection. Provide isolation valve.
   E. Connect breeching boiler outlet. Comply with Section 23 5100.
   F. Install flue-gas recirculation duct from vent to burner. Comply with Section 23 5100.
   G. Ground equipment according to Section 26 0526.
   H. Connect wiring according to Section 26 0519.

END OF SECTION
SECTION 23 7413
PACKAGED ROOF-TOP UNITS

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Packaged roof top unit.
   B. Heat exchanger.
   C. Refrigeration components.
   D. Unit operating controls.
   E. Roof mounting curb and base.
   F. Electrical power connections.
   G. Operation and maintenance service.

1.02 RELATED SECTIONS
   A. Section 23 0548 - Vibration and Seismic Controls for HVAC.
   B. Section 23 0553 - Mechanical Identification.
   C. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.
   D. Section 23 0713 - Ductwork Insulation.
   E. Section 23 0993 - Sequence of Operations for HVAC Controls.
   F. Section 23 3100 - Ductwork.
   G. Section 26 2717 - EQUIPMENT WIRING: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS
   B. AHRI 270 - Sound Performance Rating of Outdoor Unitary Equipment; 2015.
   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.

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.
2. Extra Filters: One set for each unit.

1.05 QUALITY ASSURANCE
A. Regulatory Requirements:
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.
5. Provide gas fired heating modules for installation in combination gas fired heating and
cooling units, certified by the AGA specifically for outdoor applications.

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 five year manufacturer's warranty to include parts coverage for heat exchangers.

PART 2 PRODUCTS
2.01 PACKAGED ROOF-TOP UNITS - 3 THRU 10 TON UNITS
A. Manufacturers:
1. The Trane Company.
2. The Carrier Corporation.
3. Lennox International.
B. General:
1. Provide combination heating and cooling units, specifically designed for installing totally
exposed on the roof, with convertible airflow arrangement. All units shall be factory
assembled, internally wired, fully charged with refrigerant, and 100 percent run tested to
check heating and cooling operation, fan and blower rotation, and control sequence before
leaving the factory. Upon installation in their permanent locations on the roof of a building,
connections to service piping, electrical service, and ductwork shall only be required to put
units in operation.
C. Unit Casing:
1. Cabinet: Galvanized steel, phosphatized, properly reinforced for maximum strength and
rigidity, with all welded steel angle and channel framework as required, and finished with
an air-dry paint. Include gasketed removable access doors with piano hinges and locking
handle. Structural members shall be minimum 18 gage (1.20 mm), with access doors or
removable panels of minimum 20 gage (0.90 mm).
2. Units cabinet surface shall be tested 1000 hours in salt spray test in compliance with
ASTM B117.
3. Cabinet construction shall allow for all service/ maintenance from one side of the unit.
4. Cabinet top cover shall be one piece construction or where seams exits, it shall be
double-hemmed and gasket-sealed.
5. Access Panels: Water- and air-tight panels with handles shall provide access to filters,
heating section, return air fan section (where applicable), supply air fan section, evaporator
coil section, and unit control section.
6. Unit's base pan shall have a raised 1 1/8 inch high lip around the supply and return openings for water integrity.
7. Insulation: Provide 1/2 inch thick fiberglass insulation with foil face on all exterior panels in contact with the return and conditioned air stream. All edges must be captured so that there is no insulation exposed in the air stream.
8. Provide openings through the unit base for power, control, and gas connections.
10. The base of the unit shall have forklift and crane lifting provisions.

D. Fans and Motors:
1. Provide evaporator fan section with forward curved, double width, double inlet, centrifugal type fan.
2. Provide self-aligning, grease lubricated, ball or sleeve bearings with permanent lubrication fittings.
3. Provide units with belt driven supply fans with adjustable motor sheaves.
4. Outdoor and Indoor Fan motors shall be permanently lubricated and have internal thermal overload protection.
5. Outdoor fans shall be direct drive, statically and dynamically balanced, draw through in the vertical discharge position.
6. Provide shafts constructed of solid hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.

E. Air Filters:
1. Provide filter racks integrally mounted within unit, with hinged access doors.
   a. Include 2 inch thick pleated glass fiber throwaway filter.
   b. Include 90% final filter bank where scheduled on drawings.

F. Heating Section:
1. Completely assembled and factory installed heating system shall be integral to unit, UL or CSA approved specifically for outdoor applications for use downstream from refrigerant cooling coils. Threaded connection with plug or cap provided. Provide capability for gas piping factory provided, field installed through the base gas connection.
2. Heating section shall be factory run tested prior to shipment.
3. Induced draft combustion type with direct spark ignition system, redundant main gas valve, and 2-staged heat.
4. Gas Burner Safety Controls: Provide safety controls for the proving of combustion air prior to ignition, and continuous flame supervision. Provide flame rollout switches.
5. Induced draft blower shall have combustion air proving switches and built-in thermal overload protection on fan motor.
7. Burners: Burners shall be of the in-shot type constructed of stainless steel.
8. Limit controls: High temperature limit controls will shut off gas flow in the event of excessive temperatures resulting from restricted indoor airflow or loss of indoor airflow.

G. Refrigeration Section:
1. Completely assembled and factory installed and sealed refrigerant system consisting of compressor, condenser, and evaporator section designed for use with Refrigerant R-22.
2. Compressor: Provide hermetic, direct-drive, scroll type, constant speed 3600 RPM compressors resiliently mounted with forced feed lubrication to all bearing surfaces, utilizing centrifugal type oil pumps and an oil filtering system. Include oil sight glass and integral motor overload protection.
3. Units shall have cooling capabilities down to 0 degree F as standard.
4. Provide each unit with one refrigerant circuit(s) factory-supplied completely piped with liquid line filter-drier, suction and liquid line pressure ports.

H. Condenser Section:
1. Provide internally finned seamless copper tube mechanically bonded to configured aluminum fins. Factory pressure test to 450 psig.
2. Provide vertical discharge, direct drive fans with aluminum blades. Fans shall be statically balanced. Motors shall be permanently lubricated, with integral thermal overload protection in a weather tight casing.

I. Evaporator Section:
   1. Provide configured aluminum fin surface mechanically bonded to copper tubing coil.
   2. Provide an independent expansion device for each refrigeration circuit. Factory pressure tested at 450 psig and leak tested at 200 psig.
   3. Provide factory installed thermal expansion valve (TXV) for each refrigerant circuit. Factory pressure tested at 450 psig and leak tested at 200 psig.
   4. Provide a removable, reversible, cleanable double sloped drain pan for base of evaporator coil constructed of PVC.

J. Return Air:
   1. Pressure Relief: Dampers open to relieve positive pressure in building. Provide exhaust hood with rain gutter inside unit casing.
   2. Fan System: Provide on downflow units above 6 tons, a factory supplied field installed power exhaust assembly that shall assist the barometric relief damper in the economizer in relieving building pressurization.

K. Outside Air:
   1. Provide a fully integrated factory-installed (downflow only) 100% modulating outside air economizer with unit return and barometric relief air dampers, minimum position setting, preset linkage, wiring harness with plug. Unit operation is through primary temperature controls that automatically modulate dampers to maintain space temperature conditions.
   2. Provide economizer with dry bulb control only.
   3. Provide adjustable minimum position control located in the economizer section of the unit.
   4. Provide spring return motor for outside air damper closure during unit shutdown or power interruption.

L. Operating Controls: - ***CHECK FOR COMPATIBILITY W/ SEQUENCE & BAS SYSTEM***
   1. Unit Control Panel: Provide a completely factory wired microprocessor control panel to provide for all 24 volt control functions as an integral part of the unit. The unit mounted control panel shall provide for all unit functions by making all heating, cooling, and ventilating decisions through resident software logic. Control panel shall include a location for a unit-mounted non-fused disconnect switch and 120 volt convenience outlet.
   2. Provide factory-installed indoor evaporator defrost control to prevent compressor slugging by interrupting compressor operation.
   3. Provide an anti-cycle timing and minimum on/off between stages timing in the microprocessor.
   4. Economizer Preferred Cooling: Compressor operation is integrated with economizer cycle to allow mechanical cooling when economizer is not adequate to satisfy zone requirements. Compressors are enabled if space temperature is recovering to cooling setpoint at a rate of less than 0.2 degrees per minute. Compressor low ambient lockout overrides this function.

M. Roof Curb:
   1. Contractor shall furnish factory supplied roof curb, 16 gauge perimeter made of zinc coated steel with supply and return air gasketing and wood nailer strips. Ship knocked down and provided with instructions for easy assembly.
   2. Curb shall be manufactured in accordance with the National Roofing Contractors Association guidelines.

N. ACCESSORIES
   1. 18 inch high insulated factory fabricated roof curb.
   2. 100% economizer.
   3. Unit mounted non-fused disconnect switch.
   4. 120 volt convenience outlet.
   5. Powered exhaust fan.
6. Through the base power, control, and gas connections.
7. 90% final filter bank where scheduled on drawings.

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 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.

3.03 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. Electric Heat Option
   1) Inspect wiring and connections for tightness and signs of overheating and discoloration.
   2) Check and calibrate operating and safety controls, if applicable.
   3) Verify the operation of the heating elements.
   4) Check voltage and amperage and compare readings with the watt rating on the heater.
   5) Startup/Checkout Procedure
      (a) Verify smooth operation of the fans.
      (b) Check the belts for tension, wear, cracks, and glazing.
      (c) Verify clean air filters.
      (d) Verify proper operation of the heating section.
      (e) Verify the operation of the temperature controls.

f. Provide written report to Owner.

END OF SECTION
SECTION 23 8101
TERMINAL HEAT TRANSFER UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Finned tube radiation.
B. Convector.
C. Unit heaters.
D. Fan-coil units.
E. Classroom unit ventilators.

1.02 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION
A. Storage cabinetry co-located with classroom unit ventilators.
B. Filler Sections co-located with classroom unit ventilators.
C. Outside air intake louvers and wall boxes for classroom unit ventilators and fan coil units.
D. Remote mounted line voltage thermostats for unit heaters and cabinet unit heaters.

1.03 RELATED REQUIREMENTS
A. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.
B. Section 23 0993 - Sequence of Operations for HVAC Controls.
C. Section 23 2113 - Hydronic Piping.
D. Section 23 2114 - Hydronic Specialties.

1.04 SUBMITTALS
A. Product Data: Provide catalog cut sheets, specifications, performance data, and installation instructions from each unit manufacturer.
B. Color Selection: Submit manufacturer's standard color selection chart to Architect where applicable.
C. Shop Drawings: Detailed dimensional data for outside air intake box assemblies.
D. Contract Closeout Submittals:
   1. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Owner's Representative.
E. 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: Two sets of filters for each unit requiring filters. Box and label spare filters. Store at site where directed by Owner's Representative.

1.05 WARRANTY
A. Provide one year manufacturers warranty for terminal units.

PART 2 PRODUCTS

2.01 FINNED TUBE RADIATION
A. Manufacturers:
   1. Sterling Hydronics/Mestek Technology, Inc.
   2. Rittling/Hydro-Air Components, Inc.
   3. The Trane Company.
B. General: Provide finned tube radiation of lengths and in locations as indicated, and of capacities and style as scheduled on drawings. Provide sufficient length of enclosure to extend from wall to wall in all areas unless otherwise indicated on drawings.
C. Heating Elements: Fins shall be permanently bonded to tube or pipe by mechanical expansion.
1. Non-Ferrous Elements: Seamless copper tube with soldered end connections and aluminum fins.
2. Steel Elements: Seamless type steel tube of Schedule 40 black steel pipe with threaded end connections and galvanized steel fins.

D. Standard Enclosures: Enclosures shall be manufactured from minimum 14 gauge galvanized steel, braced and reinforced for rigidity without visible fasteners. Top outlet louvers shall be integral stamped steel. Enclosure shall be phosphatized and painted inside and out with one coat of baked on primer.
   1. Provide minimum 18 gauge back plate full height of enclosure with continuous full length top mounting strip.

E. Element Hangers: Hanger brackets shall be die formed and allow for lengthwise movement of element during expansion.

F. Finish: Factory applied epoxy powder coating or baked enamel of color as selected by Architect.

G. Damper: Where not thermostatically controlled, provide knob-operated internal damper at enclosure air outlet.

H. Accessories:
   1. End panels, inside and outside corners, and enclosure extensions of same gauge and finish as enclosure.
   2. Access doors with tamper proof latches, minimum 6x6.

2.02 CONVECTORS

A. Manufacturers:
   1. Sterling Hydronics/Mestek Technology, Inc.
   2. Rittling/Hydro-Air Components, Inc.
   3. The Trane Company.

B. Unit Casing: Constructed of sheet steel, reinforced and braced for rigidity, with stamped grilles.
   1. Materials:
      a. Galvanized Steel Sheet: ASTM A653, coating designation G90.
      b. Cold-Rolled Steel Sheet: ASTM A366, cleaned, degreased, and phosphatized.
   2. Factory Finish: Baked enamel primer coat and baked powder coat enamel finish on all exposed surfaces. Submit manufacturer's standard color chart to Architect for color selection.
   3. Cabinet: Minimum 14 gauge construction removable front panel. Minimum 18 gauge construction ends, top, and back.
   4. Recessed Units: All recessed units shall be supplied with a wall seal assembly to cover wall opening around outside of cabinet. Wall seal shall be same finish as cabinet.

C. Heating Elements: Seamless copper tubing mechanically expanded into evenly spaced aluminum fins and cast iron headers, or silver brazed into cast bronze headers, steel side plates and supports, factory leak tested at 150 psi, with means of adjusting pitch of element.

D. Accessories:
   1. Damper: Where not thermostatically controlled, provide knob-operated internal damper at enclosure air outlet.
   2. Access Doors: Factory-made permanently hinged access doors, 6x6 minimum size, integral with cabinet for valve access.
   3. Insulation: 1/2" faced fiberglass insulation permanently bonded to cabinet back.

2.03 UNIT HEATERS

A. Manufacturers:
   1. Sterling Hydronics/Mestek Technology, Inc.
   2. Rittling/Hydro-Air Components, Inc.
   3. The Trane Company.
B. Unit Casing: Constructed of sheet steel, reinforced and braced for rigidity, with steel louvers or deflectors with sufficient rigidity to prevent vibration at all fan speeds.
   1. Materials:
      a. Galvanized Steel Sheet: ASTM A653, coating designation G90.
      b. Cold-Rolled Steel Sheet: ASTM A366, cleaned, degreased, and phosphatized.
   2. Factory Finish: Baked enamel of standard gray color on all exposed surfaces.
   3. Horizontal Delivery Units: Adjustable horizontal and vertical discharge louvers.
   4. Vertical Delivery Units: Deflector orifice formed into discharge panel.

C. Coils: Seamless copper tubing, with evenly spaced aluminum fins mechanically bonded to tubing. Coil shall be designed for steam or hot water application.

D. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.

E. Control: Unit mounted line voltage thermostats, and unit mounted speed controller with off position.

F. Accessories:
   2. Disconnect Switch: Factory mounted and wired disconnect switch.
   3. Remote thermostat: Line-voltage (120 VAC) heating-only wall thermostat with "off-auto" selector switch. Range 40-90 degrees F. Where shown on drawings only.

2.04 FAN COIL UNITS - ( CONCEALED DUCTED TYPE )

A. Manufacturers:
   1. The Trane Company.
   2. Environmental Technologies, Inc.
   3. Ritting/Hydro-Air Components, Inc.

B. Chassis: Galvanized heavy gauge steel with flanged edges.

C. Cabinet: 18 gauge galvanized steel with removable panels, closed cell insulation, and ducted discharge opening.

D. Coils: Seamless copper tubing with mechanically bonded aluminum fins, designed for minimum 150 psig working pressure, leak tested to 300 psig.

E. Drain Pans: Constructed of galvanized steel insulated with polystyrene of polyurethane insulation.

F. Fan Assembly: Blow thru design.
   1. Fan: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct drive.
   2. Motor: Tap wound multiple speed permanent split capacitor with permanently lubricated sleeve bearings and integral over-load protection and automatic reset, resilently mounted.

G. Inlet Plenum: 18 gauge galvanized steel with 1" filter frame and ducted inlet connection.

H. Filter: 1 inch (25 mm) thick glass fiber throw-away type.

I. Accessories:
   1. Disconnect Switch: Factory mounted and wired disconnect switch.

2.05 CLASSROOM UNIT VENTILATORS - ( TRANE )

A. Manufacturers:
   1. The Trane Company.
   2. AAF-HermanNelson.
   3. The Carrier Corporation.
B. General: Provide combination heating-ventilating units complete with an outlet air intake box. Furnish units complete with return and outlet air grilles and dampers, with capacities, airflow, and configuration as listed on drawing schedules.

C. Cabinet: Fabricate casing from heavy gage sheet steel; formed, reinforced, and braced for rigidity, with removable front panel to allow access for installation and servicing. Provide fixed discharge air grilles integral with the casing and removable air grilles for access to filters. Provide openings in the bottom and knockouts where required for piping and electrical connections, and an integral pipe tunnel for convenient crossover of piping or electrical wiring. Provide security type heads (Allen wrench type or equivalent) on all exposed cabinet fasteners and leveling legs under both ends of unit.

D. Fan and Motor Assembly:
   1. Fan and motor assembly shall be statically and dynamically balanced. Fan and motor assembly shall be direct drive type with motor located outside of air stream.
   2. Fan Assembly: Provide blow-through design assembly, complete with multiple centrifugal fans with galvanized steel wheels and fan housings. Fan board assembly shall be a single rigid assembly including fans, fan housings, bearings, and fan shaft.

E. Hydronic Coils: Copper tubes mechanically expanded into evenly spaced aluminum corrugated plate fins. Furnish coils with a threaded drain plug at the low point and manual air vent at the high point. Coils shall be tested to operate at 150 psi (1034 kPa).

F. Steam Coils: Copper tubes mechanically expanded into evenly spaced aluminum corrugated plate fins. Coils shall be double tube, steam distributing freeze-resistant type. Coils shall be tested to operate at 150 psi. Pitch coils to ensure condensate drainage.

G. DX Cooling Coils: Copper tubes mechanically expanded into evenly spaced aluminum corrugated plate fins. Coils shall be supplied with factory installed thermal expansion valve and DX low temperature limit. Coils shall be tested to operate at 150 psi.
   1. Drain Pan: Drain pan shall be constructed of corrosion resistant composite material and be insulated. A drain outlet shall be provided on both ends of the pan and be field reversible to the opposite end. Pan shall be able to be sloped in either direction for proper condensate drainage.

H. Filter Section: Provide a built-in filter frame installed in front of unit, located to filter outdoor/return air mixture before coil. Filter frame shall allow easy removal of 1 inch (25 mm) thick glass fiber throw-away type filters.

I. Dampers: Dampers shall be factory installed with nylon or other bearing requiring no lubrication.
   1. Outdoor and Return Air: Outdoor air dampers shall be two-piece, double wall construction with 1/2" fiberglass insulation encapsulated between welded 20 gage galvanized steel blades. Return air dampers shall be constructed of aluminum and be counterbalanced against back pressure. Dampers shall seal positively along damper stops fitted with extruded EPDM rubber seals
   2. Face and Bypass: Face and bypass dampers shall be constructed of aluminum and be fitted with blended mohair seals along sealing edges. Dampers shall seal positively along damper stops fitted with extruded EPDM rubber seals.

J. Factory Finish: Furnish all exposed surfaces of units with a factory applied baked urethane powder finish. Submit manufacturer's standard color chart to Architect for color selection.

PART 3 EXECUTION

3.01 INSTALLATION

   A. Install the Work of this section in accordance with manufacturer's printed installation instructions.
B. Install equipment exposed to finished areas after walls and ceiling are finished and painted. Do not damage equipment or finishes.

C. Floor Mounted Units: Install, level, and align units as required by the particular installation. Anchor to units structure.

D. Ceiling Mounted Units: Support from overhead construction by means of approved hangers, in number and size as recommended by the manufacturer.

E. Recessed Units: Coordinate with G.C. for wall opening size.

F. Unit Ventilators:
   1. Coordinate exact location of wall louvers with General Contractor. Furnish louvers and wall boxes to General Contractor for installation.
   2. Furnish matching cabinetry to General Contractor for installation. Include wall trim pieces and filler units for continuous wall-to-wall installation.

G. Fan Coil Units:
   1. Coordinate exact location of wall louvers with General Contractor. Furnish louvers and wall boxes to General Contractor for installation.

H. Finned Tube Radiation Enclosures:
   1. Left and right end panels shall be equal in length.
   2. Intermediate panels shall be equal in length and consistent throughout room.

END OF SECTION
SECTION 23 8129
VARIABLE REFRIGERANT FLOW HVAC SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Variable refrigerant volume HVAC system includes:
   1. Outdoor/condensing unit.
   2. Indoor/evaporator units.
   3. Refrigerant piping.
   4. Control panels.
   5. Control wiring.

1.02 RELATED REQUIREMENTS
A. Section 23 2300 - Refrigerant Piping: Additional requirements for refrigerant piping system.
B. Section 26 2717 - EQUIPMENT WIRING: Power connections to equipment.

1.03 REFERENCE STANDARDS
A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

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

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications:
   1. Company that has been manufacturing variable refrigerant volume heat pump equipment for at least 5 years.
B. Installer Qualifications: Trained and approved by manufacturer of equipment.

1.06 DELIVERY, STORAGE AND HANDLING
A. Deliver, store, and handle equipment and refrigerant piping according to manufacturer's recommendations.

1.07 WARRANTY
A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Compressors: Provide manufacturer's warranty for six (6) years from date of installation. During the stated period, should any part fail due to defects in material and workmanship, it shall be repaired or replaced at the discretion of Daikin AC (Americas), Inc. according to Daikin's terms and conditions. All warranty service work shall be performed by a Daikin factory trained service professional.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Basis of Design: The system design indicated in the Contract Documents is based on equipment and system designed by Mitsubishi Electric City Multi VRF.

2.02 PRODUCTS:
A. S-SERIES OUTDOOR UNIT
   1. General:
   2. The PUMY outdoor units shall be equipped with multiple circuit boards that interface to the M-NET controls system and shall perform all functions necessary for operation. The outdoor unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory.
a. The sum of connected capacity of all CITY MULTI indoor units shall range from 50% to 130% of outdoor rated capacity.
b. Outdoor unit shall have a sound rating no higher than 59 dB(A).
c. Both refrigerant lines from the outdoor unit to indoor units shall be individually insulated.
d. The outdoor unit shall have an accumulator with refrigerant level sensors and controls.
e. The outdoor unit shall have a high pressure safety switch, low pressure safety switch and over-current protection and DC bus protection.
f. The outdoor unit shall have the ability to operate with a maximum height difference of 98 feet for the PUMY-P36NHMU (-BS) & PUMY-P48NHMU (-BS) and 164 feet for the PUMY-P60NKMU (-BS) and have a total refrigerant tubing length of 393 feet for the PUMY-P36NHMU (-BS) & PUMY-P48NHMU (-BS) and 492 feet for the PUMY-P60NKMU (-BS). The greatest length is not to exceed 262 feet between the outdoor unit and the CITY MULTI indoor units and shall not require line size changes nor traps.
g. The outdoor unit shall have rated performance for heat operation at 0°F for the PUMY-P36NHMU (-BS) & PUMY-P48NHMU (-BS) and -4°F for the PUMY-P60NKMU (-BS) ambient temperature without additional low ambient controls.
h. The outdoor unit shall be capable of cooling operation down to 23°F outdoor ambient without additional low ambient controls.
i. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.

3. Unit Cabinet:
   a. The casing shall be fabricated of galvanized steel, bonderized and finished with a powder coated baked enamel.

4. Fan:
   a. The unit shall be furnished with two direct drive, variable speed motors.
   b. The fans will be forward curved type blades for quiet operation.
   c. The fan motor shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
   d. The fan motor shall be mounted for quiet operation.
   e. The fan shall be provided with a raised guard to prevent contact with moving parts.
   f. The outdoor unit shall have horizontal discharge airflow.

5. Refrigerant
   a. R410A refrigerant shall be required for all S-Series outdoor unit systems.

6. Coil:
   a. The outdoor coil shall be of nonferrous construction with lanced or corrugated fins on copper tubing.
   b. The coil fins will have a factory applied corrosion resistant blue-fin finish.
   c. The coil shall be protected with an integral metal guard.
   d. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.

7. Compressor:
   a. The compressor shall be a single high performance, inverter driven, modulating capacity scroll compressor.
   b. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable down to 41% of rated capacity for the PUMY-P36NHMU (-BS), 33% for the PUMY-P48NHMU (-BS), and 29% for the PUMY-P60NKMU (-BS).
   c. The compressor shall be equipped with an internal thermal overload.
   d. The compressor shall be mounted to avoid the transmission of vibration.

8. Electrical:
a. The outdoor unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
b. The unit shall be capable of satisfactory operation within voltage limitations of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz)
c. The outdoor unit shall be controlled by integral microprocessors.
d. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair, non-polar shielded cable to provide total integration of the system.

B. Indoor Unit (4-way ceiling-recessed cassette)
   1. General:
      a. The PLFY-P**NBMU-E* shall be a four-way cassette style indoor unit that recesses into the ceiling with a ceiling grille. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function, a test run switch, and the ability to adjust airflow patterns for different ceiling heights. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
   2. Unit Cabinet:
      a. The cabinet shall be space-saving ceiling-recessed cassette.
      b. The cabinet panel shall have provisions for a field installed filtered outside air intake.
      c. Branch ducting shall be allowed from cabinet.
      d. Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow.
      e. The grille vane angles shall be individually adjustable from the wired remote controller to customize the airflow pattern for the conditioned space.
   3. Fan:
      a. The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.
      b. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
      c. The indoor fan shall consist of five (5) speed settings, Low, Mid1, Mid2, High and Auto.
      d. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.
      e. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow.
      f. The indoor unit shall have switches that can be set to provide optimum airflow based on ceiling height and number of outlets used.
      g. The indoor unit vanes shall have 5 fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.
      h. The vanes shall have an Auto-Wave selectable option in the heating mode that shall randomly cycle the vanes up and down to evenly heat the space.
      i. If specified, the grille shall have an optional i-see sensor that will measure room temperature variations and adjust the airflow accordingly to evenly condition the space.
   4. Filter:
      a. Return air shall be filtered by means of a long-life washable filter
   5. Coil:
      a. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
      b. The tubing shall have inner grooves for high efficiency heat exchange.
      c. All tube joints shall be brazed with phos-copper or silver alloy.
      d. The coils shall be pressure tested at the factory.
      e. A condensate pan and drain shall be provided under the coil.
f. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 33 inches above the condensate pan.
g. Both refrigerant lines to the PLFY indoor units shall be insulated in accordance with the installation manual.

6. Electrical:
   a. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
   b. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

7. Controls:
   a. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system.
   b. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
   c. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F - 9.0°F adjustable deadband from set point.
   d. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
   e. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

C. Controls:
   1. General:
      a. The CITY MULTI Controls Network (CMCN) shall be capable of supporting remote controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to Building Management Systems via BACnet® and LonWorks®.

D. Electrical:
   1. General:
      a. The CMCN shall operate at 30VDC. Controller power and communications shall be via a common non-polar communications bus.
   2. Wiring:
      a. Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.
      b. Control wiring for the Smart ME remote controller shall be from the remote controller to the first associated indoor unit (TB-5) M-NET connection. The Smart ME remote controller shall be assigned an M-NET address.
      c. Control wiring for the Simple MA and Wireless MA remote controllers shall be from the remote controller (receiver) to the first associated indoor unit (TB-15) then to the remaining associated indoor units (TB-15) in a daisy chain configuration.
      d. Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply.
      e. The AE-200, AE-50, and EB-50GU centralized controller shall be capable of being networked with other AE-200, AE-50, and EB-50GU centralized controllers for centralized control.
   3. Wiring type:
      a. Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output.
   4. Network wiring shall be CAT-5 with RJ-45 connection
PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that required electrical services have been installed and are in the proper locations prior to starting installation.
   B. Verify that condensate piping has been installed and is in the proper location prior to starting installation.
   C. Notify Architect if conditions for installation are unsatisfactory.

3.02 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Install refrigerant piping in accordance with equipment manufacturer's instructions.
   C. Perform wiring in accordance with NFPA 70, National Electric Code (NEC).
   D. Coordinate with installers of systems and equipment connecting to this system.

3.03 SYSTEM STARTUP
   A. Provide manufacturer's field representative to perform system startup.
   B. Prepare and start equipment and system in accordance with manufacturer's instructions and recommendations.
   C. Adjust equipment for proper operation within manufacturer's published tolerances.

END OF SECTION
SECTION 26 0501.10
ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Electrical Demolition

1.02 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 specification sections.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify field measurements and circuiting arrangements are as shown on Drawings.
B. Verify that abandoned wiring and equipment serve only abandoned facilities.
C. Demolition drawings are based on casual field observation and existing record documents.
D. Report discrepancies to Architect / Engineer before disturbing existing installation.
E. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION
A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
B. Where applicable, coordinate utility service outages with utility service provide and Owner.
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 Electrical Service: Maintain existing system in service until modifications to system are complete. Disable system only to make switchovers and connections. Minimize outage durations.
   1. Obtain permission from Owner at least 72 hours before partially or completely disabling system.
   2. Make temporary connections to maintain service in areas adjacent to work area.
   3. Refer to specific phasing notes on the Contract Drawings.
   4. Adhere to established project specific phasing timelines.
E. Existing Fire Alarm System: Maintain existing system in service for the duration of scheduled work. Disable system only to make switchovers and connections. Minimize outage durations.
   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.
F. Existing Telephone System: Maintain existing system in service until modifications to system are complete. Disable system only to make switchovers and connections. Minimize outage durations.
   1. Notify Owner at least 24 hours before partially or completely disabling system.
   2. Notify telephone utility company at least 24 hours before partially or completely disabling system.
   3. Make temporary connections to maintain service in areas adjacent to work area.
G. Existing Security System: Maintain existing system in service until modifications to system are complete. Disable system only to make switchovers and connections. Minimize outage durations.
   1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
   2. 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. PCB-containing electrical equipment, including transformers, capacitors, and switches.
   2. PCB- and DEHP-containing lighting ballasts.
   3. 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 circuitry to source of supply.

D. Remove abandoned low voltage cabling to source of supply.

E. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

F. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned / removed. Provide blank cover for abandoned boxes that are not removed.

G. Disconnect and remove abandoned panelboards and distribution equipment.

H. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

I. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and associated components.

J. Restore adjacent construction and finishes damaged during demolition and extension work to pre-work conditions.

K. Maintain access to existing electrical installations that remain active. Modify installation or provide access panels as appropriate.

L. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified and in accordance with all NEC regulations. Where uncertainty exists, contact the project engineer for direction.

3.04 MANDATORY FLUORESCANT LAMP AND BALLAST DISPOSAL
A. Ballasts
   1. Assume all ballasts contain PCB material, unless labeled otherwise, or test sample ballasts to show materials are not PCB; submit test report to engineer.
   2. Remove all ballasts from existing luminaires indicated on contract drawings for removal.
      a. Properly dispose of all ballasts identified as not containing PCB materials.
      b. Properly dispose of all ballasts in PCB containers and pay all costs to have containers taken to EPA approved incinerators and disposed of in accordance with all EPA regulations. Follow all EPA regulations for transporting material.
         1) If ballast has leaked in existing luminaires, remove material deposited in luminaire and dispose of those materials as indicated above.
         2) Provide documentation verifying proper disposal of PCB contaminated ballasts.

B. Lamps
1. The Contractor shall employ the service of a certified disposal / recycling service company to dispose of all removed fluorescent and / or HID lamps. All disposal procedures shall be performed in accordance with EPA requirements and Subtitle C for the disposal of mercury contaminated lamps.

3.05 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 accurate typed circuit directory showing revised circuiting arrangement.

C. Luminaires: All luminaires which are to be removed and scheduled for re-installation shall be cleaned by the contractor. Replace all lamps and ballasts in fixtures adhering to project specifications. Replace broken or damaged tombstones / sockets. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry.

END OF SECTION
PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. Refer to Section 01 0000 General Requirements.

B. Provide all labor, items, articles, materials, operations, methods or equipment listed, mentioned, indicated or scheduled on the drawings and specified herein, and as required to complete the electrical work. Contract drawings and specifications are complementary and must be so construed to determine the full scope of work. 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 / code in effect on the date of these contract documents.

C. 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 of all trades 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.

D. Definitions: 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.

1.02 LICENSING

A. Division 26 contract work shall be performed by, or under, the direct supervision of a licensed electrician.

1.03 CODES, STANDARDS, AND LISTINGS

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.
   6. America National Standards Institute, ANSI: Where mentioned herein.
   9. Occupational Safety and Health Act, OSHA: Requirements for safety and health of employees.
   10. National Fire Prevention Association, NFPA:
      a. No. 70, National Electric Code, NEC.
   11. Building Code of New York State
   12. Fire 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. All wiring, conduit, and materials shown on the drawings and/or herein specified shall be in accordance with National Electrical Code (NEC), New York State Uniform Fire Prevention Building Code and Life Safety Code.

C. Wiring, conduit, and materials for all systems shall be provided in sizes and numbers sufficient to function as specified and in accordance with manufacturer's recommendations.

D. 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.

E. If requested by the Engineer, when equipment that is not specified is proposed, then provide a list of usages in New York State when the proposed equipment has been in operation for at least 3 years.

1.04 SUBMITTALS

A. Reference See Section 01 3000 - Submittal Procedures, for submittal process.

B. Furnish shop drawings as specified in Supplementary General Conditions and as follows:
   1. Submittals shall be complete by paragraph. All items specified in the same paragraph as the major item shall be included in the submittal.
   2. Partial or incomplete submittals will be returned without being reviewed.
   3. Submit Shop Drawing required by the specifications. Mark each copy or highlight shop drawings and product data to identify compliance to specifications.
   4. The Engineer will review Shop Drawings and product data and will return electronic copy. If the returned copies are stamped "REJECTED" or "REVISE AND RESUBMIT", promptly resubmit six copies meeting contractual requirements.

1.05 RECEIPTS FOR LOOSE EQUIPMENT

A. Provide one receipt for all equipment as follows, to be signed by the Owner and delivered to the Engineer prior to request for final payment:
   1. Spare fuses.
   2. Keys for panelboards and all other key operated equipment.
   3. Circuit breaker handle locks.
   4. Spare components as outlined in individual technical specifications.
   5. As built drawings.
   6. Operating and Maintenance Manuals (O&M).
   7. List of Owner's staff present for training sessions.

1.06 OPERATING AND MAINTENANCE MANUALS

A. Provide approved shop drawings, wiring diagrams, instruction manuals, operating instructions, service manuals, and signed instruction receipts bound in common folder; submit to Engineer for approval and delivery to Owner prior to request for final acceptance and payment. FOR FURTHER REQUIREMENTS, SEE SPECIFICATIONS SECTION 01 7000 - EXECUTION AND CLOSEOUT REQUIREMENTS.

B. Provide instruction on the operation and maintenance of all equipment installed in this Contract for personnel designated by the Owner. A minimum of two personnel instruction periods by qualified instructors shall be provided on normal operating procedures, minor adjustments and changes, preventive maintenance, and safety precautions. Obtain signed receipt that Owner's representative has been so instructed and can satisfactorily operate the equipment.

1.07 AS-BUILT DRAWINGS

A. Contractor shall record locations of all conduit runs with number and size of conductors as they are installed. This shall be done for all systems. Underground conduit plans shall include elevations and conduit and pull box locations shall be dimensioned.

B. As-built drawings shall include all approved Field Change Orders and BID Addendum changes.
C. As-built drawings shall be prepared for work if installation varies from arrangement shown on the Contract Drawings.

D. At completion of the job before final payment will be certified, the Contractor shall submit prints to the Engineer who will in turn transmit three copies to the Owner.

1.08 PERMITS AND INSPECTIONS

A. Cost of fees shall be included in the bid as follows:

1. Construction permits.
2. Inspections and tests as described in this section and individual technical sections.

B. Underwriters’ Certificate: Prior to submittal of Request for Final Payment, an third party electrical inspection certificate shall be obtained and submitted to the Architect / Engineer for record purposes. 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. The Inspector, LLC (800-487-0535)
4. Other Underwriters are not restricted, however credentials shall be provided for Engineer approval prior to Inspection.

1.09 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 electrical connections and relocations as required to accomplish the scheduled work. Obtain approval in writing as to date, time, and location for shutdown of existing electrical facilities or services.

1.10 DEMOLITION WORK

A. Where existing equipment removals are called for, submit a complete list identifying all equipment / component to be removed to Owner's Representative. All items that Owner wishes to retain, that do not contain asbestos or PCB or Mercury material, shall be delivered to a location as directed by the Owner. Items that Owner does not wish to retain, shall be removed from site and legally disposed of.

1. Removal and disposal of material containing asbestos, PCB's and/or mercury shall be in accordance with Federal, State and Local law requirements.

B. Where equipment is called for to be relocated, contractor shall carefully remove and properly store for reuse. Upon reinstallation at new location, contractor shall; clean and recondition as required, then reinstall where indicated on contract drawings.

C. Remove all abandoned wiring, conduit, equipment, lighting, supports, fixtures, etc. Visit each room, crawl spaces, and roofs to determine 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.

1.11 CUTTING AND PATCHING

A. Electrical 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.

1.12 FLASHING, SEALING, FIRE-STOPPING
   A. See Specification Section 26 0515 - Electrical Firestopping.

PART 2 PRODUCTS

2.01 MATERIALS
   A. All equipment and / or materials shall be new, unused, and shall carry the label of Underwriter's Laboratories Inc., whenever UL requirements are applicable.
   B. 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.
   C. "Equal materials" shall comply with Supplementary General Conditions.
   D. Drawings and specifications are based on one manufacturer's equipment requirements. The costs of all revisions required to meet the requirements of a different manufacturer's equipment (even though mentioned on the drawings or specified) furnished by the Contractor shall be borne by the Contractor.
   E. Small access doors in walls, plaster, brick, etc., shall be similar and equal to Milcor Access Doors as manufactured by Inland Steel Products Company, Milwaukee, Wisconsin. It is to be noted that various type frames are required in specific finishes. Any door having an area exceeding 324 square inches shall have two cam locks. Size and location as required for access to equipment.
   F. Provide materials that meet the following minimum requirements:
      1. Materials shall have a flame spread rating of 25 or less and a 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. Electrical equipment and systems shall meet UL Standards and requirements of the NEC.

2.02 STORAGE AND PROTECTION OF MATERIALS AND EQUIPMENT
   A. Store Materials on dry base, at least 6 in. aboveground 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.

PART 3 EXECUTION

3.01 INFORMATION FOR OTHER DIVISIONS
   A. Provide all information concerning the equipment or work of Division 26 required by other Divisions in ample time to prevent delay in building progress.

3.02 INSTALLATION
   A. All new material required shall be provided as part of this contract.
   B. Electrical Contractor shall include all work as shown and described on Site Drawings, including site electrical drawings.

3.03 ACCESS DOORS
   A. Access doors shall be furnished and installed by this Contractor.
   B. The Contractor shall include in their Bid a minimum of five 5 access doors, Price shall include necessary installation.
   C. Installation/Use of Access doors may be at the discretion of the Electrical Contractor, or as directed by the Owners Project Field Representative.
3.04 OPENINGS AND CHASES
   A. The General Construction Contractor will provide all boxed openings, chases, recesses, lintels, and bucks required for the admission of the work that are 100sq in or larger. Furnish him with all necessary information and sleeves in ample time.
   B. If openings, chases, recesses, lintels, or bucks are smaller than 100sq in in size, they shall be the responsibility of the Electrical Construction Contractor.
   C. Do not cut walls or floors that are waterproofed or pierce any structural member without written permission from the Engineer.

3.05 ANCHORS
   A. Provide anchor bolts, sleeves, washers, nuts, and templates for anchoring of equipment. Check locations as work progresses.

3.06 SLEEVES AND INSERTS
   A. Provide sleeves and inserts ahead of the general construction work and maintain them in position.
   B. The General Construction Contractor shall bear the cost of cutting and patching required to make corrections resulting from the omission or improper location of sleeves and/or inserts after being spotted by Electrical Contractor.
   C. Make sleeves in floors and partitions of galvanized steel with lock seam joints.
   D. Make sleeves of extra heavy cast iron pipe or rigid galvanized steel pipe in outside walls, foundations, and footings.
   E. Conduit sleeves shall be two sizes larger than the conduit passing through it.
   F. Terminate sleeves flush with walls, partitions, and ceilings. Terminate sleeves 1/4” above floors.
   G. Fill space between sleeve and conduit in underground walls with oakum and caulk with lead on both sides of wall, or use “Link Seal”.
   H. Fill space between sleeve and conduit with fiberglass blanket insulation when sleeve does not occur in an underground wall. Seal with an approved fire seal caulk.

3.07 SUPPORTS
   A. After thorough investigation of Architectural, Structural and Shop Drawings related to work to determine how and where equipment, fixtures, conduit, panelboards, etc., are to be supported, mounted or suspended, provide:
      1. Extra steel, bolts, inserts, pipe stands, brackets or any other items required for proper support.
      2. Supporting accessories where required, whether or not shown on drawings.

3.08 PAINTING AND PROTECTIVE COATING
   A. Finished Areas: All equipment and fittings shall be factory pre-finished and installed in such a manner as to eliminate necessity for field painting. Paint as directed when rusted or otherwise damaged. Conduit or surface raceway where shown exposed on drawings will be painted by others.
   B. Unfinished areas (except crawl spaces): Hanger rods, brackets, angle supports, straps, etc., shall be cadmium plated per ASTM 165, Type NS.
   C. Outdoor Work: All ferrous equipment and fittings cadmium plated after fabrication (ASTM 165 Type NS); all screws, nuts, washers, etc., brass or stainless steel.

3.09 ROUGHING
   A. Before roughing for equipment furnished by others, obtain approved roughing drawings and exact location for each piece of equipment. Do not “rough-in” services without approved drawings.
B. Obtain drawings or proper information giving final location of all motor and control connections.

C. Unless otherwise detailed or specified:
   1. All services shall be concealed in wall, above ceilings, etc.
   2. Work shall be exposed only where approved by the Engineer.
   3. Notify Engineer if work cannot be concealed, as intended.
   4. Conduit to be buried in concrete with approval of Engineer only and then a conduit plan must be submitted.
   5. Wiremold is to be used only per drawings as indicated. Usage otherwise only by written consent of Engineer.

3.10 CLEAN-UP

A. Contractor shall at all times keep the project free from accumulation of waste material or rubbish caused by his operation. Shall be done on a daily basis as required or directed by Engineer.

B. 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 as a result of this work.

3.11 SYSTEM START-UP AND TESTING

A. Work of any contract which includes system start-up, system cut-over or staff training shall not be done one week prior to and one week after the commencement of school except upon written approval by the Owner.

B. 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 Inspector that all building system has been returned to their original conditions.
SECTION 26 0513
MEDIUM-VOLTAGE CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES
  A. Medium voltage cable.
  B. Cable accessories.

1.02 REFERENCE STANDARDS
  A. IEEE 48 - IEEE Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV; 2009.
  C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 SUBMITTALS
  A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
  B. Product Data: Provide for cable, terminations, and accessories.
  C. Test Reports: Indicate results of cable test in tabular form and in plots of current versus voltage for incremental voltage steps, and current versus time at 30 second intervals at maximum voltage.
  D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
  E. Project Record Documents: Record actual sizes and locations of cables.

1.04 QUALITY ASSURANCE
  A. Comply with NFPA 70.
  B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles (160 km) of Project.
  C. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.01 MEDIUM-VOLTAGE CABLE
  A. Manufacturers:
  B. Provide cables with lead content less than 300 parts per million.
  C. Medium Voltage Cable: NEMA WC 70 rubber insulated cable.
     1. Voltage: 15 kV, grounded.
     2. Conductor: Copper, compact round, stranded, with foil conductor shieldconforming to Utility Company Specifications.

2.02 CABLE ACCESSORIES
  A. Manufacturers:
     1. 3M; _____: www.3m.com/#sle.
     2. TE Connectivity; Raychem Products; _____: www.te.com/#sle.
  B. Potheads: IEEE 48, Class 1 termination. Pothead with porcelain insulators, cable connector and aerial lug, sealed cable entrance and support, and insulating compound.
C. Cable Terminations: IEEE 48, Class 2 porcelain insulator cable terminator in kit form.
D. Cast Epoxy Cable Terminations: IEEE 48, Class 1 cast epoxy cable termination in kit form with stress cone, shield ground connection, wet porcelain rain shield for outdoor units, epoxy resin molding material, and accessories and molds required for proper application.
E. Modular Cable Terminations: IEEE 48, Class 1, molded-rubber cable termination in kit form with stress cone, ground clamp, non-tracking rubber skirts, load break connector, rubber cap, and aerial lug.
F. Tape Terminations: IEEE 48; Class 1, tape termination kit with semi-conductive tape, stress control tape, splicing tape, vinyl plastic tape, stress cone, mechanical ground straps, and cable preparation kit.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that conduit, duct, trench, or manholes are ready to receive cable.
   B. Cable routing is shown in approximate locations unless dimensioned. Route as required to complete wiring system.

3.02 PREPARATION
   A. Use swab to clean conduits before pulling cables.

3.03 INSTALLATION
   A. Avoid abrasion and other damage to cables during installation.
   B. Use suitable lubricants and pulling equipment.
   C. Sustain cable pulling tensions and bending radii below recommended limits.
   D. Ground cable shield at each termination and splice.

3.04 FIELD QUALITY CONTROL
   A. See Section 01 4000 - Quality Requirements, for additional requirements.
   B. Inspect exposed cable sections for physical damage.
   C. Inspect cable for proper connections as indicated.
   D. Inspect shield grounding, cable supports, and terminations for proper installation.

3.05 PROTECTION
   A. Protect installed cables from entrance of moisture.

END OF SECTION
SECTION 26 0515
ELECTRICAL 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 1hour rating.

1.03 REFERENCES

A. ASTM International:

B. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.

C. Underwriters Laboratories Inc.:
   3. UL 1479 - Fire Tests of Through-Penetration Firestops.

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 3300 - 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: 14-21 days
      5. Elongation: 5%
      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, jacketed cables, cable bundles, plastic pipes, sheet metal duct, and top of wall joints.
   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%
      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" to 1-1/2"
      3. Density: 4 to 8 pcf
      4. Product: THERMAFIBER Safing Insulation
   D. Mechanical systems with fillers. Uses: cable trays, bus duct.
   E. Sleeves:
      1. Provide sleeves in accordance with Installation requirements section.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify openings are ready to receive sleeves and firestopping materials proposed.

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, ductwork, conduit 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 cable tray, conduit, wireway, and trough penetrates 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 conduit, 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 conduit and tighten in place, in accordance with manufacturer's instructions.
   d. Interior partitions: Seal pipe penetrations at telecommunication rooms and data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

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:

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 26 0519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General project wiring requirements (600V and less).
B. Single conductor building wire.
C. Underground feeder and branch-circuit cable.
D. Service entrance cable.
E. Metal-clad cable.
F. Wiring connectors.
G. Electrical tape.
H. Heat shrink tubing.
I. Oxide inhibiting compound.
J. Wire pulling lubricant.
K. Cable ties.

1.02 REFERENCE STANDARDS

G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
H. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); 2012.
I. NECA 121 - Standard for Installing Nonmetallic-Sheathed Cable (Type NM-B) and Underground Feeder and Branch-Circuit Cable (Type UF); 2007.
L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
M. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
N. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
P. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
S. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.
T. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.03 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
C. Field Quality Control Test Reports.
D. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.04 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.
B. Mark and tag insulated conductors and cables for delivery to the site. Include:
   1. Contractor's name.
   2. Project title and number.
   3. Date of manufacture (month and year).
   4. Manufacturer's name.
   5. Data which explains the meaning of coded identification (UL assigned electrical reference numbers, UL assigned combination of color marker threads, etc.).
   6. Environmental suitability information (listed or marked "sunlight resistant" where exposed to direct rays of sun; wet locations listed/marked for use in wet locations; other applications listed/marked suitable for applications).

PART 2 PRODUCTS
2.01 CONDUCTOR AND CABLE APPLICATIONS
A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
C. Nonmetallic-sheathed cable is not permitted.
D. Metal-clad cable is permitted only as follows:
   1. Where not otherwise restricted, may be used:
      a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
      1) Maximum Length: 6 feet (1.8 m).
   2. In addition to other applicable restrictions, may not be used:
      a. Where exposed to view.
      b. Where exposed to damage.
      c. For damp, wet, or corrosive locations.
2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.
B. Provide products listed, classified, and labeled as suitable for the purpose intended.
C. Provide new conductors and cables manufactured not more than one year prior to installation.
D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
E. Comply with NEMA WC 70.
F. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
G. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
H. Conductors for Grounding and Bonding: Also comply with Section 26 0526.
I. Conductors and Cables Installed Where Exposed to Direct Rays of Sun: Listed and labeled as sunlight resistant.
J. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.
K. Conductor Material:
   1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
   2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.
   3. Tinned Copper Conductors: Comply with ASTM B33.
L. Minimum Conductor Size:
   1. Branch Circuits: 12 AWG.
      a. Exceptions:
         1) 20 A, 120 V circuits longer than 75 feet (23 m): 10 AWG, for voltage drop.
         2) 20 A, 120 V circuits longer than 150 feet (46 m): 8 AWG, for voltage drop.
         3) 20 A, 277 V circuits longer than 150 feet (46 m): 10 AWG, for voltage drop.
   2. Control Circuits: 14 AWG, unless otherwise noted..
M. Conductor Color Coding:
   1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
   2. Color Coding Method: Integrally colored insulation.
   3. Color Code:
      a. 480Y/277 V, 3 Phase, 4 Wire System:
         1) Phase A: Brown.
         2) Phase B: Orange.
         3) Phase C: Yellow.
         4) Neutral/Grounded: Gray.
      b. 208Y/120 V, 3 Phase, 4 Wire System:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
         4) Neutral/Grounded: White.
      c. Equipment Ground, All Systems: Green.
      d. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
      e. For control circuits, comply with manufacturer's recommended color code.
2.03 SINGLE CONDUCTOR BUILDING WIRE

A. Manufacturers:
   1. Copper Building Wire:

B. Description: Single conductor insulated wire.

C. Conductor Stranding:
   1. Feeders and Branch Circuits:
      b. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation:
   1. Copper Building Wire: Type THHN/THWN, except as indicated below.
      a. Size 4 AWG and Larger: Type XHHW-2.
      b. Installed Underground in Conduit: Type XHHW-2.
      d. Installed in Wet Locations: Type XHHW, XHHW-2.
      e. Wiring to gasoline and fuel oil pumps: Type THWN marked "Gasoline and Oil Resistant".

2.04 UNDERGROUND FEEDER AND BRANCH-CIRCUIT CABLE

A. Description: NFPA 70, Type UF multiple-conductor cable listed and labeled as complying with UL 493, Type UF-B.

B. Provide equipment grounding conductor unless otherwise indicated.

C. Conductor Stranding:
   2. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

2.05 SERVICE ENTRANCE CABLE

A. Conductor Stranding: Stranded.

B. Insulation Voltage Rating: 600 V.

2.06 METAL-CLAD CABLE

A. Manufacturers:
   1. AFC Cable Systems Inc: www.afcweb.com/#sle.

B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.

C. Conductor Stranding:
   2. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.

F. Grounding: Full-size integral equipment grounding conductor.

G. Armor: Steel, interlocked tape.
2.07 WIRING CONNECTORS

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

B. Wiring Connectors for Splices and Taps:
   1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
   2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.

C. Wiring Connectors for Terminations:
   1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
   2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
   3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
   4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
   5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
   6. Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
   7. Conductors for Control Circuits: Use crimped terminals for all connections.

E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F (105 degrees C) for standard applications and 302 degrees F (150 degrees C) for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
   1. Manufacturers:
      a. 3M: www.3m.com/#sle.
      c. NSI Industries LLC: www.nsiindustries.com/#sle.

H. Mechanical Connectors: Provide bolted type or set-screw type.
   1. Manufacturers:

I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
   1. Manufacturers:

J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
   1. Manufacturers:
2.08 WIRING ACCESSORIES

A. Electrical Tape:
   1. Manufacturers:
      a. 3M: www.3m.com/#sle.
   2. Vinyl Color Coding Electrical Tape: Integranlly colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
   3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F (-18 degrees C) and suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
   4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil (0.76 mm); suitable for continuous temperature environment up to 194 degrees F (90 degrees C) and short-term 266 degrees F (130 degrees C) overload service.
   5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil (3.2 mm); suitable for continuous temperature environment up to 176 degrees F (80 degrees C).
   6. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil (2.3 mm).

B. Arc Proofing Tape:
   1. Manufacturers:
      a. 3M: www.3m.com.

C. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
   1. Manufacturers:
      a. 3M: www.3m.com/#sle.

D. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.

E. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
   1. Manufacturers:
      a. 3M: www.3m.com/#sle.

F. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.02 INSTALLATION

A. Circuiting Requirements:
   1. Unless dimensioned, circuit routing indicated is diagrammatic.
2. When circuit destination is indicated and routing is not shown, determine exact routing required.

3. Arrange circuiting to minimize splices.

4. Include circuit lengths required to install connected devices within 10 ft (3.0 m) of location shown.

5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.

6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.

7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is not permitted.

8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

B. Install products in accordance with manufacturer's instructions.

C. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.

D. Install underground feeder and branch-circuit cable (Type UF-B) in accordance with NECA 121.

E. Install metal-clad cable (Type MC) in accordance with NECA 120.

F. Installation in Raceway:

1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.

2. Pull all conductors and cables together into raceway at same time.

3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.

4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.


3. Use wire management products to bundle, route, and support wiring in junction boxes, pullboxes, wireways, gutters, channels, and other locations where wiring is accessible.

I. Terminate cables using suitable fittings.

1. Metal-Clad Cable (Type MC):
   
a. Use listed fittings.
   
b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

J. Install conductors with a minimum of 12 inches (300 mm) of slack at each outlet.

K. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet (1.5 m) of slack.

L. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

M. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
N. Make wiring connections using specified wiring connectors.
   1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
   2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
   3. Do not remove conductor strands to facilitate insertion into connector.
   4. Clean contact surfaces on conductors and connectors to remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
   5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

O. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
   1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
   2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
      b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.

P. Insulate ends of spare conductors using vinyl insulating electrical tape.

Q. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 26 0515.

R. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.03 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. Branch circuits shall be tested during installation for continuity and identification and shall pass operational tests to determine that all circuits perform the function for which they are designed. For all feeder wiring rated 600 volts or less, provide 1,000 volt "Megger" insulation test prior to energizing feeders. Use a 1,000-volt motor driven megger for all tests. Test voltage shall be applied until readings reach a constant value, and until three (3) equal readings, each one (1) minute apart, are obtained. Minimum megger reading shall be 45 megohms for feeder conductors. Documents test results and submit for approval prior to energizing conductors.
D. Correct deficiencies and replace damaged or defective conductors and cables.

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 rod electrodes.

1.02 REFERENCE STANDARDS
   B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
   E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
   F. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Verify exact locations of underground metal water service pipe entrances to building.
      2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
      3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
   B. Sequencing:
      1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.04 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 and qualification data for testing agency and testing agency's field supervisor.
   C. Field quality control test reports.
   D. Operation and Maintenance Data:
      1. Instructions for periodic testing and inspection of grounding features at test wells and grounding connection for separately derived systems based on NETA Acceptance Testing Standards.
         a. Tests shall be to determine if ground resistance or impedance vaules remain within specified maximums, and instructions shall recommend corrective action if they do not.
         b. Include recommended testing intervals.

1.05 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70 and UL 467.
   B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.

B. Do not use products for applications other than as permitted by NFPA 70 and product listing.

C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

E. Grounding System Resistance:
   1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
   2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.

F. Grounding Electrode System:
   1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
      a. Provide continuous grounding electrode conductors without splice or joint.
      b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
   2. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.

G. Bonding and Equipment Grounding:
   1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
   2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
   3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
   4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
   5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
   6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
   7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
      a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
   8. Provide bonding for interior metal air ducts.
9. Provide bonding for metal building frame where not used as a grounding electrode.

H. Pole-Mounted Luminaires: Also comply with Section 26 5600.

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 0519:
   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:
   5. Manufacturers - Exothermic Welded Connections:

D. Ground Rod Electrodes:
   1. Comply with NEMA GR 1.
   3. Size: 3/4 inch (19 mm) diameter by 10 feet (3.0 m) length, unless otherwise indicated.
   4. Where rod lengths of greater than 10 feet (3.0 m) are indicated or otherwise required, sectionalized ground rods may be used.
   5. Manufacturers:

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 shown on the drawings.
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 grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.
C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70.
   1. Outdoor Installations: Unless otherwise indicated, install with top of rod 12 inches below finished grade.
   2. Indoor Installations: Unless otherwise indicated, install with 4 inches (100 mm) of top of rod exposed.

D. Equipment Grounding:
   1. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
      a. Feeders and branch circuits.
      b. Lighting circuits.
      c. Receptacle circuits.
      d. Motor and appliance branch circuits.
      e. Flexible raceway runs.
      f. As noted on the drawings.
   2. Piping:
      a. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
      b. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
      c. Provide bonding straps at new valves, actuators, and pipe joints.
   3. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
   4. Bonding Fencing: Bond corner posts and every other post with minimum #4AWG bare copper conductor connected to ground rod. Provide ground rods for fence grounding. Connect all ground rods with #4/0 AWG bare copper ground conductor. Bond fence and gates with braided type copper bonding straps.
   5. Signal and Communication Equipment:
      a. For telephone, alarm, voice and data, and other communication equipment, provide #4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, demarcation, terminal cabinet, wiring closet, and central equipment location.
         1) Terminate grounding conductor on a grounding bus at service and central equipment locations and wiring closets.
         2) Terminate grounding conductor on cabinet grounding terminal at terminal cabinets.
   6. Transient Voltage Surge Suppressors:
      a. Bond to service ground bus per manufacturer recommendations using minimum #8 AWG insulated conductor in conduit.

E. Make grounding and bonding connections using specified connectors.
   1. Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
   2. 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.
3. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
4. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

F. 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. Grounding:
   1. Grounds and grounding systems shall have a resistance to solid earth ground not exceeding following values:
      a. For grounding secondary service neutral: 5 Ohms
      b. For grounding non-current carrying metal parts associated with secondary distribution system: 5 Ohms
   2. Provide grounding tests to verify the above values. Where these values are not met, add additional ground rods or connections in order to meet these values.
F. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.
G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION
SECTION 26 0529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.02  RELATED REQUIREMENTS
A. Section 26 0534 - Conduit: Additional support and attachment requirements for conduits.
B. Section 26 0537 - Boxes: Additional support and attachment requirements for boxes.
C. Section 26 5100 - Interior Lighting: Additional support and attachment requirements for interior luminaires.

1.03  REFERENCE STANDARDS
D. MFMA-4 - Metal Framing Standards Publication; 2004.
E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
F. AWS D1.1/D1.1M - Structural Welding Code - Steel.
G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
H. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.04  SUBMITTALS
A. See Section 01 3300 - Submittal Procedures, for submittal process.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

1.05  QUALITY ASSURANCE
A. Comply with NFPA 70.
B. Installer Qualifications for Field-Welding: As specified in Section 05 5000.
C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2  PRODUCTS

2.01  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 used.
supported with a minimum safety factor of 6. Include consideration for vibration, equipment operation, and shock loads where applicable.

4. Do not use products for applications other than as permitted by NFPA 70 and product listing.

5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.

   a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
   b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
   c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
   d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. 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:

C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
   1. Manufacturers:

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.
   2. Channel Material:
      a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
   3. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch (2.66 mm).
   4. Minimum Channel Dimensions: 1-5/8 inch (41 mm) width by 13/16 inch (21 mm) height.
   5. Manufacturers:
      c. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.

E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
   1. Minimum Size, Unless Otherwise Indicated or Required:
      a. Equipment Supports: 1/2 inch (13 mm) diameter.
      b. Single Conduit up to 1 inch (27mm) trade size: 1/4 inch (6 mm) diameter.
      c. Single Conduit larger than 1 inch (27mm) trade size: 3/8 inch (10 mm) diameter.
      d. Trapeze Support for Multiple Conduits: 3/8 inch (10 mm) diameter.
      e. Outlet Boxes: 1/4 inch (6 mm) diameter.
f. Luminaires: 1/4 inch (6 mm) 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.
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. Manufacturers - Mechanical Anchors:
   b. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.

PART 3 EXECUTION

3.01 INSTALLATION

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

B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.

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

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

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

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

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

H. Field-Welding (where approved by Architect): Comply with Section 05 5000.

I. Equipment Support and Attachment:
1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls.
3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 4 inch (100 mm) high concrete pad constructed in accordance with Section 03 3000.
5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

J. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
1. Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
2. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.
K. Conduit Support and Attachment: Also comply with Section 26 0534.
L. Box Support and Attachment: Also comply with Section 26 0537.
M. Interior Luminaire Support and Attachment: Also comply with Section 26 5100.
N. Secure fasteners according to manufacturer's recommended torque settings.
O. Remove temporary supports.

3.02 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 0534
CONDUIT

PART 1  GENERAL

1.01  SECTION INCLUDES
A.  Galvanized steel rigid metal conduit (RMC).
B.  Aluminum rigid metal conduit (RMC).
C.  Liquidtight flexible metal conduit (LFMC).
D.  Electrical metallic tubing (EMT).
E.  Rigid polyvinyl chloride (PVC) conduit.
F.  Liquidtight flexible nonmetallic conduit (LFNC).
G.  Conduit fittings.
H.  Accessories.

1.02  REFERENCE STANDARDS
A.  ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2015.
B.  ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2015.
C.  ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit -- Aluminum (ERMC-A); 2015.
D.  NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
E.  NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.
G.  NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.
H.  NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
I.  NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.
J.  NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2015.
K.  NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
L.  UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
N.  UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
O.  UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
P.  UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
Q.  UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

1.03  ADMINISTRATIVE REQUIREMENTS
A.  Coordination:
   1.  Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2.  Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.04 SUBMITTALS
   A. See Section 01 3300 - Submittal Procedures, for submittal process.
   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.

1.05 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.
   B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
   C. Protect PVC conduit from sunlight.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS
   A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
   B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
   C. Underground:
      1. Under Slab on Grade: Use rigid PVC conduit.
      2. Exterior, Direct-Buried: Use rigid PVC conduit.
      3. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit or rigid PVC conduit.
      4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
      5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
      6. Where steel conduit emerges from concrete into soil, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches (100 mm) on either side of where conduit emerges.
   D. Embedded Within Concrete:
      1. Within Slab on Grade: Not permitted.
      2. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit.
3. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.

4. Where electrical metallic tubing (EMT) emerges from concrete into salt air, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches (100 mm) on either side of where conduit emerges.

E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).

F. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit or aluminum rigid metal conduit.

I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.
   a. Locations subject to physical damage include, but are not limited to:
      Where exposed below 8 feet (2.4 m).


L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit.

M. Corrosive Locations Above Ground: Use PVC-coated galvanized steel rigid metal conduit.

N. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
   1. Maximum Length: 6 feet (1.8 m).

O. 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 (1.8 m) unless otherwise indicated.

   a. Vibrating equipment includes, but is not limited to:
      i. Transformers.
      ii. Motors.

P. Fished in Existing Walls, Where Necessary: Use flexible metal conduit.

2.02 CONDUIT REQUIREMENTS

A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.

B. Fittings for Grounding and Bonding: Also comply with Section 26 0526.

C. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

D. Provide products listed, classified, and labeled as suitable for the purpose intended.

E. 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: 1/2 inch (16 mm) trade size.
   5. Underground, Exterior: 1 inch (27 mm) trade size.

F. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:
   1. Manufacturers:
   2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. 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 ALUMINUM RIGID METAL CONDUIT (RMC)

A. Manufacturers:

B. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.

C. Fittings:
   1. Manufacturers:
   2. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.05 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:
   1. AFC Cable Systems, Inc: www.afcweb.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:
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.
B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
C. Fittings:
1. Manufacturers:
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Material: Use steel or malleable iron.

2.07 ELECTRICAL METALLIC TUBING (EMT)
A. Manufacturers:
B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
C. Fittings:
1. Manufacturers:
   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   3. Material: Use steel or malleable iron.
   a. Do not use die cast zinc fittings.
   4. Connectors and Couplings: Use compression (gland) or set-screw type.
   a. Do not use indenter type connectors and couplings.

2.08 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT
A. Manufacturers:
B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 80 unless otherwise indicated; 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 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

A. Manufacturers:
   1. AFC Cable Systems, Inc:  www.afcweb.com/#sle.

B. Description:  NFPA 70, Type LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660.

C. Fittings:
   1. Manufacturer:  Same as manufacturer of conduit to be connected.
   2. Description:  Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for the type of conduit to be connected.

2.10 ACCESSORIES

A. Corrosion Protection Tape:  PVC-based, minimum thickness of 20 mil (0.51 mm).
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 (890 N).
E. Modular Seals for Conduit Penetrations:  Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on drawings.
B. Verify that mounting surfaces are ready to receive conduits.
C. Verify that conditions are satisfactory for installation prior to starting work.
D. Verify routing and termination locations of conduit prior to rough-in.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.
C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
D. Install aluminum rigid metal conduit (RMC) in accordance with NECA 102.
E. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
F. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.
G. Conduit Routing:
   1. Unless dimensioned, conduit routing indicated is diagrammatic.
   2. When conduit destination is indicated and routing is not shown, determine exact routing required.
   3. Conduits in the following areas may be exposed, unless otherwise indicated:
      a. Electrical rooms.
      b. Mechanical equipment rooms.
      c. Within joists in areas with no ceiling.
   4. 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.
5. Arrange conduit to maintain adequate headroom, clearances, and access.
6. Arrange conduit to provide no more than the equivalent of three 90 degree bends between pull points.
7. Arrange conduit to provide no more than 150 feet (46 m) between pull points.
8. Route conduits above water and drain piping where possible.
9. Maintain minimum clearance of 6 inches (150 mm) between conduits and piping for other systems.
10. Maintain minimum clearance of 12 inches (300 mm) between conduits and hot surfaces. This includes, but is not limited to:
   a. Heaters.
   b. Hot water piping.
   c. Flues.
11. Group parallel conduits in the same area together on a common rack.

H. 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 conduit clamp to support single conduit from beam clamp or threaded rod.
   6. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
   7. Use of spring steel conduit clips for support of conduits is not permitted.
   8. Use of wire for support of conduits is not permitted.
   9. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.

I. 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.

J. Penetrations:
   1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
   2. Make penetrations perpendicular to surfaces unless otherwise indicated.
   3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
   4. Conceal bends for conduit risers emerging above ground.
   5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Provide suitable modular seal where conduits penetrate exterior wall below grade.
7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
8. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
9. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 26 0515.

K. Underground Installation:
   1. Provide trenching and backfilling in accordance with Section 31 2316 and Section 31 2323.
   2. Minimum Cover, Unless Otherwise Indicated or Required:
      b. Under Slab on Grade: 12 inches (300 mm) to bottom of slab.
   3. Provide underground warning tape in accordance with Section 26 0553 along entire conduit length.

L. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 3000 with minimum concrete cover of 3 inches (76 mm) on all sides unless otherwise indicated.

M. 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.

N. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
   1. Where conduits pass from outdoors into conditioned interior spaces.
   2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
   3. Where conduits penetrate coolers or freezers.

O. 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 (300 mm) at each end.

P. Provide grounding and bonding in accordance with Section 26 0526.

Q. Identify conduits in accordance with Section 26 0553.

R. Where conduits are installed exposed, paint all conduits and boxes in accordance with section 09 9000.

S. Where at flush panels in new construction, provide three (3) spare 1 1/2" conduits stubbed to accessible locations for future use.

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. 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
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Surface raceway systems.
B. Wireways.

1.02 REFERENCE STANDARDS
A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
D. NEMA PRP 5 - Installation Guidelines for Surface Nonmetallic Raceway; 2015.
E. UL 5 - Surface Metal Raceways and Fittings; Current Edition, Including All Revisions.
F. UL 5A - Nonmetallic Surface Raceways and Fittings; Current Edition, Including All Revisions.
G. UL 111 - Outline of Investigation for Multioutlet Assemblies; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate the placement of raceways with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate rough-in locations of outlet boxes provided under Section 26 0537 and conduit provided under Section 26 0534 as required for installation of raceways provided under this section.
   3. Verify minimum sizes of raceways with the actual conductors and components to be installed.
   4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
B. Sequencing:
   1. Do not install raceways until final surface finishes and painting are complete.
   2. Do not begin installation of conductors and cables until installation of raceways is complete between outlet, junction and splicing points.

1.04 SUBMITTALS
A. See Section 01 3300 - Submittal Procedures, for submittal process.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets including dimensions, knockout sizes and locations, materials, fabrication details, finishes, service condition requirements, and accessories.
   1. Surface Raceway Systems: Include information on fill capacities for conductors and cables.

1.05 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.
B. Products: Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.
PART 2 PRODUCTS

2.01 RACEWAY REQUIREMENTS

A. Provide all components, fittings, supports, and accessories required for a complete raceway system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Do not use raceways for applications other than as permitted by NFPA 70 and product listing.

2.02 SURFACE RACEWAY SYSTEMS

2.03 WIREWAYS

A. Manufacturers:
   3. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

B. Description: Lay-in wireways and wiring troughs with removable covers; listed and labeled as complying with UL 870.

C. Wireway Type, Unless Otherwise Indicated:
   1. Indoor Clean, Dry Locations: NEMA 250, Type 1, painted steel with screw-cover.
   2. Outdoor Locations: NEMA 250, Type 3R, painted steel with screw-cover; include provision for padlocking.

D. Finish for Painted Steel Wireways: Manufacturer's standard grey unless otherwise indicated.

E. Minimum Wireway Size: 4 by 4 inches (100 by 100 mm) unless otherwise indicated.

F. Where wireway size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.04 TWO-PIECE DUAL CHANNEL SURFACE RACEWAY

A. Basis of Design: Wiremold 5400TB Series.

B. Acceptable Manufacturers:
   1. The Wiremold Co.
   2. Hubbell Wiring Devices
   3. Mono Systems

C. Materials: The raceway and all system components must be composed of UL Listed materials and exhibit nonflammable self-extinguishing characteristics, tested to comparable specifications of UL94V-0. The raceway base and cover shall be manufactured of rigid PVC compound.

D. Color: Finish shall be Ivory.

E. Raceway:
   1. The raceway shall be a two-piece design with a base and snap-on covers. The raceway base shall accept both a single cover that spans the entire base or two individual TwinSnap™ covers. Total width shall be 5.25" by 1.75" deep with an approximate thickness of .095". The base and cover shall be available in 8' lengths. The raceway shall be available with two wiring channels separated by one integral barrier.
   2. Each channel must be large enough to accept standard power and communication devices without restricting capacity of the adjacent channel.

F. Fittings and Inserts:
   1. A complete line of full capacity corner elbows and tee fittings must be available to maintain a controlled 2" cable bend radius which meets the specifications for Fiber Optic and UTP/STP cabling and exceeds the TIA 569 requirements for communication pathways.
   2. A full complement of fittings for the cable area shall be available including, but not limited to 45 degree and 90 degree flat, vertical inside, and outside elbows, tee and cross fittings, couplings for joining sections of the tray, reducers, end blanks, field-installed dividers, wire clips, and all other components necessary to make the system as described on the
contract drawings workable. The fittings and inserts shall have finish matching that of the wiremold assembly.

G. Device Brackets and plates:
1. Device brackets shall be available for mounting standard devices in-line or offset from the raceway. A device bracket shall provide up to three single-gang openings at one location. Faceplates shall be 5507 Series that match and fit flush in the device plate. They shall be manufactured of rigid PVC compound.

H. Plastic Overlapping Cover Bracket and Faceplates:
1. A complete line of full capacity corner elbows and tee fittings must be available to maintain a controlled 2" cable bend radius which meets the specifications for Fiber Optic and UTP/STP cabling and exceeds the TIA 569 requirements for communication pathways.
2. Cover and face plates for communication devices shall be compatible with modular devices as specified in "Wiring Devices", 26 2726.

I. Communication Modular Devices and Identification:
1. The raceway manufacturer will provide a complete line of connectivity outlets and modular inserts for UTP, STP, fiber optic, coaxial, and other cabling types with faceplates and bezels to facilitate mounting.
2. Port identification labels, snap-in icon buttons as well as write-on station identification labels shall be provided for each assembly.
3. Refer to "Wiring Devices", 26 2726 specification section for additional requirements.

J. Branch Circuits and Receptacles: Refer to Power plans for branch circuit wiring requirements. Provide branch circuits and receptacles as identified on drawings. Coordinate wiring device manufacturer and model numbers to provide receptacles that are designed for the raceway product.
1. Devices shall comply with requirements (ampacity, voltage and quality/grade) as specified in Section 26 2726 “Wiring Devices”.

2.05 ONE PIECE SINGLE CHANNEL SURFACE RACEWAY

A. Basis of Design: Wiremold 700 Series.
B. Materials: Galvanized steel
C. Color: Finish shall be Ivory.
D. Raceway:
1. The raceway shall be of a one-piece design with a base and cover factory assembled. Total width shall be 0.75 inches by 0.66 inches deep with a cross sectional area of 0.25 square inches. The raceway base and cover shall have an approximate thickness of 0.40 inches. The raceway shall be available in 5 foot and 10 foot lengths. Use a manufacturer approved cutting tool for all field cuts to ensure clean, square cuts.
2. Finish shall be a base coat with a poly ester topcoat over ivory base coat.
E. Fittings and Inserts:
1. A full compliment of fittings shall be available including but not limited to mounting clips and straps, couplings, flat, internal and external elbows, cover clips, tees, entrance fittings, conduit connectors and bushings. The covers shall be painted with an enamel finish, in ivory color to match the V800 series raceway. They shall overlap the raceway to hide uneven cuts. All fittings shall be supplied with a base where applicable.
F. Device and Fixture Boxes:
1. Device boxes shall be available for mounting standard devices and faceplates. A device box shall be available to in single- or multiple-gang configurations up to six-gang. They shall range in depth from 0.94 inches to 2.75 inches. Single-gang boxes shall allow for snap-on and fastener applications. Extension boxes shall be available to adapt to existing standard flush switch and receptacle boxes. Round fixture and extension boxes shall be available to mount fixtures and other devices with mounting centers of 1-15/32”, 1-5/8”, 1-23/32”, 1-27/32”, 2-3/4”, 3-1/2”, and 4-1/16” diameters. Round fixture and extension
boxes shall be available in depths ranging from 0.47 inches to 1 inch and in diameters of 3.00 inches, 4.75 inches, 5.50 inches, and 6.38 inches. All devices and fixture box covers shall be painted with an enamel finish, ivory in color to match the raceway cover.

G. Communication Modular Devices and Identification:
1. The raceway manufacturer will provide a complete line of connectivity outlets and modular inserts for UTP, STP, fiber optic, coaxial, and other cabling types with faceplates and bezels to facilitate mounting.
2. Port identification labels, snap-in icon buttons as well as write-on station identification labels shall be provided for each assembly.
3. Refer to "Wiring Devices", 26 2726 specification section for additional requirements.

H. Branch Circuits and Receptacles: Refer to Power plans for branch circuit wiring requirements. Provide branch circuits and receptacles as identified on drawings. Coordinate wiring device manufacturer and model numbers to provide receptacles that are designed for the raceway product.
1. Devices shall comply with requirements (ampacity, voltage and quality/grade) as specified in Section 26 2726 “Wiring Devices”.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that field measurements are as shown on the drawings.
B. Verify that outlet boxes and conduit terminations are installed in proper locations and are properly sized in accordance with NFPA 70 to accommodate raceways.
C. Verify that mounting surfaces are ready to receive raceways and that final surface finishes are complete, including painting.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
A. Install products in accordance with manufacturer’s instructions.
B. Install raceways in a neat and workmanlike manner in accordance with NECA 1.
C. Surface Nonmetallic Raceways: Install in accordance with NEMA PRP 5.
D. Install raceways plumb and level.
E. Arrange wireways and associated raceway connections to comply with NFPA 70, including but not limited to requirements for deflected conductors and wireways used as pullboxes. Increase size of wireway where necessary.
F. Secure and support raceways in accordance with Section 26 0529 at intervals complying with NFPA 70 and manufacturer’s requirements.
G. Close unused raceway openings.
H. Provide grounding and bonding in accordance with Section 26 0526.
I. Identify raceways in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL
A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Inspect raceways for damage and defects.
C. Surface Raceway Systems with Integrated Devices: Test each wiring device to verify operation and proper polarity.
D. Correct wiring deficiencies and replace damaged or defective raceways.

3.04 CLEANING
A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.
3.05 PROTECTION
   A. Protect installed raceways from subsequent construction operations.

END OF SECTION
SECTION 26 0537
BOXES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches (1,650 cu cm), including those used as junction and pull boxes.

B. Underground boxes/enclosures.

1.02 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.

C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.

D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.


1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

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

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.

4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.

5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.

6. Coordinate the work with other trades to preserve insulation integrity.

7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.

8. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 3300 - Submittal Procedures, for submittal process.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for outlet and device boxes and junction and pull boxes.

1. Underground Boxes/Enclosures: Include reports for load testing in accordance with SCTE 77 certified by a professional engineer or an independent testing agency upon request.
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.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. 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 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 (1,650 cu cm), 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 for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
   3. Do not use "through-wall" boxes designed for access from both sides of wall.
   4. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
   5. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
   6. 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.

C. 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.

D. Wall Plates: Comply with Section 26 2726.

10. Manufacturers:

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
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 (1,650 cu cm):
   a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
   b. Boxes 6 square feet (0.56 sq m) and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.

D. Inground 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 (300 mm).
   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. Combination fiberglass/polymer concrete boxes/enclosures are acceptable.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as shown on drawings.
   B. Verify that mounting surfaces are ready to receive boxes.
   C. Verify that conditions are satisfactory for installation prior to starting work.
   D. Verify locations of floor boxes and outlets in offices and work areas prior to rough-in.

3.02 INSTALLATION
   A. Install products in accordance with manufacturer's instructions.
   B. Perform work in a neat and workmanlike manner in accordance with NECA 1 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.

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 (150 mm) horizontal separation unless otherwise indicated.

8. 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 (610 mm) 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 (0.0103 sq m) or such that the total aggregate area of openings exceeds 100 square inches (0.0645 sq m) for any 100 square feet (9.29 sq m) of wall area.

9. 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 0534.

10. 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. 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.

J. Install boxes plum 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 (6 mm) 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 (3 mm) at the edge of the box.

L. Install boxes as required to preserve insulation integrity.

M. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches (150 mm) from ceiling access panel or from removable recessed luminaire.

N. Inground Boxes/Enclosures:
   1. Install enclosure on gravel base, minimum 6 inches (150 mm) deep.
   2. Flush-mount enclosures located in concrete or paved areas.
   3. Mount enclosures located in landscaped areas with top at 1 inch (25 mm) above finished grade.
   4. Provide cast-in-place concrete collar constructed in accordance with Section 03 3000, minimum 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep), around enclosures that are not located in concrete areas.
5. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.

O. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

P. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 26 0515.

Q. Close unused box openings.

R. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

S. Provide grounding and bonding in accordance with Section 26 0526.

T. 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 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 color coding.
D. Voltage markers.
E. Underground warning tape.
F. Floor marking tape.

1.02 REFERENCE STANDARDS

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
D. NFPA 70E - Standard for Electrical Safety in the Workplace; 2015.

1.03 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.

1.04 SUBMITTALS

A. See Section 01 3300 - Submittal Procedures, for submittal process.
B. Product Data: Provide manufacturer’s standard catalog pages and data sheets for each product.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.06 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. Switchgear:
         1) Identify ampere rating.
         2) Identify voltage and phase.
         3) Identify installation date.
         4) Identify power source and circuit number. Include location when not within sight of equipment.
5) Use identification nameplate to identify main and tie devices. Identify spares and spaces.

6) Use identification nameplate to identify load(s) served for each branch device.
Identify spares and spaces.

d. Panelboards:
1) Identify ampere rating.
2) Identify voltage and phase.
3) Identify installation date.
4) Identify power source and circuit number. Include location when not within sight of equipment.
5) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
6) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces.
7) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.

c. Enclosed switches, circuit breakers, and motor controllers:
1) Identify voltage and phase.
2) Identify installation date.
3) Identify power source and circuit number. Include location when not within sight of equipment.
4) Identify load(s) served. Include location when not within sight of equipment.

d. Enclosed Contactors:
1) Identify ampere rating.
2) Identify voltage and phase.
3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
4) Identify coil voltage.
5) Identify load(s) and associated circuits controlled. Include location.

2. Service Equipment:
   a. Use identification nameplate to identify each service disconnecting means.
   b. Use identification nameplate at each piece of service equipment to identify the available fault current and the date calculations were performed.

3. Emergency System Equipment:
   a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
   b. Use identification nameplate to identify installation date.
   c. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
   d. Use identification nameplate to identify emergency operating instructions for emergency system equipment.

4. Use voltage marker to identify highest voltage present for each piece of electrical equipment.

5. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.

6. Use identification label on inside of door at each fused switch to identify required NEMA fuse class and size.

7. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".

8. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
   a. Minimum Size: 3.5 by 5 inches (89 mm by 127 mm).
b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.

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.

C. Identification for Raceways:
1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet (6.1 m).
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 (6.1 m).
   a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches (76 mm) 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 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 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 (6.1 m).

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.
   b. For exposed boxes in public areas, do not color code.
3. Use identification labels 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.
   a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
4. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
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.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
   1. Manufacturers:
      a. Brady Corporation: www.bradycorp.com
      b. Seton Identification Products: www.seton.com/aec
      c. Hellermann Tyton: www.hellermanntyton.com
   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 (1.6 mm); engraved text.
      a. Exception: Provide minimum thickness of 1/8 inch (3 mm) when any dimension is greater than 4 inches (100 mm).
   4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.
   5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.
   6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch (25 mm) high; Four, located at corners for larger sizes.

B. Identification Labels:
   1. Manufacturers:
      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 (25 mm) by 2.5 inches (64 mm).
   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.
      c. Other information as indicated.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height:
      a. System Designation: 1 inch (25 mm).
      b. Equipment Designation: 1/2 inch (13 mm).
      c. Other Information: 1/4 inch (6 mm).
d. Exception: Provide minimum text height of 1 inch (25 mm) for equipment located more than 10 feet (3.0 m) above floor or working platform.

5. Color:
   c. Fire Alarm System: White text on red background.

D. Format for General Information and Operating Instructions:
1. Minimum Size: 1 inch (25 mm) by 2.5 inches (64 mm).
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 (6 mm).
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 fire alarm systems.

E. Format for Receptacle Identification:
1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
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 mm).
5. Color: Black text on clear background.

2.03 WIRE AND CABLE MARKERS
A. Manufacturers:

B. Lighting and power wiring shall be color coded as indicated in Section 26 0519.
C. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth type markers suitable for the conductor or cable to be identified.
D. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
E. Legend: Power source and circuit number or other designation indicated.
F. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
   1. Do not use handwritten text.
G. Minimum Text Height: 1/8 inch (3 mm).
H. Color: Black text on white background unless otherwise indicated.

2.04 VOLTAGE MARKERS
A. Manufacturers:

B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl cloth type markers.
C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl cloth type markers.
D. Minimum Size:
   1. Markers for Equipment: 1 1/8 by 4 1/2 inches (29 by 110 mm).
   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 (29 by 110 mm).
4. Markers for Junction Boxes: 1/2 by 2 1/4 inches (13 by 57 mm).

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:

B. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

C. Foil-backed Detectable Type Tape: 3 inches (76 mm) wide, with minimum thickness of 5 mil (0.1 mm), unless otherwise required for proper detection.

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.

2.06 FLOOR MARKING TAPE

A. Manufacturers:

B. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlaminate, 3 inches (76 mm) wide, with alternating black and white stripes.

2.07 WARNING SIGNS AND LABELS

A. Manufacturers:

B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

C. Warning Signs:
   1. Materials:
      a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
      b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
   2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
   3. Minimum Size: 7 by 10 inches (178 by 254 mm) unless otherwise indicated.

D. Warning Labels:
   1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
      a. Do not use labels designed to be completed using handwritten text.
3. Minimum Size: 2 by 4 inches (51 mm by 102 mm) unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION
A. Clean surfaces to receive adhesive products according to manufacturer’s instructions.

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

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
   4. Elevated Equipment: Legible from the floor or working platform.
   5. Branch Devices: Adjacent to device.
   6. Interior Components: Legible from the point of access.
   7. Conduits: Legible from the floor.
   8. Boxes: Outside face of cover.
   9. Conductors and Cables: Legible from the point of access.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
   1. Do not use adhesives on exterior surfaces

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 12 inch(es) (_____ mm) below finished grade.

G. Secure rigid signs using stainless steel screws.

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 0573
POWER SYSTEM COORDINATION STUDIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Oxford Bus Garage
   1. Short-circuit study.
   2. Protective device coordination study.
   3. Arc flash and shock risk assessment.
      a. Includes arc flash hazard warning labels.
   4. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.02 REFERENCE STANDARDS

F. NEMA MG 1 - Motors and Generators; 2014.
H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. NFPA 70E - Standard for Electrical Safety in the Workplace; 2015.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Existing Installations: Coordinate with equipment manufacturer(s) to obtain data necessary for completion of studies.
   2. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
   3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Submit study reports prior to or concurrent with product submittals.
   2. Do not order equipment until matching study reports and product submittals have both been evaluated by Architect.
   3. Coordinate naming convention for equipment identification prior to creation of final drawings, reports, and arc flash hazard warning labels (where applicable). Naming conventions to match through-out all documents. Where conflicts occur, notify Engineer of record in writing for resolution.

C. Scheduling:
   1. Arrange access to existing facility for data collection with Owner.
   2. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner seven business days in advance.
1.04 SUBMITTALS

A. See Section 01 3300 - Submittal Procedures, for submittal process.
B. Study preparer's qualifications.
C. Field testing agency's qualifications.
D. Study reports, stamped or sealed and signed by study preparer.
E. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.
   1. Include characteristic time-current trip curves for protective devices.
   2. Include impedance data for busway.
   3. Include impedance data for engine generators.
   4. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
   5. Include documentation of listed series ratings upon request.
   6. Identify modifications made in accordance with studies that:
      a. Can be made at no additional cost to Owner.
      b. As submitted will involve a change to the contract sum.
F. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.
G. Field quality control reports.
H. Certification that field adjustable protective devices have been set in accordance with requirements of studies.
I. Project Record Documents: Revise studies as required to reflect as-built conditions.
   1. Include hard copies with operation and maintenance data submittals.
   2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.

1.05 POWER SYSTEM STUDIES

A. Scope of Studies:
   1. Perform analysis of new electrical distribution system.
   2. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (i.e., fault current contribution from motors).
   3. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.
      a. Known Operating Modes:
         1) Utility as source.
         2) Generator as source.
B. General Study Requirements:
   1. Comply with NFPA 70.
   2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.
C. Data Collection:
   1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc., as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
      a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
         1) Obtain up-to-date information from Utility Company.
b. Existing Generators: Include manufacturer/model, kW and voltage ratings, and impedance.

c. Motors: Include manufacturer/model, type (i.e., induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 1 code letter designation.

d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.

e. Protective Devices:
   1) Circuit Breakers: Include manufacturer/model, type (i.e., thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (i.e., zone selective interlocking).
   2) Fuses: Include manufacturer/model, type/class (i.e., Class J), size/rating, and speed (i.e., time delay, fast acting).

f. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.

g. Conductors: Include feeder size, material (i.e., copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.

2. Existing Installations:
   a. Provide the services of field testing agency or equipment manufacturer's representative to perform field data collection.
   b. Collect data on existing electrical distribution system necessary for completion of studies, including field verification of available existing data (e.g. construction documents, previous studies). Include actual settings for field-adjustable devices.

D. Short-Circuit Study:
   2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
      a. Maximum utility fault currents.
      b. Maximum motor contribution.
      c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel).
   3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.

E. Protective Device Coordination Study:
   1. Comply with applicable portions of IEEE 242 and IEEE 399.
   2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
   3. Analyze protective devices and associated settings for suitable margins between time-current curves to achieve full selective coordination while providing adequate protection for equipment and conductors.

F. Arc Flash and Shock Risk Assessment:
   1. Comply with NFPA 70E.
   2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.
      a. For single-phase systems, study preparer to perform calculations assuming three-phase system in accordance with IEEE 1584, yielding conservative results.
   3. For equipment with main devices mounted in separate compartmentalized sections, perform calculations on both the line and load side of the main device.
   4. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:
      a. Maximum and minimum utility fault currents.
b. Maximum and minimum motor contribution.

c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel).

G. Study Reports:
1. General Requirements:
   a. Identify date of study and study preparer.
   b. Identify study methodology and software product(s) used.
   c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.
   d. Identify base used for per unit values.
   e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
   f. Include conclusions and best course of action recommendation for resolution.

2. Short-Circuit Study:
   a. For each scenario, identify at each bus location:
      1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
      2) Fault point X/R ratio.
      3) Associated equipment short circuit current ratings.
   b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with best course of action recommendation for resolution.

3. Protective Device Coordination Study:
   a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
   b. For each graph include (where applicable):
      1) Partial single-line diagram identifying the portion of the system illustrated.
      2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.
      3) Conductors: Damage curves.
      4) Transformers: Inrush points and damage curves.
      5) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.
      6) Motors: Full load current, starting curves, and damage curves.
      7) Capacitors: Full load current and damage curves.
   c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.
      1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
      2) Include ground fault pickup and delay.
      3) Include fuse ratings.
      4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.
   d. Identify cases where either full selective coordination or adequate protection is not achieved, along with best course of action recommendation for resolution.

4. Arc Flash and Shock Risk Assessment:
   a. For each scenario, identify at each bus location:
      1) Calculated incident energy and associated working distance.
      2) Calculated arc flash boundary.
      3) Bolted fault current.
      4) Arcing fault current.
      5) Clearing time.
      6) Arc gap distance.
b. For purposes of producing arc flash hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.

c. Identify locations where the calculated maximum incident energy exceeds 40 calories per sq cm.

d. Include best course of action recommendation for resolution for reducing the incident energy at locations where the calculated maximum incident energy exceeds 8 calories per sq cm.

1.06 QUALITY ASSURANCE

A. Study Preparer Qualifications: Professional Electrical Engineer licensed in the State in which the Project is located and with minimum 5 years experience in the preparation of studies of similar type and complexity using specified computer software.

1. Study preparer may be employed by the manufacturer of the electrical distribution equipment.

B. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.

1. Acceptable Software Products:

PART 2 PRODUCTS -

2.01 ARC FLASH HAZARD WARNING LABELS

A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.

1. Materials: Comply with Section 26 0553.

2. Minimum Size: 4 by 6 inches (100 by 150 mm).

3. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
   a. Include orange header that reads "WARNING" where calculated incident energy is less than 40 calories per square cm.
   b. Include red header that reads "DANGER" where calculated incident energy is 40 calories per square cm or greater.
   c. Include the text "Arc Flash and Shock Hazard; Appropriate PPE Required" or approved equivalent.
   d. Include the following information:
      1) Arc flash boundary.
      2) Available incident energy and corresponding working distance.
      3) Site-specific PPE (personnel protective equipment) requirements.
      4) Nominal system voltage.
      5) Equipment identification.
      6) Date calculations were performed.

PART 3 EXECUTION -

3.01 INSTALLATION

A. Install arc flash warning labels in accordance with Section 26 0553.

3.02 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Provide the services of field testing agency or equipment manufacturer's representative to perform inspection, testing, and adjusting.

C. Inspect and test in accordance with NETA ATS, except Section 4.
D. Adjust equipment and protective devices for compliance with studies and recommended settings.
E. Notify Architect / Engineer of any conflicts with or deviations from studies. Obtain direction before proceeding.
F. Submit detailed reports indicating inspection and testing results, and final adjusted settings.

3.03 CLOSEOUT ACTIVITIES
A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
B. See Section 01 7900 - Demonstration and Training, for additional requirements.
C. Training: Include as part of the base bid training for Owner’s personnel on electrical safety pertaining to arc flash and shock hazards.
   1. Use site-specific arc flash and shock risk assessment report as training reference, supplemented with additional training materials as required.
   2. Provide minimum of eight hours of training.
   3. Instructor: Representative of entity performing study.
   4. Location: At project site.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

   A. Vacancy sensors.
   B. Outdoor motion sensors.
   C. Time switches.
   D. Outdoor photo controls.

1.02 REFERENCE STANDARDS

   C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
   D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
   E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
   F. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; 2015.
   G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
   H. UL 773 - Plug-in, Locking Type Photocontrols for Use with Area Lighting; Current Edition, Including All Revisions.
   J. UL 917 - Clock-Operated Switches; Current Edition, Including All Revisions.

1.03 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. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
      5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

   B. Sequencing:
      1. Do not install lighting control devices until final surface finishes and painting are complete.

1.04 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.

E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Operation and Maintenance Data: Include detailed information on device programming and setup.

G. 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 Locking Receptacle-Mounted Outdoor Photo Controls: Five percent of total quantity installed for each type, but not less than two of each type.

H. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

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

1.06 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.

1.07 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. Provide five year manufacturer warranty for all occupancy sensors.

C. Provide five year manufacturer warranty for utility grade locking receptacle-mounted outdoor photo controls.

D. 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.

2.02 OCCUPANCY SENSORS

A. Manufacturers:
   1. Hubbell Building Automation, Inc: www.hubbellautomation.com
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. Ultrasonic Occupancy Sensors: Designed to detect occupancy by sensing frequency shifts in emitted and reflected inaudible sound waves.
      c. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic 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, vacancy sensor; manual on by switch, occupancy sensor to automatically turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
   5. Dual Technology Occupancy Sensors: Field configurable manual turn-on and hold-on activation with settings for activation by either or both sensing technologies.
   6. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
   7. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.
   9. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.
   10. 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.
   11. Load Rating for Line Voltage Occupancy Sensors: As required to control the load indicated on drawings.
   12. Isolated Relay for Low Voltage Occupancy Sensors: SPDT dry contacts, ratings as required for interface with system indicated.
   13. Where wired sensors are indicated, wireless sensors are acceptable provided that all components and wiring modifications necessary for proper operation are included.
   14. Wireless Sensors:
      a. RF Range: 30 feet (9 m) through typical construction materials.
      c. Power: Battery-operated with minimum ten-year battery life.

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. Unless otherwise indicated or required to control the load indicated on drawings, provide line voltage units with self-contained relay.
      c. Where indicated, provide two-circuit units for control of two separate lighting loads, with separate manual controls and separately programmable operation for each load.
d. Operation: Operates only as vacancy sensor (manual-on/automatic-off) in accordance with California Title 24 requirements.

e. 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.

f. Finish: Grey.

g. Provide vandal resistant lenses for passive infrared (PIR) and dual technology wall switch occupancy sensors where indicated.

2. Passive Infrared (PIR) Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet (83.6 sq m).

3. Ultrasonic Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 400 square feet (37.2 sq m).

4. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet (83.6 sq m).

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. Operation: Operates only as vacancy sensor (manual-on/automatic-off) in accordance with California Title 24 requirements.

   c. Manual-Off Override Control Capability: 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. 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.

   e. Provide field adjustable dimming preset for occupied state.

   f. Finish: Grey.

2. Passive Infrared (PIR) Wall Dimmer Occupancy Sensors: Capable of detecting motion within an area of 900 square feet (83.6 sq m).

E. Ceiling Mounted Occupancy Sensors:

1. All Ceiling Mounted Occupancy Sensors:
   a. Description: Low profile occupancy sensors designed for ceiling installation.

   b. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.

   c. Provide field selectable setting for disabling LED motion detector visual indicator.

   d. Vacancy sensor configured for manual-on/automatic-off operation.

   e. Finish: white.

2. Passive Infrared (PIR) Ceiling Mounted Occupancy Sensors:
   a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet (41.8 square meters) at a mounting height of 9 feet (2.7 m), with a field of view of 360 degrees.

   b. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet (111.5 sq m) at a mounting height of 9 feet (2.7 m), with a field of view of 360 degrees.

3. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:

4. Passive Infrared/Acoustic Dual Technology Ceiling Mounted Occupancy Sensors:
   a. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet (111.5 sq m) at a mounting height of 9 feet (2.7 m).

F. Directional Occupancy Sensors:
1. All Directional Occupancy Sensors: Designed for wall or ceiling mounting, with integral swivel for field adjustment of motion detection coverage.
   a. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
   b. Provide field selectable setting for disabling LED motion detector visual indicator.
   c. Finish: White unless otherwise indicated.
2. Passive Infrared (PIR) Directional Occupancy Sensors:
   a. Standard Range Sensors: Capable of detecting motion within a distance of 40 feet (12 m) at a mounting height of 10 feet (3.1 m).
   b. Long Range Sensors: Capable of detecting motion within a distance of 80 feet (24 m) at a mounting height of 10 feet (3.1 m).
   c. High Bay Sensors: Capable of detecting motion within a distance of 50 feet (15 m) at a mounting height of 30 feet (9.1 m).
3. Passive Infrared/Ultrasonic Dual Technology Directional Occupancy Sensors: Capable of detecting motion within a distance of 40 feet (12 m) at a mounting height of 10 feet (3.1 m).
G. Luminaire Mounted Occupancy Sensors: Designed for direct luminaire installation and control, suitable for use with specified luminaires.
   1. High Bay Luminaire Mounted Occupancy Sensors: Passive infrared (PIR) type with a field of view of 360 degrees unless otherwise indicated.
      a. Unless otherwise indicated or required to control the load indicated on drawings, provide line voltage units with self-contained relay.
      b. Finish: White unless otherwise indicated.
H. Power Packs for Low Voltage Occupancy Sensors:
   1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.
   2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on drawings.
   3. Input Supply Voltage: Dual rated for 120/277 V ac.
   4. Load Rating: As required to control the load indicated on drawings.
I. Power Packs for Wireless Occupancy Sensors:
   1. Description: Plenum rated, self-contained relay compatible with specified wireless occupancy sensors for switching of line voltage loads.
   2. Input Supply Voltage: Dual rated for 120/277 V ac.
   3. Load Rating: As required to control the load indicated on drawings.
   4. Provide auxiliary contact closure output.
   5. Rated Life of Relay: One million cycles.
J. Accessories:
   1. Provide heavy duty coated steel wire protective guards compatible with specified occupancy sensors where indicated.

2.03 TIME SWITCHES
A. Manufacturers:
   1. Intermatic, Inc: www.intermatic.com/#sle.
   4. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
B. Digital Electronic Time Switches:
   1. Description: Factory-assembled solid state programmable controller with LCD display, listed and labeled as complying with UL 916 or UL 917.
   2. Program Capability:
a. Astronomic Time Switches: Single channel, capable of different schedule for each day of the week with additional holiday schedule available to override normal schedule for selected days and field-configurable astronomic feature to automatically adjust for seasonal changes in sunrise and sunset times.

3. Schedule Capacity: Not less than 16 programmable on/off operations.
4. Provide automatic daylight savings time and leap year compensation.
5. Provide power outage backup to retain programming and maintain clock.
6. Manual override: Capable of overriding current schedule both permanently and temporarily until next scheduled event.
7. Provide remote photocell input with light level adjustment.
8. Input Supply Voltage: As indicated on the drawings.
9. Output Switch Configuration: As required to control the load indicated on drawings.
10. Output Switch Contact Ratings: As required to control the load indicated on drawings.
11. Provide lockable enclosure; environmental type per NEMA 250 as specified for the following installation locations:
    a. Indoor clean, dry locations: Type 1.

2.04 OUTDOOR PHOTO CONTROLS

A. Manufacturers:
   1. Intermatic, Inc: www.intermatic.com/#sle.
   4. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. Stem-Mounted Outdoor Photo Controls:
   1. Description: Direct-wired photo control unit with threaded conduit mounting stem and field-adjustable swivel base, listed and labeled as complying with UL 773A.
   2. Housing: Weatherproof, impact resistant polycarbonate.
   4. Provide external sliding shield for field adjustment of light level activation.
   5. Light Level Activation: 1 to 5 footcandles (10.8 to 53.8 lux) turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
   6. Voltage: As required to control the load indicated on the drawings.
   7. Failure Mode: Fails to the on position.
   8. Load Rating: As required to control the load indicated on the drawings.

C. Button Type Outdoor Photo Controls
   1. Description: Direct-wired photo control unit complying with ANSI C136.24 with weatherproof gasketed wall plate where required or indicated, listed and labeled as complying with UL 773A.
   2. Housing: Weather resistant polycarbonate.
   4. Light Level Activation: 1 to 3 footcandles (10.8 to 32.3 lux) turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
   5. Voltage: As required to control the load indicated on the drawings.
   6. Failure Mode: Fails to the on position.
   7. Load Rating: As required to control the load indicated on the drawings.

2.05 EMERGENCY LIGHTING CONTROL UNITS

A. Basis of Design: Wattstopper ELCU-100. Provide product that meets or exceeds the following requirements.
   1. The Emergency Lighting Control Unit (ELCU) shall provide all required functionality to allow any standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building.
2. The emergency lighting control unit shall allow control of emergency lighting fixtures in tandem with normal lighting in an area while ensuring that emergency lighting will turn on immediately to full brightness upon loss of normal power supplying the control device. Emergency lighting operation shall be independent for each controlled area and shall not require a generalized power failure for proper operation.

3. The device shall be self contained, dimensions not to exceed 3\" x 3.5\" x 3,\" and shall be equipped with all necessary mounting hardware & boxes.

4. The device shall have normally closed dry contacts capable of switching 10 amp emergency ballast loads @ 120-277 VAC, 60 Hz, or 2 amp tungsten loads @ 120 VAC, 60 Hz.

5. The device shall have universal rated voltage inputs provided for normal power sense and normal switched power at 120-277 VAC, 60 Hz.

6. The device shall have an integral test switch. Pressing and holding this switch shall instantly force the unit into emergency mode and turn on emergency lighting. Releasing the test switch shall immediately return the unit to normal operation.

7. The unit shall provide dedicated terminals and 24 VDC source for connection to remote test switch, fire alarm system, or other external system capable of providing a normally closed dry contact closure. Breaking contact between the terminals shall force and hold the emergency lighting on until the terminals are again closed. An integral LED indicator shall indicate the unit's current remote activation status.

8. The device shall provide separate LEDs to indicate the presence of normal and emergency power sources. The LEDs shall indicate the unit's current operational mode (normal or emergency).

9. The device's normal power input terminal shall be connected to the line side of the control device such that any upstream fault causing a loss of power, including the tripping of the branch circuit breaker, will force the unit into the emergency mode and turn on the emergency lighting.

10. The unit shall automatically switch emergency lighting on and off as normal lighting is switched. When normal power is not available, the unit shall force and hold emergency lighting on regardless of the state of any external control device until normal power is restored.

11. The unit shall utilize zero crossing circuitry to protect relay contacts from the damaging effects of inrush current generated by switching electronic ballast loads.

12. Unit housing shall be UL94 V-O plenum rated and shall be equipped with compression wire terminals rated for #14 - #12 solid or stranded copper wire.

13. The unit shall be UL and cUL listed and labeled for connection to both normal and emergency lighting power sources.

14. The unit shall have a 5 year warranty.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

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. Perform work in a neat and workmanlike manner in accordance with NECA 1 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 0537 as required for installation of lighting control devices provided under this section.
   1. Locate wall switch occupancy sensors on strike side of door with edge of wall plate 3 inches (80 mm) 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. 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 (1.2 m) from air supply ducts or other sources of heavy air flow and as per manufacturer’s recommendations, in order to minimize false triggers.
J. Outdoor Photo Control Locations:
   1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.
   2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by the photo control itself.
K. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into the photo control.
L. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.
M. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.
N. Unless otherwise indicated, install switches on load side of power packs so that switch does not turn off power pack.

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. Test time switches to verify proper operation.

E. Test outdoor photo controls to verify proper operation, including time delays where applicable.

F. Test daylighting controls to verify proper operation, including light level measurements and time delays where applicable. Record test results in written report to be included with submittals.

G. 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. Adjust position of directional occupancy sensors and outdoor motion sensors to achieve optimal coverage as required.

D. 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.

E. Adjust time switch settings to achieve desired operation schedule as indicated or as directed by Architect. Record settings in written report to be included with submittals.

F. Adjust external sliding shields on outdoor photo controls under optimum lighting conditions to achieve desired turn-on and turn-off activation as indicated or as directed by Architect.

G. Adjust daylighting controls under optimum lighting conditions after all room finishes, furniture, and window treatments have been installed to achieve desired operation as indicated or as directed by Architect. Record settings in written report to be included with submittals. Readjust controls calibrated prior to installation of final room finishes, furniture, and window treatments that do not function properly as determined by Architect.

### 3.06 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore 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 lighting control devices to Architect, and correct deficiencies or make adjustments as directed.

D. 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.

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 0534 - Conduit: Flexible conduit connections.
D. Section 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS: Identification products and requirements.

1.03 REFERENCE STANDARDS
B. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers; 2015.
D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; 2015.
F. NEMA ST 20 - Dry-Type Transformers for General Applications; 2014.
G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
K. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination: Coordinate the work with placement of support framing and anchors required for mounting of transformers.

1.05 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.
   1. Vibration Isolators: Include attachment method and rated load and deflection.
C. Shop Drawings: Provide dimensioned plan and elevation views of transformers and adjacent equipment with all required clearances indicated.
D. Source Quality Control Test Reports: Include reports for tests designated in NEMA ST 20 as design and routine tests.
E. Maintenance Data: Include recommended maintenance procedures and intervals.
F. Project Record Documents: Record actual locations of transformers.
1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
B. Handle in accordance with manufacturer’s written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.08 FIELD CONDITIONS
A. Ambient Temperature: Do not exceed the following maximum temperatures during and after installation of transformers.
   1. Greater than 10 kVA: 104 degrees F (40 degrees C) maximum.
   2. Less than 10 kVA: 77 degrees F (25 degrees C) maximum.

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

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Eaton Corporation; www.eaton.com/#sle.
B. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

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 (1,000 m).
   2. Ambient Temperature:
      a. Greater than 10 kVA: Not exceeding 104 degrees F (40 degrees C).
      b. Less than 10 kVA: Not exceeding 77 degrees F (25 degrees C).
C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.
D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.
E. Basic Impulse Level: 10 kV.
F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
G. Isolate core and coil from enclosure using vibration-absorbing mounts.
H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.03 GENERAL PURPOSE TRANSFORMERS
A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.
B. Primary Voltage: 480 volts delta, 3 phase.
C. Secondary Voltage: 208Y/120 volts, 3 phase.

D. Insulation System and Allowable Average Winding Temperature Rise:
   1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.

E. Coil Conductors: Continuous copper windings with terminations brazed or welded.

F. Winding Taps:
   1. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
   2. 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.

G. Energy Efficiency: Comply with 10 CFR 431, Subpart K.

H. Sound Levels: Standard sound levels complying with NEMA ST 20.

I. Mounting Provisions:
   1. Less than 15 kVA: Suitable for wall mounting.
   2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
   3. Larger than 75 kVA: Suitable for floor mounting.

J. Transformer Enclosure: Comply with NEMA ST 20.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor clean, dry locations: Type 2.
   2. Construction:
      a. Less than 15 kVA: Totally enclosed, non-ventilated.
      b. 15 kVA and Larger: Ventilated.
   3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
   4. Provide lifting eyes or brackets.

K. Accessories:
   1. Mounting Brackets: Provide manufacturer's standard brackets.
   2. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

2.04 SOURCE QUALITY CONTROL

A. Factory test transformers according to NEMA ST 20.

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 0534, 2 feet (600 mm) 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. Mount floor-mounted transformers on properly sized 4 inch (100 mm) high concrete pad constructed in accordance with Section 03 3000.

G. Mount floor-mounted transformers using vibration isolators suitable for isolating the transformer noise from the building structure.

H. Provide seismic restraints.

I. Provide grounding and bonding in accordance with Section 26 0526.

J. 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.

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

L. Identify transformers 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 Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required.

3.04 ADJUSTING
   A. Measure primary and secondary voltages and make appropriate tap adjustments.
   B. Adjust tightness of mechanical and electrical connections to manufacturer’s recommended torque settings.

3.05 CLEANING
   A. Clean dirt and debris from transformer components according to manufacturer’s instructions.
   B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION
SECTION 26 2413
SWITCHBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Overcurrent protective devices for switchboards.

1.02 REFERENCE STANDARDS

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
D. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
E. NEMA PB 2 - Deadfront Distribution Switchboards; 2011.
F. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; 2013.
H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.
J. UL 891 - Switchboards; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
   5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchboards, enclosures, overcurrent protective devices, and other installed components and accessories.
C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
D. Project Record Documents: Record actual installed locations of switchboards and final equipment settings.
E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
1.05 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.
   B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.
   C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
   D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

PART 2 PRODUCTS
2.01 OVERCURRENT PROTECTIVE DEVICES
   A. Fusible Devices:
      1. Fusible Switches:
         a. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA KS 1, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.
         b. Fuse Clips: As required to accept indicated fuses.
            1) Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
         c. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

2.02 SOURCE QUALITY CONTROL
   A. See Section 01 4000 - Quality Requirements, for additional requirements.
   B. Factory test switchboards according to NEMA PB 2, including the following production (routine) tests on each switchboard assembly or component:
      1. Dielectric tests.
      2. Mechanical operation tests.
      3. Grounding of instrument transformer cases test.
      4. Electrical operation and control wiring tests, including polarity and sequence tests.
      5. Ground-fault sensing equipment test.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.
   C. Verify that mounting surfaces are ready to receive switchboards.
   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. Provide grounding and bonding in accordance with Section 26 0526.
   C. Install all field-installed devices, components, and accessories.
D. Provide fuses complying with Section 26 2813 for fusible switches as indicated.
E. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
F. Provide filler plates to cover unused spaces in switchboards.
G. Identify switchboards 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 observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.
C. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
D. Before energizing switchboard, perform insulation resistance testing in accordance with NECA 400 and NEMA PB 2.1.
E. Inspect and test in accordance with NETA ATS, except Section 4.
F. Perform inspections and tests listed in NETA ATS, Section 7.1.
G. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
H. Correct deficiencies and replace damaged or defective switchboards or associated components.

3.04 ADJUSTING
A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
B. Adjust alignment of switchboard covers and doors.

3.05 CLEANING
A. See Section 01 7419 - Construction Waste Management and Disposal, for additional requirements.
B. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.
C. Repair scratched or marred surfaces to match original factory finish.

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

END OF SECTION
SECTION 26 2416
PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Power distribution panelboards.
B. Lighting and appliance panelboards.
C. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS
A. Section 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. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Revision E with Supplement 1, 2013.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NECA 407 - Standard for Installing and Maintaining Panelboards; 2009.
D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
E. NEMA PB 1 - Panelboards; 2011.
F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.
H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
K. UL 67 - Panelboards; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
1.05 SUBMITTALS
   A. See Section 01 3300 - Submittal Procedures, for submittal process.
   B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
      1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
   C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
      1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
   D. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 1 as routine tests.
   E. Field Quality Control Test Reports.
   F. Provide blank test report forms and typed written plan for testing required by NETA ATS for approval.
   G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
   H. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
   I. Operations & Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.
      1. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
         a. See Section 01 6000 - Product Requirements, for additional provisions.
         b. Panelboard Keys: Two of each key. All newly provided panelboards shall be keyed alike.

1.06 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
   B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
   C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

PART 2 PRODUCTS
2.01 MANUFACTURERS
   A. Schneider Electric; Square D Products: I-Line Series (bases of design)
   B. Eaton Corporation;
D. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet (2,000 m).
   2. Ambient Temperature:
      a. Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).

C. Short Circuit Current Rating:
   1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
   1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
   2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

H. Conductor Terminations: Suitable for use with the conductors to be installed.

I. 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.
   2. Boxes: Galvanized steel unless otherwise indicated.
      a. Provide wiring gutters sized to accommodate the conductors to be installed.
      b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
      c. Provide painted steel boxes for surface-mounted panelboards where indicated, finish to match fronts.
   3. Fronts:
      a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
      b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
      c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
   4. Lockable Doors: All locks keyed alike unless otherwise indicated.

J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

K. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.

L. Load centers are not acceptable.
2.03 POWER DISTRIBUTION PANELBOARDS
   A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type,
      circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and
      features as indicated on the drawings.
   B. Conductor Terminations:
      1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper
         conductors.
      2. Main and Neutral Lug Type: Mechanical.
   C. Bussing:
      1. Phase and Neutral Bus Material: Copper.
      2. Ground Bus Material: Copper.
   D. Circuit Breakers:
      1. Provide bolt-on type.
      2. Provide thermal magnetic circuit breakers unless otherwise indicated.
   E. Enclosures:
      1. Provide surface-mounted enclosures unless otherwise indicated.
      2. Fronts: Provide trims to cover access to load terminals, wiring gutters, and other live
         parts, with exposed access to overcurrent protective device handles.
      3. Provide clear plastic circuit directory holder mounted on inside of door.

2.04 BRANCH CIRCUIT DISTRIBUTION PANELBOARDS
   A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit
      type, circuit breaker type, and listed and labeled as complying with UL 67; ratings,
      configurations and features as indicated on the drawings.
   B. Conductor Terminations:
      1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper
         conductors.
      2. Main and Neutral Lug Type: Mechanical.
   C. Bussing:
      1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective
         devices.
      2. Phase and Neutral Bus Material: Copper.
   D. Circuit Breakers: Thermal magnetic bolt-on type.
   E. Enclosures:
      1. Provide surface-mounted or flush-mounted enclosures as indicated.
      2. Fronts: Provide door-in-door trim with piano hinged cover for access to load terminals and
         wiring gutters, and separate lockable full piano hinged door with concealed for access to
         overcurrent protective device handles without exposing live parts. "Lift and shift" fronts will
         not be allowed.
      3. Provide clear plastic circuit directory holder mounted on inside of door.

2.05 OVERCURRENT PROTECTIVE DEVICES
   A. Molded Case Circuit Breakers:
      1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit
         breakers listed and labeled as complying with UL 489, and complying with FS W-C-375
         where applicable; ratings, configurations, and features as indicated on the drawings.
      2. Interrupting Capacity:
         a. Provide circuit breakers with interrupting capacity as required to provide the short
            circuit current rating indicated, but not less than:
            1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
            2) 14,000 rms symmetrical amperes at 480 VAC.
b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

3. Conductor Terminations:
   a. Provide mechanical lugs unless otherwise indicated.
   b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
   a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.

5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
   a. Provide the following field-adjustable trip response settings:
      1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
      2) Long time delay.
      3) Short time pickup and delay.
      4) Instantaneous pickup.
      5) Ground fault pickup and delay where ground fault protection is indicated.


7. Provide the following circuit breaker types where indicated:
   a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.

8. Do not use tandem circuit breakers.

9. Do not use handle ties in lieu of multi-pole circuit breakers.

10. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.

11. Provide the following features and accessories where indicated or where required to complete installation:
    a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
    b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.

2.06 SOURCE QUALITY CONTROL
   A. See Section 01 4000 - Quality Requirements, for additional requirements.
   B. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as shown on the drawings.
   B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
   C. Verify that mounting surfaces are ready to receive panelboards.
   D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
   A. Install products in accordance with manufacturer's instructions.
   B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.
   C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
   D. Provide required supports in accordance with Section 26 0529.
   E. Install panelboards plumb.
F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches (2000 mm) above the floor or working platform.

H. Mount floor-mounted power distribution panelboards on properly sized 3 inch (80 mm) high concrete pad constructed in accordance with Section 03 3000.

I. Provide minimum of six spare 1 inch (27 mm) trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.

J. Provide grounding and bonding in accordance with Section 26 0526.

K. Install all field-installed branch devices, components, and accessories.

L. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.

M. Provide filler plates to cover unused spaces in panelboards.

N. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
   1. Fire detection and alarm circuits.
   2. Communications equipment circuits.
   3. Intrusion detection and access control system circuits.
   4. Video surveillance system circuits.

O. Identify panelboards in accordance with Section 26 0553.

P. Provide typed circuit directory for each branch circuit panelboard. Accurately identify all existing and new loads. Revise directory to reflect circuiting changes required to balance phase loads.

Q. Provide 4" concrete house keeping pad beneath Power Distribution Panelboards.

### 3.03 FIELD QUALITY CONTROL

- See Section 01 4000 - Quality Requirements, for additional requirements.
- Provide seven (7) day prior notification of engineer and owner for testing observations.
- Inspect and test in accordance with NETA ATS, except Section 4.
- Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 225 amperes. Tests listed as optional are not required.
- Test GFCI circuit breakers to verify proper operation.
- Test shunt trips to verify proper operation.
- Correct deficiencies and replace damaged or defective panelboards or associated components.

### 3.04 ADJUSTING

- Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- Adjust alignment of panelboard fronts.
- Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

### 3.05 CLEANING

- Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical connections to equipment.

1.02 RELATED REQUIREMENTS

A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables.
B. Section 26 0534 - Conduit.
C. Section 26 0537 - Boxes.
D. Section 26 2726 - Wiring Devices.
E. Section 26 2818 - Enclosed Switches.
F. Section 26 2913 - Enclosed Controllers.

1.03 REFERENCE STANDARDS

A. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R2015).
B. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2016.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

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

1.05 SUBMITTALS

A. See Section 01 3300 - Submittal Procedures, for submittal process.
B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Products: Listed, classified, and labeled as suitable for the purpose intended.
C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 MATERIALS

A. Disconnect Switches: As specified in Section 26 2818 and in individual equipment sections.
B. Wiring Devices: As specified in Section 26 2726.
C. Flexible Conduit: As specified in Section 26 0518.
D. Wire and Cable: As specified in Section 26 0518.
E. Boxes: As specified in Section 26 0537.
2.02 EQUIPMENT CONNECTIONS
   A. Refer to Equipment Connection Schedule in Contract Documents:

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. Limit length of flexible raceway to 60" max.
   C. Connect heat producing equipment using wire and cable with insulation suitable for
      temperatures encountered.
   D. Provide receptacle outlet to accommodate connection with attachment plug.
   E. Provide cord and cap where field-supplied attachment plug is required.
   F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and
      equipment connection boxes.
   G. Install disconnect switches, controllers, control stations, and control devices to complete
      equipment wiring requirements.
   H. Install terminal block jumpers to complete equipment wiring requirements.
   I. Install interconnecting conduit and wiring between devices and equipment to complete
      equipment wiring requirements.
   J. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and
      ceilings.

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.
E. Floor box service fittings.
F. Service Poles

1.02 REFERENCE STANDARDS
B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Revision G, 2014.
C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
E. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R2015).
F. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2016.
G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. UL 1310 - Class 2 Power Units; Current Edition, Including All Revisions.

1.03 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 the contract documents to obtain direction prior to proceeding with work.
B. Sequencing:
   1. Do not install wiring devices until final surface finishes and painting are complete.

1.04 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. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
D. Operation and Maintenance Data:
   1. Wall Dimmers: Include information on operation and setting of presets.
   2. GFCl Receptacles: Include information on status indicators and testing procedures and intervals.

E. Project Record Documents: Record actual installed locations of wiring devices.

F. 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 Keys for Locking Switches: five of each type.
   3. Extra Surge Protection Receptacles: five of each type.
   4. Extra Wall Plates: Ten of each style, size, and finish.
   5. Extra Flush Floor Service Fittings: Two of each type.

1.05 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.06 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 MANUFACTURERS
   C. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us
   D. Source Limitations: Where possible, provide products for each type of wiring device produced by a single manufacturer and obtained from a single supplier.
   E. 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.

2.02 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 GFCl receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
   D. Provide GFCl protection for receptacles installed within 6 feet (1.8 m) of sinks.
   E. Provide GFCl protection for receptacles installed in kitchens.
   F. Provide GFCl 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.
   I. For flush floor service fittings, use carpet flanges for installations in carpeted floors.

2.03 WIRING DEVICE FINISHES
   A. Provide wiring device finishes as described below unless otherwise indicated.
   B. Wiring Devices, Unless Otherwise Indicated: Gray with gray nylon wall plate.
   C. Wiring Devices Installed in Finished Spaces: Gray with gray nylon wall plate.
   D. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate.
E. Wiring Devices Installed in Wet or Damp Locations: Gray with specified weatherproof cover.
F. Surge Protection Receptacles: Blue.
G. Flush Floor Box Service Fittings: Gray wiring devices with aluminum cover and ring/flange.

### 2.04 WALL SWITCHES

#### A. Manufacturers:
3. Pass & Seymour, a brand of Legrand North America, Inc; www.legrand.us

#### 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.

### 2.05 WALL DIMMERS

#### A. Manufacturers:
3. Pass & Seymour, a brand of Legrand North America, Inc; www.legrand.us

#### B. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.

#### C. Control: Slide control type with separate on/off switch.

#### D. Power Rating, Unless Otherwise Indicated or Required to Control the Load Indicated on the Drawings:

#### E. Provide accessory wall switches to match dimmer appearance when installed adjacent to each other.

### 2.06 RECEPTACLES

#### A. Manufacturers:
4. Pass & Seymour, a brand of Legrand North America, Inc; www.legrand.us

#### 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: Commercial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
2. Weather Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498
Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

D. GFCI Receptacles:
   1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
      a. Provide test and reset buttons of same color as device.
   2. Standard GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R.
   3. Weather Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

E. USB Charging Devices:
   1. USB Charging Devices - General Requirements: Listed as complying with UL 1310.
      a. Charging Capacity - Two-Port Devices: 2.1 A, minimum.
   2. USB Charging / Receptacle Combination Devices: Two-port USB charging device and receptacle, commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.

F. Surge Protection Receptacles:
   1. Surge Protection Receptacles - General Requirements: Listed and labeled as complying with UL 1449, Type 2 or 3.
      a. Energy Dissipation: Not less than 240 J per mode.
      b. Protected Modes: L-N, L-G, N-G.
      c. UL 1449 Voltage Protection Rating (VPR): Not more than 700 V for L-N, L-G modes and 1200 V for N-G mode.
      d. Diagnostics:
         2) Audible Notification: Provide switchable audible alarm to report that surge protection is not functional.

2.07 WALL PLATES

A. Manufacturers:
   4. Pass & Seymour, a brand of Legrand North America, Inc; www.legrand.us
   5. 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.
   3. Screws: Metal with slotted heads finished to match wall plate finish.

C. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.

D. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.

E. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.
F. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

2.08 FLOOR BOX SERVICE FITTINGS

A. Manufacturers:
   3. Wiremold, a brand of Legrand North America, Inc; :: www.legrand.us

B. Description: Service fittings compatible with floor boxes provided under Section 26 0537 with components, adapters, and trims required for complete installation.

C. Flush Floor Service Fittings:
   1. Single Service Flush Convenience Receptacles:
      a. Cover: Rectangular.
      b. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).

   2. Single Service Flush Communications Outlets:
      a. Cover: Rectangular.

   3. Dual Service Flush Combination Outlets:
      a. Cover: Rectangular.
      b. Configuration:
         1) Power: One standard convenience duplex receptacle(s) with duplex flap opening(s).
         2) Communications: (as indicated on plans).
         3) Voice and Data Jacks: As specified in Section 27 1000.

   4. Accessories:
      a. Tile Rings: Finish to match covers; configuration as required to accommodate specified covers.
      b. Carpet Flanges: Finish to match covers; configuration as required to accommodate specified covers.

PART 3 EXECUTION

3.01 EXAMINATION

A. 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.

B. Verify that final surface finishes are complete, including painting.

C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

D. 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 a neat and workmanlike manner in accordance with NECA 1 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 0537 as required for installation of wiring devices provided under this section.
   1. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
   2. Where multiple receptacles or wall switches are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
3. Locate wall switches on strike side of door with edge of wall plate 3 inches (80 mm) from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.

4. 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. Where required, connect wiring devices using pigtails not less than 6 inches (150 mm) long. Do not connect more than one conductor to wiring device terminals.

E. 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.

F. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

G. Unless otherwise indicated, GFCI receptacles may be connected to provide feed-through protection to downstream devices. Label such devices to indicate they are protected by upstream GFCI protection.

H. Install wiring devices plumb and level with mounting yoke held rigidly in place.

I. Install wall switches with OFF position down.

J. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

K. Do not share neutral conductor on branch circuits utilizing wall dimmers.

L. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on right.

M. 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.

N. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

O. 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 dimmer with circuit energized to verify proper operation.

D. Test each receptacle to verify operation and proper polarity.

E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.

F. Inspect each surge protection receptacle to verify surge protection is active.

G. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
H. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.05 ADJUSTING
A. Adjust devices and wall plates to be flush and level.
B. Adjust presets for wall dimmers according to manufacturer's instructions as directed by Architect.

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

END OF SECTION
SECTION 26 2813
FUSES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Fuses.

1.02 REFERENCE STANDARDS
A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.
B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
      a. Fusible Switches for Switchboards: See Section 26 2413.
      b. Fusible Enclosed Switches: See Section 26 2818.
   2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
   3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS
A. See Section 01 3300 - Submittal Procedures, for submittal process.
B. Product Data: Include the following for each fuse type indicated:
   1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   2. Let-through current curves for fuses with current-limiting characteristics.
   3. Time-current curves, coordination charts and tables, and related data.
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 Fuses: One set(s) of three for each type and size installed.
   3. Special tools if required for installation or removal of fuses.
D. Operation and Maintenance Data:
   1. Time-current curves, coordination charts and tables, and related data.
   2. Ambient temperature adjustment information.

1.05 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
1.06 PROJECT CONDITIONS
A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 PRODUCTS

2.01 MANUFACTURERS
D. Ferraz Shawmut, Inc.
E. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

2.02 APPLICATIONS
A. Service Entrance:
   1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
   2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.
B. Individual Motor Branch Circuits: Class RK1, time-delay.
C. In-Line Protection for Pole-Mounted Luminaires: Class CC, time-delay.

2.03 FUSES
A. Provide products listed, classified, and labeled as suitable for the purpose intended.
B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
C. Provide fuses of the same type, rating, and manufacturer within the same switch.
D. Comply with UL 248-1.
E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
F. Voltage Rating: Suitable for circuit voltage.
G. Class R Fuses: Comply with UL 248-12.
   1. Class RK1, Time-Delay Fuses:
H. Class L Fuses: Comply with UL 248-10.
I. Class CC Fuses: Comply with UL 248-4.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
A. Do not install fuses until circuits are ready to be energized.
B. Install fuses with label oriented such that manufacturer, type, and size are easily read.
C. Install spare fuse cabinet in convenient location in main electrical room unless otherwise indicated.
D. Identify spare fuse cabinet in accordance with Section 26 0553.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Enclosed circuit breakers.

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.
D. Section 26 0573 - Power System Coordination Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

1.03 REFERENCE STANDARDS
A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Revision E with Supplement 1, 2013.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.
   1. Include characteristic trip curves for each type and rating of circuit breaker upon request.
C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of enclosed circuit breakers and adjacent equipment with all required clearances indicated.

D. Field Quality Control Test Reports.
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. Project Record Documents: Record actual installed locations of enclosed circuit breakers.
G. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.

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 circuit breaker internal components, enclosure, and finish.

1.08 FIELD CONDITIONS
A. Maintain ambient temperature between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C) during and after installation of enclosed circuit breakers.

PART 2 PRODUCTS
2.01 MANUFACTURERS
B. Schneider Electric; Square D Products; www.schneider-electric.us.
D. Source Limitations: Furnish enclosed circuit breakers 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 CIRCUIT BREAKERS
A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
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 (2,000 m).
   2. Ambient Temperature: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).
D. Short Circuit Current Rating:
   1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location indicated on the drawings.
E. Enclosed Circuit Breakers Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
F. Conductor Terminations: Suitable for use with the conductors to be installed.
G. Provide electronic trip circuit breakers where indicated.
H. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.

I. 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.

J. Provide externally operable handle with means for locking in the OFF position.

K. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

L. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

2.03 MOLDED CASE CIRCUIT BREAKERS

A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

B. Interrupting Capacity:
   1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
   2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

C. Conductor Terminations:
   1. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
   1. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
   2. Provide interchangeable trip units where indicated.

E. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
   1. Provide the following field-adjustable trip response settings:
      a. Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
      b. Long time delay.
      c. Short time pickup and delay.
      d. Instantaneous pickup.
      e. Ground fault pickup and delay where ground fault protection is indicated.
   2. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.

F. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

G. Provide the following circuit breaker types where indicated:
   1. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.

H. Provide the following features and accessories where indicated or where required to complete installation:
   1. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
   2. Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
3. Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated.
   B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.
   C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.
   D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
   A. Install products in accordance with manufacturer's instructions.
   B. Perform work in accordance with NECA 1 (general workmanship).
   C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
   D. Provide required supports in accordance with Section 26 0529.
   E. Install enclosed circuit breakers plumb.
   F. Install flush-mounted enclosed circuit breakers so that trims fit completely flush to wall with no gaps and rough opening completely covered.
   G. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches (2000 mm) above the floor or working platform.
   H. Provide grounding and bonding in accordance with Section 26 0526.
   I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
   J. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 0573.
   K. Set field-adjustable ground fault protection pickup and time delay settings.
   L. Identify enclosed circuit breakers 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 manufacturer's instructions and NETA ATS, except Section 4.
   C. Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers used for service entrance and for circuit breakers larger than 200 amperes. Tests listed as optional are not required.
   D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
   E. Test shunt trips to verify proper operation.
   F. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

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 circuit breaker enclosures and components according to manufacturer's instructions.
B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Enclosed safety switches.

1.02 REFERENCE STANDARDS
   A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
   B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
   C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
   E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
   F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
   H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

1.03 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. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS
   A. See Section 01 3300 - Submittal Procedures, for submittal process.
   B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
   C. Field Quality Control Test Reports.
   D. Project Record Documents: Record actual locations of enclosed switches.
   E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.05 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 FIELD CONDITIONS
   A. Maintain ambient temperature between -22 degrees F (-30 degrees C) and 104 degrees F (40 degrees C) during and after installation of enclosed switches.
PART 2 PRODUCTS

2.01 MANUFACTURERS

B. Schneider Electric; Square D Products:  www.schneider-electric.us.
D. Source Limitations:  Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ENCLOSED SAFETY SWITCHES

A. Description:  Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
B. Provide products listed, classified, and labeled as suitable for the purpose intended.
C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude:  Less than 6,600 feet (2,000 m).
   2. Ambient Temperature: Between -22 degrees F (-30 degrees C) and 104 degrees F (40 degrees C).
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.
   a. Minimum Ratings:
      a. Double Throw Switches Protected by Class R, Class J, or Class T Fuses:  100,000 rms symmetrical amperes.
G. Provide with switch blade contact position that is visible when the cover is open.
H. Fuse Clips for Fusible Switches:  As required to accept fuses indicated.
   1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
I. Conductor Terminations:  Suitable for use with the conductors to be installed.
J. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
K. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
L. Enclosures:  Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250:  Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations:  Type 1.
      b. Outdoor Locations:  Type 3R.
   2. Finish for Painted Steel Enclosures:  Manufacturer's standard, factory applied grey unless otherwise indicated.
M. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
N. Heavy Duty Switches:
   2. Conductor Terminations:
      a. Provide mechanical lugs unless otherwise indicated.
b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install enclosed switches in accordance with manufacturer's instructions.

B. Install enclosed switches securely, in a neat and workmanlike manner in accordance with NECA 1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required supports in accordance with Section 26 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 (2000 mm) above the floor or working platform.

G. Provide grounding and bonding in accordance with Section 26 0526.

H. Provide fuses complying with Section 26 2813 for fusible switches as indicated or as required by equipment manufacturer's recommendations.

I. Identify enclosed switches in accordance with Section 26 0553.

3.02 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.

3.03 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.04 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
PART 1  GENERAL

1.01  SECTION INCLUDES

A. Enclosed NEMA motor controllers for low-voltage (600 V and less) applications:
   1. Magnetic motor starters.
   2. General purpose contactors.

B. Overcurrent protective devices for motor controllers, including overload relays.

C. Motor control accessories:
   1. Auxiliary contacts.
   2. Pilot devices.

1.02  REFERENCE STANDARDS

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
F. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

1.03  ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   2. Coordinate the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.
   3. Coordinate the work to provide motor controllers and associated wiring suitable for interface with control devices to be installed.
   4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   6. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
1.04 SUBMITTALS
A. See Section 01 3300 - Submittal Procedures, for submittal process.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.
   1. Include characteristic trip curves for each type and rating of overcurrent protective device.
C. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of enclosed motor controllers.
   2. Include wiring diagrams showing all factory and field connections.
   3. Include documentation demonstrating selective coordination upon request.
D. Field Quality Control Test Reports.
E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.05 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 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 internal components, enclosure, and finish.

1.07 PROJECT CONDITIONS
A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
   1. Notify Owner, in writing, no fewer than ten (10) days in advance of proposed interruption of electrical service.
   2. Indicate method of providing temporary utilities.
   3. Do not proceed with interruption of electrical service without Owner's written permission.

1.08 COORDINATION
A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
B. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
C. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.09 EXTRA MATERIALS
A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Spare Fuses: Furnish three (3) spare of each type and rating.
2. Indicating Lights: Two (2) of each type installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

E. Source Limitations: Furnish enclosed motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 ENCLOSED MOTOR CONTROLLERS

A. Provide enclosed motor controller assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.
B. Provide products listed, classified, and labeled as suitable for the purpose intended.
C. Description: Enclosed motor controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.
D. Service Conditions:
   1. Provide motor controllers and associated components suitable for operation under the following service conditions without derating:
      a. Altitude:
         1) Class 1 Km Equipment (devices utilizing power semiconductors, e.g. variable frequency controllers): Less than 3,300 feet (1,000 m).
         2) Class 2 Km Equipment (electromagnetic and manual devices): Less than 6,600 feet (2,000 m).
      b. Ambient Temperature: Between 32 degrees F (0 degrees C) and 104 degrees F (40 degrees C).
   2. Provide motor controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.
E. Short Circuit Current Rating:
   1. Provide motor controllers with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
   2. Listed series ratings are not acceptable.
F. Conductor Terminations: Suitable for use with the conductors to be installed.
G. Enclosures:
   2. Environment Type per NEMA 250: As indicated on the drawings.
   3. Finish: Manufacturer's standard unless otherwise indicated.
H. Instrument Transformers:
   2. Select suitable ratio, burden, and accuracy as required for connected devices.
I. Magnetic Motor Starters: Combination type unless otherwise indicated.
   1. Combination Magnetic Motor Starters: NEMA ICS 2, Class A combination motor controllers with magnetic contactor(s), externally operable disconnect and overload relay(s).
   2. Noncombination Magnetic Motor Starters: NEMA ICS 2, Class A non-combination motor controllers with magnetic contactor(s) and overload relay(s).
3. Configuration: Full-voltage non-reversing unless otherwise indicated.
4. Minimum Starter Size: NEMA Size 0.
5. Use of non-standard starter sizes smaller than specified standard NEMA sizes is not permitted.
   a. Circuit Breakers: Motor circuit protectors (magnetic-only) unless otherwise indicated or required.
   b. Disconnect Switches: Fusible type unless otherwise indicated.
   c. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
   d. Provide auxiliary interlock for disconnection of external control power sources where applicable.
7. Overload Relays: Solid-state type unless otherwise indicated.
8. Pilot Devices Required:
   a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings.
   b. Single-Speed, Non-Reversing Starters:
      1) Pushbuttons: START-STOP.
      2) Selector Switches: HAND/OFF/AUTO.
      3) Indicating Lights: Red ON, Green OFF.
   c. Provide externally operable handle with means for locking in the OFF position.
   d. Provide safety interlock to prevent opening the cover with the disconnect in the OFF position.
   e. Provide auxiliary interlock for disconnection of external control power sources where applicable.
9. Overload Relays:
   1. Provide overload relays and, where applicable, associated current elements/heaters, selected according to actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
   2. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
   3. Trip-free operation.
   4. Visible trip indication.
   5. Resettable.
      a. Employ manual reset unless otherwise indicated.
      b. Employ automatic reset or remote reset where indicated.
      c. Do not employ automatic reset with two-wire control.
   6. Bimetallic Thermal Overload Relays:

J. Manual Motor Starters:
   1. Description: NEMA ICS 2, Class A manually-operated motor controllers with overload relay(s).
   2. Configuration: Non-reversing unless otherwise indicated.
   3. Fractional-Horsepower Manual Motor Starters:
      a. Furnish with toggle operator.
      b. Overload Relays: Bimetallic or melting alloy thermal type.
      c. Provide means for locking operator in the OFF position.
      d. Furnish Red ON indicating light.
   4. Integral-Horsepower Manual Motor Starters:
      a. Furnish with toggle or pushbutton operator.
      b. Overload Relays: Bimetallic or melting alloy thermal type.
      c. Provide means for locking operator in the OFF position.
      d. Furnish Red ON indicating light.
      e. Provide auxiliary contact; normally open (NO) or normally closed (NC) as indicated or as required.

K. Motor-Starting Switches: Horsepower-rated switches without overload protection; toggle operator.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Overload Relays:
   1. Provide overload relays and, where applicable, associated current elements/heaters, selected according to actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
   2. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
   3. Trip-free operation.
   4. Visible trip indication.
   5. Resettable.
      a. Employ manual reset unless otherwise indicated.
      b. Employ automatic reset or remote reset where indicated.
      c. Do not employ automatic reset with two-wire control.
   6. Bimetallic Thermal Overload Relays:
a. Provide ambient temperature compensation.
b. Interchangeable current elements/heaters.
c. Adjustable trip; plus/minus 10 percent of nominal, minimum.
d. Trip test function.

7. Melting Alloy Thermal Overload Relays:
   a. Interchangeable current elements/heaters.

8. Solid-State Overload Relays:
   a. Adjustable full load current.
   b. Phase loss protection.
   c. Phase imbalance protection.
   d. Ambient temperature insensitive.
   e. Thermal memory.
   f. Trip test function.
   g. Provide isolated alarm contact.

B. Fusible Disconnect Switches:
   1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA KS 1, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.
   2. Fuse Clips: As required to accept indicated fuses.
      a. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
   3. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

C. Circuit Breakers:
   1. Interrupting Capacity (not applicable to motor circuit protectors):
      a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
      b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
   2. Motor Circuit Protectors:
      a. Description: Instantaneous-trip circuit breakers furnished with magnetic instantaneous tripping elements for short circuit protection, but not with thermal inverse time tripping elements for overload protection; UL 489 recognized only for use as part of a listed combination motor controller with overload protection; ratings, configurations, and features as indicated on the drawings.
      b. Provide field-adjustable magnetic instantaneous trip setting.
      c. Provide the following features and accessories where indicated or where required to complete installation:

2.04 MOTOR CONTROL ACCESSORIES

A. Auxiliary Contacts:
   1. Comply with NEMA ICS 5.
   2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each magnetic motor starter, minimum.

B. Pilot Devices:
   1. Comply with NEMA ICS 5; heavy-duty type.
   2. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
   3. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
4. Indicating Lights: Push-to-test type unless otherwise indicated.
5. Provide LED lamp source for indicating lights and illuminated devices.

C. Control and Timing Relays:
   1. Comply with NEMA ICS 5.
   2. Provide number and type of relays indicated or required to perform necessary functions.
   3. Timing Relays: Electronic or pneumatic as indicated.

D. Control Power Transformers:
   1. Size to accommodate burden of contactor coil(s) and all connected auxiliary devices, plus _____ VA spare capacity.
   2. Include primary and secondary fuses.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as shown on the drawings.
   B. Verify that ratings of enclosed motor controllers are consistent with the indicated requirements.
   C. Verify that mounting surfaces are ready to receive enclosed motor controllers.
   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. Install motor controllers 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 components in accordance with Section 26 0529.
   E. Install enclosed motor controllers plumb and level.
   F. Provide grounding and bonding in accordance with Section 26 0526.
   G. Install all field-installed devices, components, and accessories.
   H. Provide fuses complying with Section 26 2813 for fusible switches as indicated.
   I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
   J. Set field-adjustable motor controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and NFPA 70.
   K. Set field-adjustable circuit breaker tripping function settings as indicated.
   L. Identify enclosed motor controllers in accordance with Section 26 0553.
   M. Bundle, train, and support wiring in enclosures.
   N. Connect hand-off-automatic switch and other automatic-control devices where applicable.
      1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
      2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.03 FIELD QUALITY CONTROL
   A. See Section 01 4000 - Quality Requirements, for additional requirements.
   B. Perform the following field tests and inspections and prepare test reports:
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Inspect and test in accordance with NETA ATS, except Section 4.

D. Motor Starters: Perform inspections and tests listed in NETA ATS, Section 7.16.1.1. Tests listed as optional are not required.

E. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

F. Correct deficiencies and replace damaged or defective enclosed motor controllers or associated components.

G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

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 motor controller enclosures and components according to manufacturer's instructions.

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

3.06 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 motor controllers to Owner, and correct deficiencies or make adjustments as directed.

D. Training: Train Owner's personnel on operation, adjustment, and maintenance of enclosed motor controllers and associated 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: Manufacturer's authorized representative.

4. Location: At project site.

3.07 PROTECTION

A. Protect installed enclosed motor controllers from subsequent construction operations.
SECTION 26 2923
VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Variable frequency controllers.

1.02 REFERENCE STANDARDS

B. NEMA ICS 7 - Industrial Control and Systems: Adjustable-Speed Drives; 2014.
C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, including All Applicable Amendments and Supplements.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.

1.04 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

C. Schneider Electric; Square D Products; Model: www.schneider-electric.us.

2.02 DESCRIPTION

A. Variable Frequency Controllers: Enclosed controllers suitable for operating the indicated loads, in conformance with requirements of NEMA ICS 7. Select unspecified features and options in accordance with NEMA ICS 3.1.
   1. Employ microprocessor-based inverter logic isolated from power circuits.
   2. Employ pulse-width-modulated inverter system.
   3. Design for ability to operate controller with motor disconnected from output.
   4. Design to attempt five automatic restarts following fault condition before locking out and requiring manual restart.
B. Enclosures: NEMA 250, Type 1, suitable for equipment application in places regularly open to the public.
C. Finish: Manufacturer's standard enamel.

2.03 OPERATING REQUIREMENTS
   A. Current Limit Adjustment: 60 to 110 percent of rated.
   B. Acceleration Rate Adjustment: 0.5 to 30 seconds.
   C. Deceleration Rate Adjustment: 1 to 30 seconds.
   D. Input Signal: 4 to 20 mA DC.

2.04 COMPONENTS
   A. Display: Provide integral digital display to indicate output voltage, output frequency, and output current.
   B. Status Indicators: Separate indicators for overcurrent, overvoltage, ground fault, overtemperature, and input power ON.
   C. Furnish HAND-OFF-AUTOMATIC selector switch and manual speed control.
   D. Include undervoltage release.
   E. Control Power Source: Separate circuit.
   F. Door Interlocks: Furnish mechanical means to prevent opening of equipment with power connected, or to disconnect power if door is opened; include means for defeating interlock by qualified persons.
   G. Safety Interlocks: Furnish terminals for remote contact to inhibit starting under both manual and automatic mode.
   H. Control Interlocks: Furnish terminals for remote contact to allow starting in automatic mode.
   I. Manual Bypass: Furnish contactor, motor running overload protection, and short circuit protection for full voltage, non-reversing operation of the motor. Include isolation switch to allow maintenance of inverter during bypass operation.
   J. Emergency Stop: Use dynamic brakes for emergency stop function.
   K. Disconnecting Means: Include integral fused disconnect switch on the line side of each controller.
   L. Wiring Terminations: Match conductor materials and sizes indicated.

2.05 SOURCE QUALITY CONTROL
   A. Shop inspect and perform standard productions tests for each controller.
   B. Make completed controller available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner at least 7 days before inspection is allowed.
   C. Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify Owner at least 7 days before inspections and tests are scheduled.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that surface is suitable for controller installation.
   B. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.

3.02 INSTALLATION
   A. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.
   B. Tighten accessible connections and mechanical fasteners after placing controller.
   C. Provide fuses in fusible switches; refer to Section 26 2813 for product requirements.
   D. Select and install overload heater elements in motor controllers to match installed motor characteristics.
E. Identify variable frequency controllers in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL
   A. Perform field inspection and testing in accordance with Section 01 4000.
   B. Inspect and test in accordance with NETA ATS, except Section 4.
   C. Perform inspections and tests listed in NETA ATS, Section 7.17.

3.04 ADJUSTING
   A. Make final adjustments to installed controller to assure proper operation of load system. Obtain performance requirements from installer of driven loads.

3.05 CLOSEOUT ACTIVITIES
   A. Demonstrate operation of controllers in automatic and manual modes.

3.06 MAINTENANCE
   A. See Section 01 7000 - Execution Requirements, for additional requirements relating to maintenance service.
   B. Provide a separate maintenance contract for specified maintenance service.
   C. Provide service and maintenance of controllers for one year from Date of Substantial Completion.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Packaged engine generator system and associated components and accessories:
      1. Engine and engine accessory equipment.
      2. Alternator (generator).
      3. Generator set control system.
      4. Generator set enclosure.

1.02 RELATED REQUIREMENTS
   A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
   B. Section 23 1123 - Facility Natural-Gas Piping.
   C. Section 23 5100 - Breechings, Chimneys, and Stacks: Engine exhaust piping.
      1. Includes installation of exhaust silencer specified in this section.
   D. Section 26 0526 - Grounding and Bonding for Electrical Systems.
   E. Section 26 0529 - Hangers and Supports for Electrical Systems.
   F. Section 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS: Identification products and requirements.
   G. Section 26 3600 - Transfer Switches.

1.03 REFERENCE STANDARDS
   B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
   C. NECA/EGSA 404 - Standard for Installing Generator Sets; 2014.
   D. NEMA MG 1 - Motors and Generators; 2014.
   F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
   I. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.
   J. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.
         a. Transfer Switches: See Section 26 3600.
      2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for engine generator system.
      3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
      4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.05 SUBMITTALS

A. See Section 01 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.

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. Fuel Storage Tank Calculations: Indicate maximum running time for generator set configuration provided.

E. Specimen Warranty: Submit sample of manufacturer's warranty.

F. Manufacturer's factory emissions certification.

G. Manufacturer's certification that products meet or exceed specified requirements.

H. Source quality control test reports.

I. 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.

J. Manufacturer's detailed field testing procedures.

K. Field quality control test reports.

L. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

M. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

N. Maintenance contracts.

O. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

P. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70 (National Electrical Code).
   2. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).

B. 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 one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS
B. Substitutions: See Section 01 6000 - Product Requirements.
C. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.
D. Source Limitations: Furnish engine generator sets and associated components and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 PACKAGED ENGINE GENERATOR SYSTEM
A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
B. Provide products listed, classified, and labeled as suitable for the purpose intended.
C. System Description:
D. Packaged Engine Generator Set:
      a. Industrial Gaseous Generator Set; Model SG275 - Standby Power Rating of 275 kW.
   2. Voltage: 480Y/277 V, 3 phase, 60 Hz.
   3. Main Line Circuit Breaker:
      a. Type: Thermal magnetic.
      b. Trip Rating: 400 amps.
      c. Features:
         1) Auxiliary contacts.
E. Generator Set General Requirements:
   1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
   2. Factory-assembled, with components mounted on suitable base.
   3. List and label engine generator assembly as complying with UL 2200.
4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.

F. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.

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 - Gaseous (Spark Ignition):
   1. Fuel Source: Natural gas.
   2. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
   3. Provide components/features indicated and as necessary for operation and/or required by applicable codes, including but not limited to:
      a. Carburetor.
      b. Gas pressure regulators.
      c. Fuel shutoff control valves.
      d. Low gas pressure switches.

C. Engine Starting System:
   1. System Type: Electric, with DC solenoid-activated starting motor(s).
   2. Battery(s):
      a. Battery Type: Lead-acid.
      b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.
      c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.
   4. Battery Charger:
a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
c. Recognized as complying with UL 1236.
d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
f. Provide alarm output contacts as necessary for alarm indications.

5. Battery Heater: Provide thermostatically controlled battery heater to improve starting under cold ambient conditions.

D. Engine Speed Control System (Governor):
   2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

E. Engine Lubrication System:
   1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.
   2. Oil Heater: Provide thermostatically controlled oil heater to improve starting under cold ambient conditions.

F. Engine Cooling System:
   1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
   2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.
   3. Ducted Radiators: Where ducted radiator air discharge is to be field-installed, provide suitable radiator duct flange/adapter.
   4. Coolant Heater: Provide thermostatically controlled coolant heater to improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.

G. Engine Air Intake and Exhaust System:
   1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
   2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.
   3. Exhaust Silencer: Provide critical grade or better exhaust silencer with sound attenuation not less than basis of design; select according to manufacturer's recommendations to meet sound performance requirements, where specified.

2.04 ALTERNATOR (GENERATOR)

A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.

B. Exciter:
   1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
   2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.

C. Temperature Rise: Comply with UL 2200.

D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.

E. Enclosure: NEMA MG 1, drip-proof.

F. Total Harmonic Distortion: Not greater than five percent.

G. Alternator Heater: Provide strip heater to prevent moisture condensation on alternator windings.

2.05 GENERATOR SET CONTROL SYSTEM

A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.

B. Control Panel:
   1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
   2. Generator Set Control Functions:
      a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
      c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
      d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
      e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
      f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
      g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.

C. 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).

D. 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 (warning).
      6) Low oil pressure (shutdown).
      7) Overspeed (shutdown).
      8) Low fuel level (warning).
      9) Low coolant level (warning/shutdown).
10) Generator control not in automatic mode (warning).
11) High battery voltage (warning).
12) Low cranking voltage (warning).
13) Low battery voltage (warning).
14) 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).

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 for Level 1 systems including but not limited to the following indications:
   1) Overcrank (shutdown).
   2) Low coolant temperature (warning).
   3) High coolant temperature (warning).
   4) High coolant temperature (shutdown).
   5) Low oil pressure (warning).
   6) Low oil pressure (shutdown).
   7) Overspeed (shutdown).
   8) Low fuel level (warning).
   9) Low coolant level (warning/shutdown).
  10) Generator control not in automatic mode (warning).
  11) High battery voltage (warning).
  12) Low cranking voltage (warning).
  13) Low battery voltage (warning).
  14) 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: 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. Exhaust Silencers: Where exhaust silencers are mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as necessary for operation at rated load under worst case ambient temperature.
J. Enclosure Space Heater: Provide thermostatically controlled enclosure space heater to prevent condensation and improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.

2.07 SOURCE QUALITY CONTROL
A. See Section 01 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.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that field measurements are as indicated.
B. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.
C. Verify that rough-ins for field connections are in the proper locations.
D. Verify that mounting surfaces are ready to receive equipment.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
A. Perform work in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer's instructions.
C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.
D. Arrange equipment to provide minimum clearances and required maintenance access.
E. Unless otherwise indicated, mount generator set on properly sized 6 inch (150 mm) high concrete pad constructed in accordance with Section 03 3000. Provide suitable vibration isolators, where not factory installed.
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 in accordance with Section 23 5100, where not factory installed.
   1. Include piping expansion joints, piping insulation, thimble, condensation trap/drain, rain cap, hangers/supports, etc. as indicated or as required.
   2. Do not exceed manufacturer's maximum back pressure requirements.
J. Install exhaust silencer in accordance with Section 23 5100, where not factory installed.
K. Provide grounding and bonding in accordance with Section 26 0526.
L. 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. Include up to three (3) manufacturer's start-up site visits.
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. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
K. 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 three(3) four hours of training sessions.
   3. Instructor: Manufacturer's authorized representative.
   4. Location: At project site.
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. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of engine generator system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

C. Conduct site visit at least once every three months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.

D. Provide trouble call-back service upon notification by Owner:
   1. 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.

E. 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
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Transfer switches for low-voltage (600 V and less) applications and associated accessories:
   1. Automatic transfer switches.
   2. Includes bypass/isolation transfer switches.

1.02 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
G. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compatibility of transfer switches to be installed with work provided under other sections or by others.
   2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Coordinate the work with placement of supports, anchors, etc. required for mounting.
   5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.04 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.
   1. Where applicable, include characteristic trip curves for overcurrent protective devices upon request.
C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.
   1. Clearly indicate whether proposed short circuit current ratings are based on testing with specific overcurrent protective devices or time durations; indicate short-time ratings where applicable.
D. Specimen Warranty: Submit sample of manufacturer's warranty.
E. Evidence of qualifications for installer.
F. Source quality control test reports.
G. Manufacturer’s detailed field testing procedures.
H. Field quality control test reports.
I. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.
J. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
K. Maintenance contracts.
L. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.
M. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Bypass/Isolation Transfer Switches: Provide accessories (ramps, dollies, etc.) necessary for removal of drawout components.

1.05 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.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
   1. Authorized service facilities located within 200 miles (320 km) of project site.
D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with power transfer systems of similar size, type, and complexity; manufacturer's authorized installer.
E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store transfer switches in accordance with manufacturer's instructions.
B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
C. Handle carefully in accordance with manufacturer's instructions to avoid damage to transfer switch components, enclosure, and finish.

1.07 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. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS


B. Substitutions: See Section 01 6000 - Product Requirements.

C. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

D. Source Limitations: Furnish transfer switches and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 TRANSFER SWITCHES

A. Provide complete power transfer system consisting of all required equipment, conduit, boxes, wiring, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Applications:
   1. Utilize open transition transfer unless otherwise indicated or required.
   2. For transfer of highly inductive loads (e.g. large motors and transformers), utilize open transition transfer with in-phase monitor or delayed transition transfer.

D. Construction Type: Either "contactor type" (open contact) or "breaker type" (enclosed contact) transfer switches complying with specified requirements are acceptable.

E. Automatic Transfer Switch:
      a. Generac GTS Series Automatic Transfer Switch, Selectable Open In-Phase/Delayed Transition.

F. Comply with NEMA ICS 10 Part 1, and list and label as complying with UL 1008 for the classification of the intended application (e.g. emergency, optional standby).

G. Do not use double throw safety switches or other equipment not specifically designed for power transfer applications and listed as transfer switch equipment.

H. Load Classification: Classified for total system load (any combination of motor, electric discharge lamp, resistive, and tungsten lamp loads with tungsten lamp loads not exceeding 30 percent of the continuous current rating) unless otherwise indicated or required.

I. Switching Methods:
   1. Open Transition:
      a. Provide break-before-make transfer without a neutral position that is not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.
      b. Where in-phase transfer is indicated, utilize in-phase monitor to initiate transfer when phase angle difference between sources is near zero to limit in-rush currents.
   2. Delayed Transition:
      a. Provide break-before-make transfer with programmable time delay in a neutral position not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.

   3. Obtain control power for transfer operation from line side of source to which the load is to be transferred.
J. Service Conditions: Provide transfer switches suitable for continuous operation at indicated ratings under the service conditions at the installed location.

K. Enclosures:
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Outdoor Locations: Type 3R or Type 4.
   2. Finish: Manufacturer's standard unless otherwise indicated.

L. Short Circuit Current Rating:
   1. Withstand and Closing Rating: Provide transfer switches, when protected by the supply side overcurrent protective devices to be installed, with listed withstand and closing rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.

M. Automatic Transfer Switches:
   1. Description: Transfer switches with automatically initiated transfer between sources; electrically operated and mechanically held.
   2. Control Functions:
      a. Automatic mode.
      b. Test Mode: Simulates failure of primary/normal source.
      c. Voltage and Frequency Sensing:
         1) Undervoltage sensing for each phase of primary/normal source; adjustable dropout/pickup settings.
         2) Undervoltage sensing for alternate/emergency source; adjustable dropout/pickup settings.
         3) Underfrequency sensing for alternate/emergency source; adjustable dropout/pickup settings.
      d. Outputs:
         1) Contacts for engine start/shutdown (except where direct generator communication interface is provided).
         2) Auxiliary contacts; one set(s) for each switch position.
      e. Adjustable Time Delays:
         1) Engine generator start time delay; delays engine start signal to override momentary primary/normal source failures.
         2) Transfer to alternate/emergency source time delay.
         3) Retransfer to primary/normal source time delay.
         4) Engine generator cooldown time delay; delays engine shutdown following retransfer to primary/normal source to permit generator to run unloaded for cooldown period.
      f. In-Phase Monitor (Open Transition Transfer Switches): Monitors phase angle difference between sources for initiating in-phase transfer.
      g. Engine Exerciser: Provides programmable scheduled exercising of engine generator selectable with or without transfer to load; provides memory retention during power outage.
   3. Status Indications:
      a. Connected to alternate/emergency source.
      b. Connected to primary/normal source.
      c. Alternate/emergency source available.
   4. Automatic Sequence of Operations:
      a. Upon failure of primary/normal source for a programmable time period (engine generator start time delay), initiate starting of engine generator where applicable.
      b. When alternate/emergency source is available, transfer load to alternate/emergency source after programmable time delay.
c. When primary/normal source has been restored, retransfer to primary/normal source after a programmable time delay. Bypass time delay if alternate/emergency source fails and primary/normal source is available.
d. Where applicable, initiate shutdown of engine generator after programmable engine cooldown time delay.

N. Bypass/Isolation Transfer Switches:
   1. Description: Factory-assembled units consisting of interconnected transfer switch and bypass/isolation switch that permits manual bypass and isolation of the transfer switch with connection of the load to either source.
   2. Bypass/Isolation Switch Type: Provide overlapping (make-before-break) switches with no interruption of power to load. Load break (break-before-make) switches that interrupt power to load are not acceptable.
   3. Bypass/Isolation Operation:
      a. Operable from exterior of enclosure.
      b. Normal Mode: Provides for normal operation of transfer switch.
      c. Test Mode: Provides for operational testing of bypassed transfer switch without affecting power to load.
      d. Isolate Mode: Provides for complete isolation of transfer switch from all power sources, permitting removal from unit.

O. Remote Annunciators:
   1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
   2. Transfer Switch Status Indications:
      a. Connected to alternate/emergency source.
      b. Connected to primary/normal source.
      c. Alternate/emergency source available.

P. Interface with Other Work:
   1. Interface with engine generators as specified in Section 26 3213.
   2. Interface with building automation system as specified in Section __________.

2.03 SOURCE QUALITY CONTROL
A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Perform production tests on transfer switches at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that field measurements are as indicated.
B. Verify that the ratings and configurations of transfer switches are consistent with the indicated requirements.
C. Verify that rough-ins for field connections are in the proper locations.
D. Verify that mounting surfaces are ready to receive transfer switches.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
A. Perform work in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer's instructions.
C. Arrange equipment to provide minimum clearances and required maintenance access.
D. Provide required support and attachment in accordance with Section 26 0529.
E. Install transfer switches plumb and level.
F. Unless otherwise indicated, mount floor-mounted transfer switches on properly sized 4 inch (100 mm) high concrete pad constructed in accordance with Section 03 3000.

G. Provide grounding and bonding in accordance with Section 26 0526.

H. Identify transfer switches and associated system wiring 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 observe installation and assist in inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

C. Prepare and start system in accordance with manufacturer's instructions.

D. Automatic Transfer Switches:
   1. Inspect and test in accordance with NETA ATS, except Section 4.
   2. Perform inspections and tests listed in NETA ATS, Section 7.22.3. The insulation-resistance tests listed as optional are not required.

E. Provide additional inspection and testing as required for completion of associated engine generator testing as specified in Section 26 3213.

F. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 CLEANING

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

3.05 CLOSEOUT ACTIVITIES

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

B. See Section 01 7900 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of transfer switches to Owner, and correct deficiencies or make adjustments as directed.

D. Training: Train Owner's personnel on operation, adjustment, and maintenance of transfer switches.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

E. Coordinate with related generator demonstration and training as specified in Section 26 3213.

3.06 PROTECTION

A. Protect installed transfer switches from subsequent construction operations.

3.07 MAINTENANCE

A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of transfer switches for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

C. Conduct site visit at least once every three months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.

D. Provide trouble call-back service upon notification by Owner:
   1. 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.

E. 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 4300
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Surge protective devices for service entrance locations.
B. Surge protective devices for distribution locations.
C. Surge protective devices for branch panelboard locations.

1.02 ABBREVIATIONS AND ACRONYMS
B. SPD: Surge Protective Device.

1.03 REFERENCE STANDARDS
B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
E. UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to ordering equipment.

1.05 DESCRIPTION
A. Provide a complete Transient Voltage Surge Suppression (TVSS) system as described herein and as documented on the Contract Documents.
B. Provide surge suppression at each building service entrance switchboard or panelboard, and at other locations as indicated on the Contract Drawings.

1.06 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
C. Documentation from manufacturer stating TVSS incorporates all mode protection (i.e. line-to-neutral, line-to-line, line-to-ground, neutral-to-ground) “Reduced-Mode” variations (3,4, or 7 modes) will not be accepted.
D. Documentation certifying that submitting manufacturing facility is ISO 9001:2000 Compliant and in current good standing of same.
E. Certificates: Manufacturer’s documentation of listing for compliance with the following standards:
   1. UL 1449,
   2. UL 1283 (for Type 2 SPDs).
3. cUL approved.

F. Documentation of specified system's NEMA LS 1, 1992 test results and IEEE C62.41-2002 testing shall be included as required product data submittal information. Documentation to include: independent surge current test data, Category C, B, A test results (to include the Cat. A, 2kv, 67A, 100kHz Ring-wave to demonstrate “true” sine-wave tracking capability) and proof of products maximum continuous operating voltage.

G. Field Quality Control Test Reports.

H. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

I. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.

J. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.07 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience. Operates a Quality System Certified manufacturing facility as ISO 9001:2000 Compliant.

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

1.08 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.09 FIELD CONDITIONS

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

1.10 WARRANTY

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

B. Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Field-installed, Externally Mounted Surge Protective Devices:

B. Factory-installed, Internally Mounted Surge Protective Devices:
   1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.

C. Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.
2.02 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.

B. Only TVSS devices manufactured after February 9, 2007 and are UL LISTED to UL 1449 2nd Edition shall be accepted.

C. TVSS devices shall be rated for the class of service necessary for the application. Protection shall be provided L-N, L-G, L-L & N-G (Per IEEE Std. 1100-1999 8.6.1 & NEMA LS-1 2.2.7) for all applications.

D. Branch panel units must incorporate "True" sine-wave tracking directly connected protection elements for each and every mode within the electrical system to which it is connected. Products utilizing basic EMI/RFI filter performance specifically will not be considered acceptable as equal to sine-wave tracking and therefore are not to be submitted. Products displaying this capability in any less than ALL MODES will be deemed unacceptable. (e.g. L-N only, L-L only or L-G only)

E. Sine-wave tracking capability must be demonstrated by furnishing an ANSI/IEEE Category A, 2kV, 67A, 100kHz Ringwave test as defined in ANSI/IEEE C62.41-1991, at the 270 degree phase angle, with the "let-through voltage" not to exceed 60V in all modes of the device at the voltage rated for the project. Manufacturers not providing this documentation or meeting this requirement for branch panel locations will be deemed unacceptable.

F. TVSS devices shall be designed for AC power systems with a minimum of AC follow current after operation. The surge current rating must be sufficient to meet the requirement of the application at clamp levels below the damage level of the equipment installed.

G. Manufacturer shall provide permanently-connected devices parallel mounted to the service entrance, distribution, and branch panels, series connected devices for individual equipment protection and all other locations as indicated and required on Contract Drawings. TVSS device drawings shall be made available upon request.

H. TVSS circuitry shall include only solid-state clamping components to limit the surge voltage and divert the surge current. TVSS components that "crowbar" (e.g. spark gaps, gas tubes, SCR's, etc.) shall not be accepted.

I. Protected Modes: The TVSS system shall provide protection for all 10 modes. True distinct and independent protection circuitry for each mode is required. Reduced mode TVSS with only 3, 4 or 7 dedicated, distinct, independent protection modes are not acceptable and are not to be submitted.


J. UL 1449 Voltage Protection Ratings (VPRs):

   1. 208Y/120V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
   2. 240/120V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
   3. 480Y/277V System Voltage: Not more than 1,500 V for L-N, L-G, and N-G modes and 2,000 V for L-L mode.

K. The TVSS shall provide as a minimum, over-current, over temperature protection in the form of component-level thermal fusing to ensure safe failure and prevent thermal runaway. This component-level fusing shall be an integral part of the MOV itself, and not silver wire independently laid across each MOV.

L. Surge protective devices shall contain short circuit current safety fusing within each device where no upstream circuit breaker is specified, per over-current protection requirements of the NEC 2014. This fusing will be independent of the "component-level" fusing and specifically for over-current protection and shall be constructed utilizing surge rated, cartridge fuses and not rated 'silver-fuse-wire'
M. The fusing mechanisms employed must effectively coordinate their performance in conjunction with the high current abnormal over-voltage testing under UL 1449 2nd Edition as defined above.

N. The Transient Voltage Surge Suppressor (TVSS) shall be of a parallel design using fast-acting transient energy protection that will divert and dissipate the surge energy.

O. The TVSS shall be self-restoring and fully automatic with a total response time not to exceed 1 nanosecond.

P. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

Q. Circuit Configuration: The circuit configuration of the suppression units shall be bi-directional, thermal stress reducing, totally encapsulated, custom parallel and solid state.

R. Encapsulation: The circuit shall be encapsulated in a UL Listed as 94V-0 Flame Retardant (or better) potting compound to reduce component stress and ensure stability and durability of the TVSS device. TVSS devices encapsulated in sand or other properties not meeting the above criteria are expressly prohibited and are not to be submitted.

S. Maintenance Restrictions
   1. No suppression unit shall be supplied which requires scheduled preventive maintenance or replacement parts. Units requiring functional testing, special test equipment, or special training to monitor surge protection device (SPD) status are not acceptable. TVSS devices shall require no routine maintenance. TVSS devices are considered non-repairable items and shall be fully replaced upon failure.

T. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   1. Indoor clean, dry locations: Type 1.
   2. Outdoor locations: Type 4X.

U. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:
   1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.
   2. Provide flush-mounted SPD where mounted in public areas or adjacent to flush-mounted equipment.

V. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.
   1. Panelboards: See Section 26 2416.

2.03 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

A. Unless otherwise indicated, provide factory-installed, internally mounted SPDs.

B. List and label as complying with UL 1449, Type 1 or Type 2.

C. Distribution locations include SPDs connected to distribution panelboards.

D. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.

E. Surge Current Rating: Not less than 80 kA per mode/160 kA per phase.

F. Repetitive Surge Current Capacity: Not less than 3,500 impulses.

G. UL 1449 Nominal Discharge Current (I-n): 20 kA.

H. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.

I. Diagnostics:
   1. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.

2.04 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

A. Unless otherwise indicated, provide field-installed, externally mounted or factory-installed, internally mounted SPDs.

B. List and label as complying with UL 1449, Type 1 or Type 2.

C. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.

D. Surge Current Rating: Not less than 60 kA per mode/120 kA per phase.

E. Repetitive Surge Current Capacity: Not less than 2,000 impulses.

F. UL 1449 Nominal Discharge Current (I-n): 20 kA.

G. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.

H. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).

1. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.

I. Diagnostics:

1. Protection Status Monitoring: Provide indicator lights to report the protection status.


3. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.

4. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.

J. Products - Field-installed, Externally Mounted Surge Protective Devices:

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.

C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of drawings and manufacturer's instructions.

D. Verify system grounding and bonding is in accordance with Section 26 0526, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.

3.02 INSTALLATION

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

B. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

C. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.

D. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.
E. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26.0526 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

F. Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.

3.03 FIELD QUALITY CONTROL

A. See Section 01.4000 - 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 7.19.1.

3.04 CLEANING

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

END OF SECTION
SECTION 26 5100
INTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Interior luminaires.
B. Emergency lighting units.
C. Exit signs.
D. LED drivers.
E. Luminaire accessories.

1.02 REFERENCE STANDARDS
C. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Cor 1, 2012).
G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
J. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2012.
K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
N. UL 1598 - Luminaires; Current Edition, Including All Revisions.

1.03 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. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
   4. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.
1.04 SUBMITTALS
A. See Section 01 3300 - Submittal Procedures, for submittal process.
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.
      b. Include IES LM-79 test report upon request.
   2. Provide electronic files of photometric data certified by a National Voluntary Laboratory
      Accreditation Program (NVLAP) lab or independent testing agency in IESNA LM-63
      standard format upon request.
C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use
stipulated by product testing agency. Include instructions for storage, handling, protection,
examination, preparation, and installation of product.
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. Extra Lenses and Louvers: Two percent of total quantity installed for each type, but not
      less than one of each type.
   3. Extra LED Drivers: Two percent of total quantity installed for each type, but not less than
      one of each type.
E. Project Record Documents: Record actual connections and locations of luminaires and any
associated remote components.

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

1.06 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.

1.07 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. Provide five year manufacturer warranty for all LED luminaires, including drivers. Warranty shall
   warrant performance, lifetime and color consistency of the luminaire.
C. Provide five year pro-rata warranty for batteries for emergency lighting units.
D. Provide ten year pro-rata warranty for batteries for self-powered exit signs.

PART 2 PRODUCTS
2.01 MANUFACTURERS - LUMINAIRES
B. Cooper Lighting, a division of Cooper Industries: www.cooperindustries.com.
D. Substitutions: See Section 01 6000 - Product Requirements, except where individual luminaire types are designated with substitutions not permitted.

2.02 LUMINAIRE TYPES
A. Furnish products along with components as indicated in luminaire schedule included on the drawings.
B. Substitutions: See Section 01 6000 - Product Requirements, except where individual luminaire types are designated with substitutions not permitted.

2.03 LUMINAIRES
A. Manufacturers:
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:
2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.
I. LED Luminaires:
1. Components: UL 8750 recognized or listed as applicable.
2. Tested in accordance with IES LM-79 and IES LM-80.
3. Light source should be tested at a minimum case temperature of 70 degrees C.
4. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data. The module shall not exceed a temperature specified by OEM manufacturer in order to maintain 50,000 hours of life.
5. Modules shall conform to the lamp standard, IEC62471 ‘Photobiological Safety of Lamps and Lamp Systems’.
6. Provide "future-proof" modules (module dimensions remain constant) with fixed dimension formats and fixed optical interfaces.
7. Fixture shall have a negative temperature coefficient (NTC) which regulates the light output down if certain critical temperature points have been exceeded.
8. Provide fixtures with Fortimo LED systems portfolio utilizing LED Module and Driver.
9. Module must adhere to Zhaga compliant certified light engine, where applicable.
10. Minimum CRI shall be 80.
11. Correlated Color Temperature shall be within +/-245K of stated value. A range of commonly used CCT’s (2,700K, 3,000K, 3,500K, 4,000K) shall be available to ensure that a wide variety of lighting needs can be met.
12. Provide 100% of units within 4 standard deviation color matching (SDCM).
13. Units shall be dimmable and feature 100% light run control interface that allows the same light source to be used on a 0-10V, phase cut, step dim, DALI, DMX/RDM network.
14. The module shall have a Tc point to measure application temperature.

2.04 EMERGENCY LIGHTING UNITS

A. Manufacturers:

B. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.

C. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

D. Battery:
   1. Sealed maintenance-free lead calcium unless otherwise indicated.
   2. Size battery to supply all connected lamps, including emergency remote heads where indicated.

E. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.

F. Provide low-voltage disconnect to prevent battery damage from deep discharge.

G. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.

H. Accessories:
   1. Provide compatible accessory mounting brackets where indicated or required to complete installation.
   2. Provide compatible accessory high impact polycarbonate vandal shields where indicated.
   3. Provide compatible accessory wire guards where indicated.
   4. Where indicated, provide emergency remote heads that are compatible with the emergency lighting unit they are connected to and suitable for the installed location.

2.05 EXIT SIGNS

A. Manufacturers - Powered and Self-Luminous Signs:

B. Description: Internally illuminated exit signs with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
   1. Number of Faces: Single or double as indicated or as required for the installed location.
   2. Directional Arrows: As indicated or as required for the installed location.

C. Self-Powered Exit Signs:
   1. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected
lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

2. Battery: Sealed maintenance-free nickel cadmium unless otherwise indicated.

3. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.

4. Provide low-voltage disconnect to prevent battery damage from deep discharge.

5. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.

D. Accessories:
1. Provide compatible accessory high impact polycarbonate vandal shields where indicated.
2. Provide compatible accessory wire guards where indicated.

2.06 DRIVERS

A. Manufacturers:
5. Substitutions: See Section 01 6000 - Product Requirements.
6. Manufacturer Limitations: Where possible, for each type of luminaire provide ballasts produced by a single manufacturer.
7. Ballast shall be manufactured in a factory certified to ISO 9002 Quality System Standards.
8. Manufacturer shall have a 20 year history of producing electronic ballasts for the North American market.

B. Dimmable LED Drivers:
1. Regulatory Requirements:
   a. Driver shall not contain any Polychlorinated Biphenyl (PCB).
   b. Underwriters Laboratories (UL) recognized for Dry and Damp location and Canadian Standards Association (CSA) certified where applicable.
   d. Comply with ANSI C62.41 Category A for transient protection.
   e. Comply with ANSI C82.11 where applicable.
   f. Comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) EMI/RFI (conducted and radiated) and Class B for residential use.
   g. Driver shall comply with NEMA 410 for in-rush current limits.
   h. Driver shall meet the RoHS Directive 2002/95EC on the restriction of hazardous substances such as lead, cadmium, mercury, hexavalent chromium, PBB's and PBDE's.

2.07 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 shown on the drawings.

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. Install products according to manufacturer's instructions.
B. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).
C. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
D. 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 ceiling support channels or framing members.
   4. Secure pendant-mounted luminaires to building structure with redundant air-craft safety cable.
   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 gage, connected from opposing corners of each recessed luminaire to building structure.
E. 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.
F. Suspended Luminaires:
   1. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
   2. Install canopies tight to mounting surface.
   3. Unless otherwise indicated, support pendants from swivel hangers.
G. Install accessories furnished with each luminaire.
H. Bond products and metal accessories to branch circuit equipment grounding conductor.
I. Fluorescent Luminaires Controlled by Dual-Level Switching: Connect such that each switch controls the same corresponding lamps in each luminaire.
J. Emergency Lighting Units:
   1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
K. Exit Signs:
   1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
L. Install lamps in each luminaire.
M. 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. Test self-powered exit signs, emergency lighting units, and fluorescent emergency power supply units to verify proper operation upon loss of normal power supply.
E. 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.
B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect or authority having jurisdiction.
C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.

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. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.
C. 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 26 5600
EXTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Exterior luminaires.
B. Drivers.
C. Modules.
D. Poles and accessories.
E. Luminaire accessories.

1.02 REFERENCE STANDARDS

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
F. UL 1598 - Luminaires; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
   2. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.04 SUBMITTALS

A. See Section 01 3300 - Submittal Procedures, for submittal process.
B. Shop Drawings:
   1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
   2. Provide structural calculations for each pole.
C. 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, weight, effective projected area (EPA), and installed accessories; 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.
      b. Include IES LM-79 test report upon request.
   2. Poles: Include information on maximum supported effective projected area (EPA) and weight for the design wind speed.
D. Certificates for Poles and Accessories: Manufacturer's documentation that products are suitable for the luminaires to be installed and comply with designated structural design criteria.
E. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Furnish 5% of each plastic lens type, minimum (1) for each type.
   3. Furnish 10% replacement lamps for each lamp type, minimum (1) for each type.
   4. Furnish 10% of each driver type, minimum two (2) for each type.

1.05 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.
   B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.07 WARRANTY
   A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
   B. Provide three year manufacturer warranty for all LED luminaires, including drivers.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   B. Cooper Lighting, a division of Cooper Industries; www.cooperindustries.com.

2.02 LUMINAIRE TYPES
   A. Furnish products as indicated in luminaire schedule included on the drawings.
   B. Substitutions: See Section 01 6000 - Product Requirements.

2.03 LUMINAIRES
   A. Provide products that comply with requirements of NFPA 70.
   B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
   C. Provide products listed, classified, and labeled as suitable for the purpose intended.
   D. Unless otherwise indicated, provide complete luminaires including modules, drivers, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
   E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.
   F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
   G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.
   H. 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.
2.04 DRIVERS  
A. Manufacturers:
   1. Osram Sylvania; ________:  www.sylvania.com/#sle.
   4. Or equal.
B. All Drivers:
   1. LED driver shall operate at 120/277 volts with +/-10% variation tolerance.
   2. LED driver shall have adjustable output surrent to optimize lumens and efficacy of luminaire.
   3. The enclosure case of the driver must be connected to earth ground when installed in the end-use application.
   4. LED driver shall have 0.9 PF and <20% THD at maximum load under all input voltage variations.
   5. Driver shall tolerate sustained open circuit and short circuit output conditions without damage.
   6. Driver shall not contain any Polychlorinated Biphenyl (PCB’s).
   7. Provide driver complying with all current applicable federal and state efficiency/efficacy standards.
   8. Provide driver with surge protection.
   9. Driver shall manufactured in a factory certified to ISO 9001 Quality System Standards.
   10. Manufacturer shall have a twenty year history of producing electronic drivers for the North American Market.

2.05 MODULES  
A. Modules must adhere to Zhaga compliant certified light engine, where applicable.
B. 5-year limited system warranty. Warranty shall warrant performance, lifetime and color consistency of the luminaire.
C. Average rated life is 50,000 hours life with lumen maintenance 70%.
D. Minimum CRI of 80.
E. Correlated Color temperature within +/-245K of stated value.
F. 100% of units are within 4 standard deviation color matching (SDCM).
G. Manufacturer shall be in business for a minimum of 10 years.
H. Binning shall meet in accordance with American National Standards Institute (ANSI) specification #C78.377-2008.

2.06 POLES  
A. All Poles:
   1. Provide poles and associated support components suitable for the luminaire(s) and associated supports and accessories to be installed.
   2. Match existing poles on site.

PART 3 EXECUTION  
3.01 EXAMINATION  
A. Verify that field measurements are as shown on the drawings.
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 0537 as required for installation of luminaires provided under this section.
B. Install products according to manufacturer's instructions.
C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship) and NECA/IESNA 501 (exterior lighting).
D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
E. Pole-Mounted Luminaires:
   1. Foundation-Mounted Poles:
      a. Use existing concrete base for pole installation. Clean surface as required for proper installation of grout.
      b. Install poles plumb, using leveling nuts or shims as required to adjust to plumb.
      c. Tighten anchor bolt nuts to manufacturer's recommended torque.
      d. Install non-shrink grout between pole anchor base and concrete foundation, leaving small channel for condensation drainage.
   2. Grounding:
      a. Bond luminaires, metal accessories, metal poles, and foundation reinforcement to branch circuit equipment grounding conductor.
   3. Install separate service conductors, as necessary, 12 AWG copper, from each luminaire down to handhole for connection to branch circuit conductors.
F. Install accessories furnished with each luminaire.
G. Bond products and metal accessories to branch circuit equipment grounding conductor.

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. Measure illumination levels at night with calibrated meters to verify conformance with performance requirements. Record test results in written report to be included with submittals.

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/IESNA 501 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.

3.08 PROTECTION
A. Protect installed luminaires from subsequent construction operations.

3.09 SCHEDULE - SEE DRAWINGS

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 and 28.
B. Furnish and install communications cabling, systems, equipment, and accessories in accordance with the specifications and 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 QUALIFICATIONS (PRODUCTS AND SERVICES)
A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one (1) 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 3 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 4 hours of receipt of notification that service is needed. Submit name and address of all such service organizations.

1.04 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 (1) 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.
1.05 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.

1.06 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.

1.07 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.

1.08 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 re-installed as directed at no additional cost to the Owner.
   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.

1.09 EQUIPMENT IDENTIFICATION
A. Provide and install identification which clearly indicates information required for identification, use, and maintenance of equipment.
B. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 1/4” 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.

1.10 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 easily ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify the equipment being submitted for use specific to this project.

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 4 copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one (1) 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.
1.11 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 SUBMITTALS
A. Submit in accordance with Section 27 0511 – Requirements for Communications Installation.
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: 2 weeks prior to final inspection, submit four (4) 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.

1.03 APPLICABLE PUBLICATIONS
A. American Society for Testing and Materials (ASTM):
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-2002 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications:
   1. 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 2 - PRODUCTS

2.01 GROUNDING AND BONDING CONDUCTORS
A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for
equipment grounding conductors, except that wire sizes 4 AWG and larger shall be permitted to
be identified per NEC.

B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 10 AWG and
smaller shall be ASTM B1 solid bare copper wire.

2.02 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).

2.03 GROUND CONNECTIONS

A. Above Grade:
   1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external
tooth lock washers.
   2. Ground Busbars: 2-hole compression type lugs using tin-plated copper or copper alloy
      bolts and nuts.
   3. Rack and Cabinet Ground Bars: 1-hole compression-type lugs using zinc-plated or copper
      alloy fasteners.

B. Cable Shields: Make ground connections to multi-pair communications cables with metallic
shields using shield bonding connectors with screw stud connection.

2.04 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 3/8" thick x 3/4" wide.

2.05 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.

2.06 SPLICE CASE GROUND ACCESSORIES

A. Splice case grounding and bonding accessories shall be supplied by the splice case
manufacturer when available. Otherwise, use 6 AWG insulated ground wire with shield bonding
connectors. Armored fiber backbone cable shall be grounded add accessories as necessary.

PART 3 - EXECUTION

3.01 GENERAL

A. Ground in accordance with the NEC, as shown on drawings, and as hereinafter specified.

B. 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 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 milliohms or less.

E. 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.

F. Bonding Jumpers:
1. Use insulated ground wire of the size and type shown on the Drawings or use a minimum of 6 AWG insulated copper wire.
2. Assemble bonding jumpers using insulated ground wire terminated with compression connectors.

G. 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 lock washers.
2. Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lock washers, 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 2-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lock washers, and nuts.

3.03 COMMUNICATION ROOM GROUNDING
A. 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 or the telecommunications ground busbar, whichever is closer, using insulated 6 AWG ground wire bonding jumpers.

3.04 COMMUNICATIONS CABLE GROUNDING
A. Bond all metallic cable sheaths in multi-pair communications cables together at each splicing and/or terminating location to provide 100% 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.

3.05 COMMUNICATIONS RACEWAY GROUNDING
A. Conduit: Use insulated 6 AWG bonding jumpers to ground metallic conduit at each end and to bond at all intermediate metallic enclosures.
B. Wireway: use insulated 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 6 AWG bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 50'.

3.06 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 4-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.

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 SUBMITTALS
A. In accordance with GENERAL CONDITIONS, furnish the following:
B. Shop Drawings:
   1. Size and location of data racks, servers, and pull boxes
   2. The specific item proposed and its area of application shall be identified on the catalog cuts.
      a. 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.

1.03 APPLICABLE PUBLICATIONS
A. 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.
B. National Fire Protection Association (NFPA):
   1. 70-05 National Electrical Code (NEC)
C. 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
D. 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 2 - PRODUCTS
2.01 CONDUIT
A. Conduit Size: In accordance with the NEC, but not less than 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.
4. Electrical metallic tubing (EMT): Shall Conform to UL 797, ANSI C80.3. Maximum size not to exceed 4" and shall be permitted only with cable rated 600 volts or less.
5. Liquid-tight flexible metal conduit: Shall Conform to UL 360.

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. 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 2" and smaller. Use set screw type couplings with four set screws each for conduit sizes over 2". 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.

C. 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.

D. 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 0.75" 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 flat or raised covers.

2.05 INNERDUCT

A. Standard HDPE:

1. Textile Innerduct: Standard Outdoor Textile Innerduct: Micro 2", 3" and 4" single or multi-cell polyester/nylon textile innerduct containing 1,250 lb. polyester flat woven pull tape as manufactured by MaxCell:
   a. MaxCell Group/TVC Communications; 600 Plum Creek Dr.; Wadsworth, OH. 44281; Tele 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" inside diameter conduit, (e.g., a 4" plug with nine [9] 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" outside diameter or larger conduit.

2.06 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 (2) 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 1/2" to 2".
   e. Flat Internal and external elbows UL verified for a 2" 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.
   g. Design Make: Wiremold V2400 series raceway, V2475D series bridge fittings, V2410 series entrance end fittings, V2415 T fittings.
h. 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 (2) 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" 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-7 (V700 Series):
   1. One (1) 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.

2.07 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.

PART 3 - 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 8400 - 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 9005 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’ 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 1’ of changes of direction, and within 1” 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 6000 – Flashing and Sheet Metal.
   12. 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. Furred or Suspended Ceilings and in Walls:
   1. Conduit for conductors 600 volts and below:
      a. 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.
      5. Use of MC Cable and FMC 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. Limited to 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 all exposed conduit in finished spaces.

3.05 EXPANSION JOINTS
A. Conduits 3” 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 3” with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 5” 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 15” 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 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 8’ 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 200 lbs.. 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 1/4” bolt size and not less than 1-1/8” embedment.
      b. Power set fasteners not less than 1/4” diameter with depth of penetration not less than 3”.
      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 3/4", but not less than the size shown on the drawings.
C. All conduit ends shall be equipped with insulated bushings.
D. All 4" conduits within buildings shall include pull boxes after every two (2) 90 degree bends. Size boxes per the NEC.
E. Vertical conduits/sleeves through closets floors shall terminate not less than 3" below the floor and not less than 3" 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):
   1. Sizes of Conduit Trade Size  |  Radius of Conduit Bends mm, Inches
   2. 150                      |  6
   3. 230                      |  9
   4. 1-1/4                    | 14
   5. 1-1/2                    | 17
   6. 525                      | 21
   7. 2-1/2                    | 25
   8. 775                      | 31
   9. 3-1/2                    | 36
  10. 1125                     | 45
J. 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 (2) 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. Division 1 – General Requirements
   2. Section 27 1100 – Equipment Room Fittings
   3. Section 27 1500 – 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.
   5. J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, current version.
   7. TIA/EIA 758-A – Customer-Owned Outside Plant Telecommunications Cabling Standard

1.03 INSTALLER QUALIFICATIONS
A. The Contractor must be an approved installer of the specified manufacturer's copper & fiber cable. The 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. Providing 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 and Owners' 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. 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 and Owner 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 Engineer 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.

AB. **Protectors**: Electrical protection devices used to limit foreign voltages on metallic communications circuits.

AC. **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.

AD. **Racks**: An open, freestanding, floor-mounted structure, typically made of aluminum or steel, used to mount equipment; usually referred to as an equipment rack.

AE. **Telecommunication Outlet (TO)**: Connecting device mounted in a work area used to terminate horizontal cable and interconnect cabling with station equipment.

AF. **Telecommunications Room (TR)**: Distributes communications services to users within a serving zone and interconnects with the BER. Typically, the TR contains passive equipment used for cross-connect and active network equipment used for LANs. TR is sometimes referred to as the communications equipment room.

AG. **Wide Area Network (WAN)**: Active communications transmission facilities extending beyond the premises.

AH. **Wiring Block**: Punch down terminating equipment used to develop twisted-pair cross-connect facilities.

1.06 **SYSTEM DESCRIPTION**

A. 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. Video Surveillance
4. Security System
5. 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 Telecom Room (MTR) to each other building’s Main Telecom Room (MTR) in all buildings on the campus / region. This project includes modification to the fiber backbone as shown on the drawings and further detailed in the Specifications.

2. Intra-building Backbone: The intra-building subsystem refers to all twisted-pair and fiber optic backbone communications cabling connecting the Main Telecommunications Room (MTR) to each Intermediate Telecommunication Room (ITR) 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 Main Telecom Rooms (MTR), in Intermediate Telecom Rooms (ITRs) and Telecommunications Enclosures (TEs). Complete work as shown in the drawings and as specified in Section 27 1100.

4. Horizontal Distribution: Horizontal distribution building cable to telecommunication outlets a. (TOs). Section 27 1500 is included for termination & testing required for the installation of Cat 6 and Cat 6a 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 Telecom Outlet (TO) and station equipment. Complete work as shown in the drawings and as specified in Section 27 1500 – Cat 6 or SECTION 27 1501 - Cat 6a.

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 and / or Cat 6a).
2. 100-ohm multi-pair unshielded twisted-pair cable. (Cat 3).
3. 8.3/125-micron single mode 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.
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:
1.08 WARRANTY
A. 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 Contractor must be an approved installer of the specified manufacturer’s copper & fiber cable. The Contractor is responsible for workmanship and installation practices in accordance with the specified manufacturer’s copper & fiber cable extended warranty programs. 

Extended Warranty is not required on this project but Installer must be certified to install cabling per Manufacturer’s Extended Warranty Program / Training/ Certification requirements.

D. Company certificate and 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 and testing for a length of no less than 1 year.

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.

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 and 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 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. 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.

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
PART 1 GENERAL

1.01 SUMMARY
   A. The communications equipment room will be referred as Telecommunications Room (TR) in this document is intended to house racks, cabinets and equipment necessary for the support of the communications cabling infrastructure.

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. Division 1 – General Requirements
      2. Section 27 1000 – Structured Cabling General Requirements
      3. Section 27 1500 – Horizontal Cabling – Cat 6

1.03 REFERENCES
   A. All work shall be performed in accordance with the following codes and industry standards, unless noted otherwise:
      B. NFPA 70 – National Electrical Code, current version adopted by local or State AHJ.
      D. TIA/EIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces, current version.
      F. J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, current version.
      H. TIA-310 - D Cabinets, Rack, and Associated Equipment

1.04 WARRANTY
   A. The Contractor must be an approved installer of the specified manufacturer’s copper & fiber cable. The Contractor is responsible for workmanship and installation practices in accordance with the specified manufacturer’s copper and fiber cable extended warranty programs.

PART 2 PRODUCTS

2.01 APPROVALS AND SUBSTITUTIONS
   A. All products shall be provided as specified, without exception, unless approved in writing prior to the bid. All products shall be “NEW”.
   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.

PART 3 EXECUTION

3.01 INSTALLATION PRACTICES
   A. All materials shall be installed as per the manufacturers’ instructions, unless noted otherwise.
   B. All equipment racks, cabinets, enclosures, cable tray, conduits, and patch panels shall be bonded to the Telecommunications Grounding Busbar (TMG) (one per Telecommunications Room), which shall be bonded to the Telecommunications Main Grounding Busbar (TMGB), which shall be grounded to the main electrical ground in the main electrical room. Coordinate with electrical contractor. Coordinate exact routing and connection points with the electrical
work. All surfaces that are used as a bond shall be filed to bare metal before completing connections.

C. Install cable tray as shown in drawing package. The locations shown may need to be adjusted slightly in the field to assure proper placement.

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 Rooms (MTR, ITR) to Telecommunication Outlets / Network Jacks throughout the site.

B. All existing copper network cabling that is being re-terminated shall also be re-tested to performance level of cable. Test reports shall be submitted.

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. Division 01 – General Requirements.
   2. Section 27 1000 – Structured Cabling General Requirements.
   3. Section 27 0526 – Grounding and Bonding for Communications Systems.
   4. Section 27 1100 – 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.
   5. J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, current version.

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 6, (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).

E. Furnish and install all materials necessary for a complete and working system.

1.05 WARRANTY

A. The Contractor must be an approved certified installer of the cabling manufacturer. The 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 6 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 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 CABLES

A. Category 6 unshielded twisted pair (Superior Essex DataGain Category 6+):
   1. 100 ohm, Category 6, 23AWG, 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:
         1) Blue: Wall Jacks for standard network connections.
         2) Orange: Video Surveillance Cameras.

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 6 UTP cables as specified herein.
   1. 8-position modular jack, Category 6, IDC terminals, T568A/B wiring scheme.
   2. Each jack must be stamped or have icons to identify it as CAT 6.
   3. Color – See Color Coding in Paragraph 2.02 above.
   4. Panduit CJ688TG-X

2.04 BISCUIT BLOCKS (WIRELESS ACCESS POINTS & IP CAMERAS)

A. Two Port Keystone Surface Mount Blocks:
   1. 2 port, label field, surface mount, Accepts Panduit TG Mini-com Modular Jacks.
      a. Panduit Part No. UICBX2IW-A.

2.05 TERMINATION BLOCKS (110 STYLE)

A. Category 6 110-style blocks.

B. Category 6, 96 Pair, (24 Port) 110-style, with mounting legs, wall -mount.
   1. Panduit GPKBW24Y.

C. Category 6, 144 Pair, (36 Port) 110-style, with mounting legs, wall -mount.
   1. Panduit GPKBW144Y.

D. Category 6, 288 Pair, (72 Port) 110-style, with mounting legs, wall -mount.
   1. Panduit GPKBW72Y.

E. Category 6, 432 Pair, (108 Port) 110-style, with mounting legs, wall -mount.
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.

D. Field terminated copper and fiber optic patch cords and jumpers shall not be allowed. All patch cords shall be pre-terminated by the manufacturer.

E. All work shall be performed in a professional manner.

F. Install cable after interior of building has been physically protected from the weather and all mechanical work likely to damage cabling has been completed.

G. Before installing cabling, ensure all cable pathways are completely and thoroughly cleaned:

H. Inspect conduit, wireway, cable trays, and innerduct installed by others.

I. Clean any additional enclosed raceway and innerduct systems furnished.

J. Provide protection for exposed cables where subject to damage.

K. 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.

L. 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.

M. 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.

N. A pull cord (nylon; 1/8” minimum) shall be co-installed with all cable installed in any conduit.

O. Cable raceways shall not be filled greater than the TIA/EIA-569-A maximum fill for the particular raceway type.

P. 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.

Q. 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.

R. 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.

S. 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.

T. 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.
G. Provide the following minimum separation distances between pathways for copper communications cables and power wiring of 480 volts or less:
   1. 12" from electric motors, fluorescent light fixtures, and unshielded power lines carrying up to 3 kVA.
   2. 36" from electrical equipment and unshielded power lines carrying more than 5 kVA.
   3. 48" from large electrical motors or transformers.
H. Open or Nonmetal Communications Pathways:
   1. 2-1/2" from electrical equipment and unshielded power lines carrying up to 2 kVA.
   2. 6" 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" from power lines enclosed in a grounded metal conduit (or equivalent shielding) carrying from 2 kVA to 5 kVA.
   5. 6" 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 1/2".
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 1" of the termination point.
G. Pair untwist at the termination shall not exceed 1/2”).
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/EIA568-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:
   a. 2.05.1.1.1.1.1 Circuit ID.
   b. 2.05.1.1.1.1.2 All information from PART 22.093.05D.4 above.
   c. 2.05.1.1.1.1.3 Test result, “Pass” or “Fail”.
   d. 2.05.1.1.1.1.4 Date and Time of test.
   e. 2.05.1.1.1.1.5 Project Name.
   f. 2.05.1.1.1.1.6 NVP.
   g. 2.05.1.1.1.1.7 Version of software.
   h. 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” of the termination point, and again at approximately 48” 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 5313
GPS (PRIMEX) WIRELESS CLOCK SYSTEM

PART 1 GENERAL

1.01 GENERAL
   A. OXford Bus Garage: Provide complete new system.
   B. Oxford Academy - Middle School:
      1. Provide additions and modifications to the existing system as indicated on plans.
   C. Oxford Primary School - High School:
      1. Provide additions and modifications to the existing system as indicated on plans.

1.02 SECTION INCLUDES
   A. Transmission Systems
      1. G.P.S. Receiver
      2. Primary Transmitter
      3. Satellite Transmitter
   B. 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 DEFINITIONS
   A. GPS: Global Positioning System, a worldwide system that employs 24 satellites in an integrated
      network to determine geographic location anywhere in the world, and which employs and
      transmits atomic time, the most accurate and reliable time.

1.06 SYSTEM DESCRIPTION
   A. GPS wireless clock system shall continually synchronize clocks throughout the facility, and shall
      be capable of clock readouts in multiple time zones where desired.
   B. 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.
   C. 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.
   D. 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.
   E. 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.
   F. Clock locations shall be as indicated, and clocks shall be fully portable, capable of being
      relocated at any time.
   G. The system must operate in accordance with a “Radio Station Authorization” Form FCC 601 –
      LM, granted by the Federal Communications Commission (FCC). This license will be issued to
      and held by the end user.

1.07 REGULATORY REQUIREMENTS
   A. Equipment and components furnished shall be of manufacturer’s latest model.
   B. The end user will hold a license, known as a “Radio Station Authorization” granted by the FCC.
1. This license grants the end user protected use for wireless transmission at the designated frequency.
2. This license will designate a unique “call sign” for each end user.
3. The Supplier shall assist the Owner in obtaining the FCC License.

C. Transmitter and receiver shall comply with Part 90 of FCC rules as follows:
   1. This device may not cause harmful interference, and
   2. This device must accept interference received, including interference that may cause undesired operation.
   3. Transmitter frequency shall be governed by FCC Part 90.35.
   4. Transmitter output power shall be governed by FCC Part 90 257 (b)

D. System shall be installed in compliance with local and state authorities having jurisdiction.

1.08 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.

1.09 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.

1.10 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.

1.11 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.

1.12 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.
1.13 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
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.

2.02 SEQUENCE OF OPERATION
A. Transmitter Operation: When power is first applied to the transmitter, it checks for and displays the software version. It then checks the position of the switches and stores their position in memory. The transmitter looks for the GPS time signal. Once the transmitter has received the GPS time, it sets its internal clock to that time. The transmitter then starts to transmit its internal time once every second. The transmitter updates its internal clock every time it receives valid time data from the GPS.
B. Analog Clock Operation:
   1. Apply power or insert batteries. Follow set up procedures detailed in manufacturer’s instructions.
   2. After initial setup, the clock will shut off the receiver. Six times each day, the microprocessor will activate the receiver and starting with the stored channel, it will again look for a valid time signal. If necessary, the clocks will resynchronize to the correct time.
   3. If the clock has not decoded a valid time signal for a pre-determined number of days, it will go to a step mode. Non signal reception can be caused by low battery voltage. If this occurs, replace the batteries.

2.03 EQUIPMENT
A. General: The clock system shall include a transmitter, a roof or window mounted GPS receiver, indicating clocks, and all accessories for complete operation.
B. GPS Receiver: GPS roof mounted, with attached 100 ft cable.
   1. The GPS Receiver shall be a complete GPS receiver including antenna in a waterproof case, designed for roof or outdoor mounting. Provide mounting bracket for attachment to roof structure.
   2. The GPS Receiver cable must be plenum rated.
C. Transmitter: Primex Wireless Model 14400, consisting of wireless transmitter with GPS receiver, a surge suppressor/battery backup, and a mounting shelf. Unit shall obtain current atomic time from satellite. The clock system shall transmit time continuously to all clocks in the system.
   1. Transmission:
      a. Frequency Range: 72.100 to 72.400 MHz.
      b. Transmission Power: 1 watt (30dBm) maximum
      c. Radio technology: narrowband FM
      d. Number of channels: 16
      e. Channel bandwidth: 20 kHz maximum
      f. Transition mode: one-way communication
      g. Data rate: 2 KBps
      h. Operating range: 32 degree F to 158 degrees F (0 degrees C. to 70 degrees C).
   2. Transmitter: Provide minimum of two (2) transmitters and placed in location as indicated on Drawings.
      a. Transmitter output power: +26 to +30 dBm
b. Frequency deviation: +/- 4 kHz

c. Transmitter power requirements: 120 VAC 60 Hz

d. Internal power requirements: 5 VDC

e. Carrier frequency stability: +/- 20 ppm

3. Transmitter shall have 16 selectable channels to assure interference-free reception.

4. Transmitter shall have the following switches:


   b. Daylight Saving Time bypass switch.

   c. 12-hour or 24-hour display.

5. Transmitter housing shall be black metal case, 16-3/4 inches (424.4mm) by 12 inches (304.8mm) by 1-7/8 inches (46.4mm) in size.

6. Antenna shall be 46 inches (1168mm) high, commercial type, mounted on top center of transmitter housing. Antenna gain shall be < 2.2 dB. Antenna polarization shall be vertical.

7. Transmitter housing shall incorporate a display which shall include the following:

   a. Time readout

   b. AM and PM indicator if 12-hour time display is set

   c. Day and date readout

   d. Indicator for daylight savings or standard time

   e. LED which shall flash red in event of reception problem

   f. GPS reception indicator

8. Transmitter shall contain an internal clock such that failure of reception from the GPS will not disable the operation of the clocks.

D. Power supply (included)

1. Input: 120 volt AC 50/60 Hz, 0.4 amps.

2. Output: 9 volt DC, 1.5 amps.

E. Surge Protector/Battery Backup (included).

1. Input: 120 volt AC 60 Hz +/- 1 Hz.

2. Output: 120 volt AC, 500VA, 300 watts


F. Additional Equipment

1. Wireless Receiver Switches: Switches shall receive time packets from the Primary Transmitter and relay the synchronized time to the Satellite Transmitter connected to it. The unit shall include the following:

   a. Antenna mounted on top of the switch housing, 11-1/2 inches long.

   b. Power Supply:

      1) Input 120 VAC 50/60 Hz, 0.4 amps

      2) Output: 9 volt DC, 1.5 amps

   c. RS 232 data cable, 5 feet (1.5mm) long

   d. Daylight Savings Time bypass switch

   e. Dimensions: 4-1/4 inches long, 5/-3/4 inches wide, 1-1/4 inches deep.

   f. Weight: 12 ounces.

   g. Operating Range: 32 degrees F to 158 degrees F (0 to 70 degrees C)

2. Satellite Transmitters Primex Wireless Model 14401: Satellite Transmitters shall receive the signal from the Wireless Receiver Switches and transmit the signal to the devices in its vicinity, which are out of the range from the Master Transmitter. The unit shall include the following:

   a. Antenna mounted on top of the housing, 46 inches (1168mm) long.

   b. Wireless Receiver Switch.

   c. Power Supply

      1) Input: 120 VAC, 50/60 Hz, 0.4 amps

      2) Output: 9 volt DC, 1.5 amps.
d. 6 foot (1.83m) cord  
e. Surge Suppressor/Battery Backup  
f. Mounting Shelf.  
g. Transmission Power: 1 watt maximum  
h. 72MHz frequency.  

G. Traditional analog clocks (battery): Analog clocks shall be wall mounted. Clocks shall have polycarbonate frame and polycarbonate lens. Face shall be white. Hour and minute hands shall be black.  
1. General Use Areas:  
   a. 12-1/2 inch diameter analog clock: Primex Model 14155
2. Gymnasium and Cafeteria areas:  
   a. 16” diameter analog clock: Primex Model 14163
3. Battery-operated, minimum 5-year (Lithium) battery life.  
4. Analog clocks shall be capable of automatically adjusting for Daylight Saving Time. An on-off switch located on the transmitter shall disable this function if desired.  
5. Time shall be automatically updated from the transmitter 6 times per day.  
6. Analog clocks shall remember the time during changing of batteries.  
7. Tamper proof/theft resistant clock lock mounting slots.  
8. Provide Lithium batteries, sizes as required for full function.  
9. Analog clock receivers shall be as follows:  
   a. Receiver sensitivity: >-110 dBm  
   b. Receiver power: Lithium batteries as required  
   c. Antenna type: internal  
   d. Antenna gain: -7 dBi
10. If the transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded. If signal transmission is not restored after 48 hours, the second hand will “five step” as a visual indicator that the signal has been lost. Should the clocks lose power and signal, the clocks will not function.

H. Wire guards: Provide one for each analog clock located in gymnasium areas and elsewhere designated on the drawings with a "WG" adjacent to the clock symbol. Provide:  
1. Model No. 14123, 18 by 18 inch (457.2 by 457.2mm) size, for 16 inch (406.4mm) diameter analog clocks.

I. Cable Connection Sealant: Radio Shack Coaxial Cable Connector Sealant 278-1645, or approved electrical grade silicone sealant.

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. GPS Unit: Install on roof in location indicated, in clear view of the sky. Install unit in location free from standing water, and above accumulations of leaves or debris. Seal cable connection to GPS with cable connection sealant. Any added cable lengths must be protected from outside elements.  
B. Transmitter:  
   1. Locate transmitter where indicated or where required for adequate operation. Place transmitter a minimum of 2 to 3 feet above the floor, away from large metal objects such as filing cabinets, lockers or metal framed walls.  
   2. Attach receiver to transmitter using cable.
3. Connect antenna to transmitter, using care not to strip threads.
4. Connect power supply to the transmitter.
5. Set the channel number on the display to correspond to the FCC license.
6. Plug power supply into electrical outlet.

C. 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.

D. 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
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Oxford Bus Garage: Provide complete new video surveillance system consisting of all required equipment, cameras, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
   1. Video surveillance system requirements.
   2. Video recording and viewing equipment.
   3. Cameras.
   4. Accessories.

1.02 REFERENCE STANDARDS
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate the placement of cameras with structural members, ductwork, piping, equipment, luminaires, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
   2. Coordinate the work with other installers to provide power for cameras and equipment at required locations.
   3. Notify Architect/Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
B. Preinstallation Meetings:
   1. Conduct meeting with facility representative to review camera and equipment locations and camera field of view objectives. Make minor adjustments / relocations per discussions with Owner. Record changes on as-built drawings.
   2. Conduct meeting with facility representative and other related equipment manufacturers to discuss video surveillance system interface requirements.

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include elevations and details of proposed equipment arrangements. Include system interconnection schematic diagrams. Include requirements for interface with other systems.
C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each system component. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.
D. Design Data:
   1. Standby battery/UPS calculations.
   2. Video storage capacity calculations.
E. Certify that proposed system design and components meet or exceed specified requirements.
F. Field quality control test reports.
G. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

H. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

I. Maintenance contracts.

J. Software: One copy of software not resident in read-only memory.

1.05 QUALITY ASSURANCE
A. Comply with the following:
   1. NFPA 70.
   2. Applicable TIA/EIA standards.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with video surveillance systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized manufacturer's representative.
   1. Contract maintenance office located within 100 miles (160 km) of project site.

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

1.06 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and NECA 303.

B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.07 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. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS
2.01 MANUFACTURERS

B. Cameras - Basis of Design: Axis Communications as indicated under product descriptions below: www.axis.com/#sle.

C. Substitutions: See Section 01 6000 - Product Requirements.

D. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

E. Source Limitations: Where possible, furnish system components and accessories produced by a single manufacturer and obtained from a single supplier.
2.02 VIDEO SURVEILLANCE SYSTEM
A. Provide new video surveillance system consisting of all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
B. System Description: IP system with connection to network (IP) cameras.
   1. Video Storage Capacity: Suitable for storing video from all cameras for 90 days.
   2. System Battery Backup: Provide batteries/uninterruptible power supplies (UPS) as required for 15 minutes full operation.
   3. Surge Protection:
      a. Provide surge protection for exterior cameras.
C. Cameras Required:
   1. See article "CAMERAS" below for product descriptions.
D. Video Recording and Viewing Equipment Required:
   1. See article "VIDEO RECORDING AND VIEWING EQUIPMENT" below for product descriptions.
E. Interface with Other Systems:
   1. Provide products compatible with other systems requiring interface with video surveillance system.
   2. Interface with access control system as specified in Section 28 1000.
      a. Capable of affecting camera/video operation for selected access control system events.
   3. Interface with intrusion detection system as specified in Section 28 3111.
F. Provide products listed, classified, and labeled as suitable for the purpose intended.

2.03 VIDEO RECORDING AND VIEWING EQUIPMENT
A. Provide video recording and viewing equipment compatible with cameras to be connected.
B. Network Video Recorders (NVRs):
   1. Supports connection of network (IP) cameras.
   2. Supports continuous and event-based recording.
C. Computers:
   1. Workstation Computers: Unless otherwise indicated, workstation computer hardware not furnished by video surveillance system manufacturer to be provided by Contractor as part of work of this section, meeting video surveillance system equipment manufacturer's minimum requirements.
   2. Servers: Unless otherwise indicated, server hardware not furnished by video surveillance system manufacturer to be provided by Contractor as part of work of this section, meeting video surveillance system equipment manufacturer's minimum requirements.
D. Software:
   1. Unless otherwise indicated, provide all software and licenses required for fully operational system.

2.04 CAMERAS
A. Provide cameras and associated accessories suitable for operation under the service conditions at the installed location. Provide additional components (e.g. enclosures, heaters, blowers, etc.) as required.
B. Where not factory-installed, provide additional components (e.g. lenses, mounting accessories, etc.) as necessary for complete installation.
C. Network (IP) Cameras:
   1. Signal-to-Noise Ratio: Not less than 50 dB.
2. Provide the following standard features:
   b. Automatic gain control.
   c. Automatic white balance.
   d. Web-based interface for remote viewing and setup.
   e. Password protected security access.

   b. Maximum Frame Rate: 50/60 fps at 50/60 Hz.
   d. Minimum Illumination/Light Sensitivity: 0.1 lux (color).
   e. Lens: 2.8-8.5 mm, F1.2; horizontal field of view of 92.3-33.3 degrees; varifocal, P-Iris.
   f. Features: Zipstream, audio support (two-way), forensic capture wide dynamic range, Lightfinder, local storage, Power over Ethernet (PoE), day and night functionality, image rotation (0, 90, 180, or 270 degrees).

   a. Main Unit; Model F44:
      1) Supports up to four F Series sensor units.
      2) Individual capture mode settings for each sensor unit.
      3) Maximum Video Resolution: 1920 x 1080.
      4) Maximum Frame Rate: 25/30 fps at 50/60 Hz.
      5) Features: Zipstream, audio support (two-way), forensic capture wide dynamic range, local storage, Power over Ethernet (PoE), four alarm inputs/outputs, Quad View (single stream capturing video from all four sensor units in four quadrants).
   b. Sensor Units:
      1) Bullet Sensor Unit Model F1004; maximum resolution of 1280 x 720; 1/4 inch image sensor; minimum illumination of 0.4 lux (color); 2.1 mm, F2.2 fixed iris lens; horizontal field of view of 102 degrees.
      2) Sensor Unit Model F1004; maximum resolution of 1280 x 720; 1/4 inch image sensor; minimum illumination of 0.4 lux (color); 2.1 mm, F2.2 fixed iris lens; horizontal field of view of 102 degrees.
      3) Sensor Unit Model F1005-E (Outdoor); maximum resolution of 1920 x 1080; 1/2.8 inch image sensor; minimum illumination of 0.3 lux (color); 2.8 mm, F2.0 fixed iris lens; horizontal field of view of 113 degrees; IP66/IP67 casing.
      4) Dome Sensor Unit Model F4005-E (Outdoor); maximum resolution of 1920 x 1080; 1.2.8 inch image sensor; minimum illumination of 0.3 lux (color); 2.8 mm, F2.0 lens; horizontal field of view of 110 degrees; IP66/IK09 casing.

   a. Maximum Video Resolution: 1920 x 1080.
   b. Maximum Frame Rate: 25/30 fps at 50/60 Hz.
   c. Image Sensor Size: 1/2.8 inch.
   d. Minimum Illumination/Light Sensitivity (Color): 0.18 lux.
   e. Lens: 2.8-10 mm, F1.6; horizontal field of view of 93-32 degrees; varifocal, P-Iris, remote focus and zoom.
   f. Features: Forensic capture wide dynamic range, Zipstream, Lightfinder, local storage, Power over Ethernet (PoE), day and night functionality, built-in IR illumination, image rotation (0, 90, 180, or 270 degrees), IP66/IP67/NEMA 4X casing.

   a. Maximum Video Resolution: 2048 x 2048.
b. Maximum Frame Rate: 25/30 fps at 50/60 Hz.
c. Image Sensor Size: 1/1.8 inch/6 MP.
d. Minimum Illumination/Light Sensitivity (Color): 0.3 lux.
e. Lens: 1.6 mm, F2.8; horizontal field of view of 185 degrees, vertical field of view of 185 degrees; fixed focus, fixed iris.
f. Features: Zipstream, dynamic contrast wide dynamic range, local storage, Power over Ethernet (PoE), image rotation (0, 180 degrees), HDMI output.

   a. Maximum Video Resolution: 1920 x 1080.
   b. Maximum Frame Rate: 50/60 fps at 50/60 Hz.
   c. Image Sensor Size: 1/2.8 inch.
   d. Minimum Illumination/Light Sensitivity (Color): 0.2 lux.
   e. Lens: 4.3-129 mm, F1.6-4.7; horizontal field of view of 65.6-2.0 degrees; autofocus, auto-iris.
   f. Pan/Pan Speed: 360 degrees endless pan; 0.05-120 degrees/sec pan speed.
   g. Tilt/Tilt Speed: Minus 90 to plus 45 degrees tilt; 0.05-60 degrees/sec tilt speed.
   h. Zoom: 30x optical/12x digital zoom.
   i. Features: Local storage, Zipstream, forensic capture wide dynamic range, SFP slot, day and night functionality, IP66/NEMA 4X casing, integral wiper, image stabilization, four alarm inputs/outputs, focus recall.

D. Camera Enclosures and Mounting Brackets:
   1. Where not factory-installed, provide accessory camera enclosures suitable for operation under the service conditions at the installed location.
   2. Where not factory-installed, provide accessory camera mounting brackets necessary for installation.

2.05 ACCESSORIES

A. Provide components as indicated or as required for connection of video surveillance system to devices and other systems indicated.

B. Provide network switches as required for network connections to system components.

C. Provide cables as indicated or as required for connections between system components.
   1. Data Cables for IP Network Connections: Unshielded twisted pair (UTP), Cat. 6A, complying with Section 27 1000.

D. Provide accessory racks/cabinets as indicated or as required for equipment mounting.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings and configurations of system components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive system components.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install video surveillance system in accordance with NECA 1 (general workmanship) and NECA 303.

B. Install products in accordance with manufacturer's instructions.

C. Provide required support and attachment in accordance with Section 26 0529.
D. Wiring Method: Unless otherwise indicated, use cables (not in conduit).
   1. Use suitable listed cables in wet locations, including underground raceways.
   2. Use suitable listed cables for vertical riser applications.
   3. Use listed plenum rated cables for all interior installations.
   4. Install wiring in an appropriate raceway for the following:
      a. Where required for rough-in.
      b. Where required by authorities having jurisdiction.
      c. Where exposed to damage.
      d. Where installed outside the building.
      e. For exposed connections from outlet boxes to cameras.
   5. Conduit: Comply with Section 26 0534.
   6. Conceal all cables unless specifically indicated to be exposed.
   7. Cables in the following areas may be exposed, unless otherwise indicated:
      a. Equipment closets.
   8. Route exposed cables parallel or perpendicular to building structural members and surfaces.
   9. Include service loop cable lengths to allow relocation of cameras within 30 ft (9.0 m) of installed location.

E. Provide grounding and bonding in accordance with Section 26 0526.
F. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
G. Identify system wiring and components in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL
A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.
C. Prepare and start system in accordance with manufacturer's instructions.
D. Adjust cameras to provide desired field of view and produce suitable images under all service lighting conditions.
E. Program system parameters according to requirements of Owner.
F. Test for proper interface with other systems.
G. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
H. 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.
4. Location: At project site.

3.06 PROTECTION
   A. Protect installed system components from subsequent construction operations.

3.07 MAINTENANCE
   A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
   B. Provide to Owner, a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of video surveillance system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
   C. Conduct site visit at least once every three months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.
   D. Provide trouble call-back service upon notification by Owner:
      1. Include allowance for call-back service during normal working hours at no extra cost to Owner.
      2. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION
SECTION 28 3100.40
FIRE DETECTION AND ALARM (NFS 320 BOD)

PART 1 GENERAL

1.01 SCOPE OF WORK

A. This Section covers a complete fire alarm system, including initiating devices, notification appliances, controls, and supervisory devices.

B. Work covered by this section includes the furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the drawings and specifications.
   1. Oxford Academy - Middle School: Provide additions and modifications to existing Simplex-Tyco #4100ES Fire Alarm and Detection System.
   2. Oxford Primary School and High School: Provide additions and modifications to existing Simplex-Tyco #4100U Fire Alarm and Detection System.

C. The work shall consist of all necessary hardware equipment and software programming to perform the following functions:
   1. Fire alarm system detection and notification operations.
   2. Control and monitoring of and other equipment as indicated in the drawings and specifications.

1.02 CONSTRUCTION PHASING:

A. Contactor shall phase construction to maintain existing FACP until complete installation of new fire alarm system or until system/device switch over becomes necessary. The existing fire alarm system shall remain in operation at all times during the installation of the new fire alarm system. The new fire alarm system cabling and head-end equipment shall be installed so as to not interfere with the existing system equipment.
   1. Notify Owner no fewer than seven (7) days in advance of proposed switch over of fire alarm service. Indicate in writing, estimated system downtimes required for system cutover.
   2. Do not proceed with interruption of fire alarm service without Owner's written permission.

B. The existing Dialer shall remain in use until the existing system has been removed in its entirety. Upon completion of new Fire Alarm System, the existing telephone lines shall be disconnected from the old FACP, extended and connected to the FACP DACT.

C. Coordinate with Owner for phasing of work.

1.03 COORDINATION WITH TRADES

A. The system provider shall coordinate the system design, installation, and testing with all other affected systems and trades.

B. The system design drawings (Required Submittal) shall include detailed information as to how the fire alarm system will interface with other systems such as Elevator Control Equipment, DDC, or Building Automation Systems where such connections have been proposed and/or are required.

C. The system design shall also coordinate final equipment and peripheral device locations with all other trades such as light fixtures, dampers, ceilings, mechanical equipment, sprinklers, etc.

1.04 SUMMARY

A. Demolition: Oxford Academy - Middle School, Oxford Primary - High School
   1. Refer to the contract drawings for additional information. Demolition shall include the removal of the select system components as indicated on plans.

B. New Work:
   1. Provide a complete, addressable microprocessor-based FACP.
2. Provide required zone modules to connect existing zones. Zone module(s) must be UL Listed for existing zone devices, or all existing zone devices will be replaced as part of this contract.
3. Install new addressable fire alarm devices where indicated on the contract drawings. All new addressable devices shall utilize new fire alarm cable.
4. Install new addressable pull station devices where indicated on the contract drawings. All new pull stations shall utilize new fire alarm cable.
5. Provide required signal circuits to accommodate all proposed notification appliance devices. Where necessary, provide additional NAC power supplies and circuits to meet NFPA 72 battery backup requirements.
6. Provide required control panel relays to accommodate all new control circuits.
7. Provide required addressable modules for all new addressable devices plus 25% spare capacity for initiating devices, per module.
8. Replace all existing conventional style duct smoke detectors with new addressable type duct detectors.
9. Provide new fire alarm annunciator panels at the main entrance and other areas if so indicated on the contract documents.
10. Fire alarm control panel shall have the capability to replace existing zone devices with new addressable devices using existing wiring.

1. Provide additions and deletions to support scheduled work and additional devices added this project; including all; wiring, conduit, modules, batteries, connections, associated components, and programming for complete fully operational system.

1.05 PERFORMANCE REQUIREMENTS
A. Contractor shall provide a smoke detector in each elevator shaft if, and only if, the shaft penetrates three or more floor slabs and if there is currently a smoke hatch or if a smoke hatch is proposed.
B. Contractor shall provide a heat detector in each elevator shaft if, and only if, the shaft is equipped with a sprinkler head.
C. If the existing elevator machine room's are equipped with a sprinkler head, then contractor shall provide a heat detector to protect the space. Upon activation of the heat detector, elevator power shall be shunt tripped.
   1. Verify that head detector is fixed head and that temperature setting is properly selected to trip prior to activation of sprinkler flow.
   2. Provide necessary Shunt trip equipment on the elevator control panel and provide necessary relay and interface modules for proper operation in accordance with NFPA 72.
D. There is an existing elevator in the Building. Contractor shall verify existing elevator recall function, if elevator recall is supported by the current elevator:
   1. Coordinate with Elevator Service Representative for programming interface. Provide all necessary interface relay modules, etc.
   2. Elevator Service Rep shall perform full test of recall system to ensure proper operation after all connections have been made.
   3. Costs associated with having the Elevator Service Representative visit the site to verify proper operation shall be billed directly to the owner by the Elevator Service Company.
   4. Elevator shall be provided with Phase 1 emergency recall operation in accordance with ASME A17.1-2004, Paragraphs 2.27.3.2.3. Coordinate Phase 1 emergency recall operation with the local fire department.
E. Comply with all applicable NFPA 72, current edition requirements.
F. Fire alarm signal initiation shall be by one or more of the following devices:
   2. Heat detectors.
   3. Smoke detectors.
4. Duct Smoke Detectors.
5. Fuel Station Fire Suppression Activation.
6. Automatic sprinkler system water flow.

G. Fire alarm signal shall initiate the following actions:
1. Alarm notification appliances shall operate continuously.
2. Identify alarm at the FACP and remote annunciators.
3. De-energize electromagnetic door holders (if installed).
4. Transmit an alarm signal to the remote alarm receiving station.
5. Unlock electric door locks in designated egress paths.
6. Close smoke dampers in air ducts of system serving zone where alarm was initiated.
7. Record events in the system memory.
8. Shut down equipment identified as requiring Fire Alarm Shutdown.
9. Record events by the system printer.

H. Supervisory Operations: Upon activation of a supervisory device, the system shall operate as follows:
1. Supervisory Equipment shall consist of:
   a. Fire-protection system valve: Tamper and/or Flow.
   b. Gas (LP or Natural Gas) Detection Devices
   c. Carbon Monoxide Detection Devices
2. Activate the system supervisory service audible signal and illuminate the LED at the control unit and the remote annunciator
3. Pressing the Supervisory Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory LED “on” indicating off-normal condition.
4. Transmission of supervisory signal to the supervising station.

I. System trouble signal initiation shall be by one or more of the following devices or actions:
1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at the FACP.
4. Ground or a single break in FACP internal circuits.
5. Abnormal ac voltage at the FACP.
6. A break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at the FACP or annunciator.

J. System Trouble and Supervisory Signal Actions: Ring trouble bell and annunciate at the FACP and remote annunciators. Record the event on system printer.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level III, as supervisor, and NICET I and II all other installers.

B. Installer and equipment vendor shall be Licensed by the State of NY to install security and fire alarm systems.

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

D. System provider shall be factory authorized and maintain an office within 100 miles of project site.

E. Within one week of project award, the system supplier shall review the contract drawings and fire alarm design rendered by the Engineer Of Record for compliance with relevant codes and local AHJ policies. If the system designer finds any obvious code-related design deficiencies, they shall be immediately reported to the Engineer Of Record prior to preparation of the
submittals and shop drawings. The Engineer Of Record will review the list of deficiencies and direct the system provider on how to proceed with addressing the deficiencies.

1.07 SUBMITTALS

A. General: Submit the following according to Conditions of Contract.
   1. Alternate products must be submitted to the Engineer at the time of bid for approval. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
   2. Qualification Data: For Installer
      a. Factory training certificate.
      b. NICET Certification.
      c. NYS Fire/Security System Installation License.
   3. Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
   4. Indicate the candela ratings and loudness settings for all audible and visual devices planned for installation.
   5. Graphic Map: Submit proposed sample floor plan intended for use as the graphic map locator for the FAA and FACP.
   6. Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.
   7. Shop drawings showing system details including location of FACP, all devices, circuiting and details of graphic annunciator.
   8. System power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate in accordance with the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.
   9. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of IDC, SLC, NAC, relay, sensor, and auxiliary control circuits.
  10. Operating instructions for FACP.
  11. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.
  12. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
  13. Record of field tests of system.

B. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions, if required, to make clarifications or revisions to obtain approval.

1.08 MAINTENANCE SERVICE

A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months, using factory-authorized service representatives.

B. Basic Services: Systematic, routine maintenance visits on a quarterly basis at times scheduled with the Owner. In addition, respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.
C. Additional Services: Perform services within the above 12-month period not classified as routine maintenance or as warranty work when authorized in writing. Compensation for additional services must be agreed upon in writing prior to performing services.

D. Renewal of Maintenance Service Contract: No later than 60 days prior to the expiration of the maintenance services contract, deliver to the Owner a proposal to provide contract maintenance and repair services for an additional one-year term. Owner will be under no obligation to accept maintenance service contract renewal proposal.

1.09 EXTRA MATERIALS

A. General: Furnish extra materials as listed herein. Materials may be used during construction to satisfy field discovered conditions, at the Engineers discretion. Materials not used shall be turned over to the owner prior to substantial completion.

1. Break Rods for Manual Stations: Furnish quantity equal to 15 percent of the number of manual stations installed; minimum of 6 rods.

2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed but not less than four (4) units.

3. Notification Appliances: Furnish quantity equal to 5 percent of each type and number of units installed, but not less than 5 of each type.

4. Smoke/Heat Detectors or Sensors, Fire Detectors, Flame Detectors, Gas detectors, CO detectors: Furnish quantity equal to 5 percent of each type and number of units installed but not less than one of each type.

5. Duct Smoke Detectors: Furnish (5) five units to be used during construction for field discovered units. Coordinate with the Engineer prior to installation.

6. Fuses: Four (4) of each type installed in the system.


PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. FACP and Equipment: Basis of Design is a Notifier NFS 320.
   a. Edwards Systems Technology Inc.
   b. NOTIFIER; a GE-Honeywell Company.
   c. Siemens Building Technologies, Inc.; a Cerberus Division.
   d. SimplexGrinnell LP; a Tyco International Company.

2. Wire and Cable:
   a. Comtran Corporation.
   b. Helix/HiTemp Cables, Inc.; a Draka USA Company.
   c. Rockbestos-Suprenant Cable Corporation; a Marmon Group Company.
   d. West Penn Wire/CDT; a division of Cable Design Technologies.

3. Audible and Visual Signals:
   a. Amseco; a division of Kobishi America, Inc.
   b. Commercial Products Group.
   c. Gentex Corporation.
   d. System Sensor; a GE-Honeywell Company.
   e. Wheel lock.

2.02 SYSTEM CONFIGURATION

A. System Wiring Configuration:

1. Transmission shall be hard-wired, using separate individual circuits for each zone of alarm operation as required or addressable signal transmission, dedicated to fire alarm service only.
2. System connections for initiating device circuits shall be Class B, Style D, signaling line circuits shall be Class B, Style 4 and notification appliance circuits shall be Class B, Style Y.

2.03 FIRE ALARM CONTROL PANEL (FACP)

A. Main FACP or network node shall be a NOTIFIER Model NFS-320, or approved equal and shall contain a microprocessor based Central Processing Unit (CPU) and power supply in an economical space saving single board design. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system controlled devices.

B. Operator Control
   1. Acknowledge Switch:
      a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition.
      b. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.
   2. Alarm Silence Switch:
      a. Activation of the alarm silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition after an alarm condition. The selection of notification circuits and relays that are silenceable by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.
   3. Alarm Activate (Drill) Switch:
      a. The Alarm Activate switch shall activate all notification appliance circuits. The drill function shall latch until the panel is silenced or reset.
   4. System Reset Switch:
      a. Activation of the System Reset switch shall cause all electronically-latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition.
   5. Lamp Test:
      a. The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.

C. System Capacity and General Operation
   1. The control panel or each network node shall provide, or be capable of 318 intelligent/addressable devices.
   2. The control panel or each network node shall include Form-C alarm, trouble, supervisory, and security relays rated at a minimum of 2.0 amps @ 30 VDC.
   3. It shall also include four Class B (NFPA Style Y) or Class A (NFPA Style Z) programmable Notification Appliance Circuits.
   4. The Notification Appliance Circuits shall be programmable to Synchronize with System Sensor, Gentex and Wheelock Notification Appliances.
   5. The system shall include a full featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display (LCD), individual color coded system status LEDs, and an alphanumeric keypad with easy touch rubber keys for the field programming and control of the fire alarm system.
   6. The system shall be programmable, configurable, and expandable in the field without the need for special tools, PROM programmers or PC based programmers. It shall not require replacement of memory ICs to facilitate programming changes.
   7. The system shall allow the programming of any input to activate any output or group of outputs. Systems that have limited programming (such as general alarm), have
complicated programming (such as a diode matrix), or require a laptop personal computer are not considered suitable substitutes.

8. The FACP shall support up to 20 logic equations, including "and," "or," and "not," or time delay equations to be used for advanced programming. Logic equations shall require the use of a PC with a software utility designed for programming.

9. The FACP or each network node shall provide the following features:
   a. Drift compensation to extend detector accuracy over life. Drift compensation shall also include a smoothing feature, allowing transient noise signals to be filtered out.
   b. Detector sensitivity test, meeting requirements of NFPA 72, Chapter 7.
   c. Maintenance alert, with two levels (maintenance alert/maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.
   d. Nine sensitivity levels for alarm, selected by detector. The alarm level range shall be .5 to 2.35 percent per foot for photoelectric detectors and 0.5 to 2.5 percent per foot for ionization detectors. The system shall also support sensitive advanced detection laser detectors with an alarm level range of .03 percent per foot to 1.0 percent per foot. The system shall also include up to nine levels of Prealarm, selected by detector, to indicate impending alarms to maintenance personnel.
   e. The ability to display or print system reports.
   f. Alarm verification, with counters and a trouble indication to alert maintenance personnel when a detector enters verification 20 times.
   g. PAS presignal, meeting NFPA 72 3-8.3 requirements.
   h. Rapid manual station reporting (under 3 seconds) and shall meet NFPA 72 Chapter 1 requirements for activation of notification circuits within 10 seconds of initiating device activation.
   i. Periodic detector test, conducted automatically by the software.
   j. Self optimizing pre-alarm for advanced fire warning, which allows each detector to learn its particular environment and set its prealarm level to just above normal peaks.
   k. Cross zoning with the capability of counting: two detectors in alarm, two software zones in alarm, or one smoke detector and one thermal detector.
   l. Walk test, with a check for two detectors set to same address.
   m. Control-by-time for non-fire operations, with holiday schedules.
   n. Day/night automatic adjustment of detector sensitivity.
   o. Device blink control for sleeping areas.

10. The FACP shall be capable of coding main panel node notification circuits in March Time (120 PPM), Temporal (NFPA 72 A-2-2.2.2), and California Code. Panel notification circuits (NAC 1,2,3 and 4) shall also support Two-Stage operation, Canadian Dual Stage (3 minutes) and Canadian Dual Stage (5 minutes). Two stage operation shall allow 20 Pulses Per Minute (PPM) on alarm and 120 PPM after 5 minutes or when a second device activates. Canadian Dual stage is the same as Two-Stage except will only switch to second stage by activation of Drill Switch 3 or 5 minute timer. The panel shall also provide a coding option that will synchronize specific strobe lights designed to accept a specific "sync pulse."

11. Network Communication
   a. The FACP shall be capable of communicating on a Local Area Network (LAN), a firmware package that utilizes a peer-to-peer, inherently regenerative communication format and protocol.

D. Central Microprocessor
   1. The microprocessor shall be a state-of-the-art, high speed, 16-bit RISC device and it shall communicate with, monitor and control all external interfaces. It shall include an EPROM for system program storage, Flash memory for building-specific program storage, and a "watch dog" timer circuit to detect and report microprocessor failure.
   2. The microprocessor shall contain and execute all control-by-event programs for specific action to be taken if an alarm condition is detected by the system. Control-by-event
equations shall be held in non-volatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.

3. The microprocessor shall also provide a real-time clock for time annotation of system displays, printer, and history file. The time-of-day and date shall not be lost if system primary and secondary power supplies fail. The real time clock may also be used to control non-fire functions at programmed time-of-day, day-of-week, and day-of-year.

4. A special program check function shall be provided to detect common operator errors.

5. An auto-program (self-learn) function shall be provided to quickly install initial functions and make the system operational.

6. For flexibility and to ensure program validity, an optional Windows(TM) based program utility shall be available. This program shall be used to off-line program the system with batch upload/download, and have the ability to upgrade the manufacturers (FLASH) system code changes. This program shall also have a verification utility, which scans the program files, identifying possible errors. It shall also have the ability to compare old program files to new ones, identifying differences in the two files to allow complete testing of any system operating changes. This shall be in compliance with the NFPA 72 requirements for testing after system modification.

E. System Display

1. The system shall support an 80 character display. The display shall include an 80-character backlit alphanumeric Liquid Crystal Display (LCD) and a full PC style QWERTY keypad.

2. The display shall provide all the controls and indicators used by the system operator:
   a. The 80-character display shall include the following operator control switches: ACKNOWLEDGE, ALARM SILENCE, ALARM ACTIVATE (drill), SYSTEM RESET, and LAMP TEST.

3. The display shall annunciate status information and custom alphanumeric labels for all intelligent detectors, addressable modules, internal panel circuits, and software zones.

4. The display shall also provide Light-Emitting Diodes.
   a. The 80-character display shall provide 12 Light-Emitting-Diodes (LEDs), that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM WARNING, SECURITY ALARM, SUPERVISORY SIGNAL, SYSTEM TROUBLE, DISABLED POINTS, ALARM SILENCED, Controls Active, Pre-Discharge, Discharge and Abort.

5. The display shall provide a QWERTY type keypad
   a. The 80-character display keypad shall be an easy to use QWERTY type keypad, similar to a PC keyboard. This shall be part of the standard system and have the capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be provided to prevent unauthorized system control or programming.

6. The system shall support the display of battery charging current and voltage on the 80-character LCD display.

F. Signaling Line Circuits (SLC)

1. Each FACP or FACP network node shall support one SLC. Each SLC interface shall provide power to and communicate with up to 159 intelligent detectors (ionization, photoelectric or thermal) and 159 intelligent modules (monitor or control) for a loop capacity of 318 devices. SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.

2. CPU shall receive analog information from all intelligent detectors to be processed to determine whether normal, alarm, prealarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

G. Serial Interfaces
1. The system shall include two serial EIA-232 interfaces. Each interface shall be a means of connecting UL Listed Information Technology Equipment (ITE) peripherals.
   a. One EIA-232 interface shall be used to connect an UL-Listed 40 or 80 column printer. Printers that are not UL-Listed are not considered acceptable substitutes.
   b. One EIA-232 interface shall be used to connect an UL-Listed 40 or 80 column printer. Printers that are not UL-Listed are not considered acceptable substitutes.
   c. One EIA-232 interface shall be used to connect a UL-listed CRT terminal. This interface shall include special protocol methods that allow off-site monitoring of the FACP over standard dial-up phone lines. This ancillary capability shall allow remote readout of all status information, including analog values, and shall not interfere with or degrade FACP operations when used. It shall allow remote FACP Acknowledge, Reset, or Signal Silence in this mode. It shall also allow adjustment of detector sensitivity and readout of the history file.
   d. The system shall include an EIA-485 port for the serial connection of optional annunciators and remote LCD displays.
   e. The EIA-485 interface may be used for network connection to a proprietary-receiving unit.

H. Enclosures:
   1. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
   2. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.
   3. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be site configured for either right or left hand hinging.

I. Power Supply:
   1. A high tech off-line switching power supply shall be available for the fire alarm control panel or network node and provide 6.0 amps of available power for the control panel and peripheral devices.
   2. Provisions will be made to allow the audio-visual power to be increased as required by adding modular expansion audio-visual power supplies.
   3. Positive-Temperature-Coefficient (PTC) thermistors, circuit breakers, or other over-current protection shall be provided on all power outputs. The power supply shall provide an integral battery charger for use with batteries up to 55 AH or may be used with an external battery and charger system. Battery arrangement may be configured in the field.
   4. The power supply shall continuously monitor all field wires for earth ground conditions, and shall have the following LED indicators:
      a. Ground Fault LED
      b. AC Power Fail LED
      c. NAC on LED (4)
   5. The main power supply shall operate on 120 VAC, 60 Hz, and shall provide all necessary power for the FACP.
   6. The main power supply shall provide a battery charger using dual-rate charging techniques for fast battery recharge and be capable of charging batteries up to 200 AH.
   7. All circuits shall be power-limited, per UL864 requirements.

J. Field Charging Power Supply (FCPS)
   1. The FCPS is a device designed for use as either a remote 24 volt power supply or used to power Notification Appliances.
   2. The FCPS shall offer up to 6.0 amps (4.0 amps continuous) of regulated 24 volt power. It shall include an integral charger designed to charge 7.0 amp hour batteries and to support 60 hour standby.
   3. The Field Charging Power Supply shall have two input triggers. The input trigger shall be a Notification Appliance Circuit (from the fire alarm control panel) or a relay. Four outputs
(two Style Y or Z and two style Y) shall be available for connection to the Notification devices.

4. The FCPS shall include an attractive surface mount backbox.

5. The Field Charging Power Supply shall include the ability to delay the AC fail delay per NFPA requirements.

6. The FCPS include power limited circuitry, per 1995 UL standards.

K. Specific System Operations

1. Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system from the system keypad. Sensitivity range shall be within the allowed UL window and have a minimum of 9 levels.

2. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 5 to 30 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

3. Point Disable: Any addressable device or conventional circuit in the system may be enabled or disabled through the system keypad.

4. Point Read: The system shall be able to display or print the following point status diagnostic functions:
   a. Device status
   b. Device type
   c. Custom device label
   d. View analog detector values
   e. Device zone assignments
   f. All program parameters

5. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system status.

6. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 800 events. Up to 200 events shall be dedicated to alarm and the remaining events are general purpose. Systems that do not have dedicated alarm storage, where events are overridden by non-alarm type events, are not suitable substitutes. Each of these activations will be stored and time and date stamped with the actual time of the activation. The contents of the history buffer may be manually reviewed, one event at a time, or printed in its entirety. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable substitutes.

7. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is above or below normal limits, then the system will enter the trouble mode, and the particular detector will be annunciated on the system display, and printed on the optional printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

8. Pre-Alarm Function: The system shall provide two levels of pre-alarm warning to give advance notice of a possible fire situation. Both pre-alarm levels shall be fully field adjustable. The first level shall give an audible indication at the panel. The second level shall give an audible indication and may also activate control relays. The system shall also have the ability to activate local detector sounder bases at the pre-alarm level, to assist in avoiding nuisance alarms.

9. Software Zones: The FACP shall provide 100 software zones, 10 additional special function zones, 10 releasing zones, and 20 logic zones.
10. The fire alarm control panel shall include a walk test feature. It shall include the ability to test initiating device circuits and notification appliance circuits from the field without returning to the panel to reset the system. Operation shall be as follows:
   a. Alarming an initiating device shall activate programmed outputs, which are selected to participate in walk test, for 3 seconds.
   b. Introducing a trouble into the initiating device shall activate the programmed outputs for 8 seconds.
   c. All devices tested in walk test shall be recorded in the history buffer.

2.04 REMOTE LCD ANNUNCIATOR (FAA)
   A. Provide remote LCD Fire Alarm Annunciators, where indicated on the drawings. The Remote LCD Annunciator shall use the same Primary Acknowledge, Silence, and Reset Keys; Status LEDs and LCD Display as the FACP.
   B. Annunciator shall have super-twist LCD display with two lines of 40 characters each. Annunciator shall be provided with four (4) programmable control switches and associated LEDs.
   C. Under normal conditions the LCD shall display a "SYSTEM IS NORMAL" message and the current time and date.
   D. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.
   E. The LCD shall display the following information relative to the abnormal condition of a point in the system:
      1. 40 character custom location label.
      2. Type of device (e.g., smoke, pull station,水流).
      3. Point status (e.g., alarm, trouble).
   F. Operator keys shall be key switch enabled to prevent unauthorized use. The key shall only be removable in the disabled position. Acknowledge, Silence and Reset operation shall be the same as the FACP.

2.05 EMERGENCY POWER SUPPLY
   A. General: Components include battery, charger, and an automatic transfer switch.
   B. Battery: Sealed lead-acid or nickel cadmium type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 24 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm notification devices in alarm mode for a period of 15 minutes.

2.06 HORN AND COMBINATION HORN/STROBE EQUIPMENT:
   A. Sounder:
      1. Electronic sounders shall operate on 24 VDC nominal.
      2. Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dBA measured at 10 feet from the device.
      3. Shall be flush or surface mounted as shown on plans.
   B. Strobe:
      1. The maximum pulse duration shall be 2/10 of one second.
      2. Strobe intensity shall meet the requirements of UL 1971.
      3. The flash rate shall meet the requirements of UL 1971.

2.07 ADDRESSABLE DEVICES - GENERAL REQUIREMENTS
   A. Addressable devices shall use simple to install and maintain decade, decimal address switches. Devices shall be capable of being set to an address in a range of 001 to 159.
B. Addressable devices, which use a binary-coded address setting method, such as a DIP-switch, are not an allowable substitute.

C. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel Signaling Line Circuits.

D. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash green under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.

E. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.

F. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.

G. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Bases shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications.

H. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

I. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).

J. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.

K. Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.

L. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

M. Addressable modules shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box. An optional surface mount Lexan enclosure shall be available.

2.08 MANUAL PULL STATION

A. Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.

B. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

C. Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.
2.09 PHOTOELECTRIC SMOKE DETECTOR
   A. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

2.10 LASER PHOTO SMOKE DETECTOR
   A. The intelligent laser photo smoke detector shall be a spot type detector that incorporates an extremely bright laser diode and an integral lens that focuses the light beam to a very small volume near a receiving photo sensor. The scattering of smoke particles shall activate the photo sensor.
   B. The laser detector shall have conductive plastic so that dust accumulation is reduced significantly.
   C. The intelligent laser photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.03 percent per foot.
   D. The laser detector shall not require expensive conduit, special fittings or PVC pipe.
   E. The intelligent laser photo detector shall support standard, relay, isolator and sounder detector bases.
   F. The laser photo detector shall not require other cleaning requirements than those listed in NFPA 72. Replacement, refurbishment or specialized cleaning of the detector head shall not be required.
   G. The laser photo detector shall include two bicolor LEDs that flash green in normal operation and turn on steady red in alarm.

2.11 IONIZATION SMOKE DETECTOR
   A. The detectors shall use the dual-chamber ionization principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analog level of products of combustion.

2.12 INTELLIGENT MULTICRITERIA ACCLIMATING DETECTOR
   A. The intelligent multi criteria Acclimate detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.
   B. The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).
   C. The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

2.13 INTELLIGENT THERMAL DETECTOR
   A. Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.
2.14 INTELLIGENT DUCT SMOKE DETECTOR
A. The smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.
B. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

2.15 HOSTILE AREA SMOKE DETECTOR
A. The detector shall be designed to provide early warning smoke detection in environments where traditional smoke detectors are not practical.
B. The detector shall have a filter system to remove particles down to 25 microns.
C. This filter system shall remove unwanted airborne particles and water mist. This shall allow the detector to operate in environments where traditional smoke detectors would have nuisance alarms.
D. The filter system shall consist of 2 filters one of which is field replaceable.
E. The filter system shall have an intake fan to draw air and smoke through the filters into the sensing chamber.
F. The filter system shall be supervised so that if the filter is clogged or the fan fails the control panel reports trouble.
G. The filter system shall be powered from 24 VDC separate from the SLC communications.
H. The detector shall utilize a photoelectric sensing chamber.

2.16 ADDRESSABLE DRY CONTACT MONITOR MODULE
A. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.
B. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
C. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.

2.17 TWO WIRE DETECTOR MONITOR MODULE
A. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).
B. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

2.18 ADDRESSABLE CONTROL MODULE
A. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances.
B. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation.
C. Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised UL listed remote power supply.
D. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.
2.19 ADDRESSABLE RELAY MODULE
A. Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

2.20 ISOLATOR MODULE
A. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.
B. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
C. The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
D. The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

2.21 SMOKE CONTROL ANNUNCIATOR
A. On/Auto/Off switches and status indicators (LEDS) shall be provided for monitoring and manual control of each fan, damper, HVAC control unit, stairwell pressurization fan, and smoke exhaust fan. To ensure compliance the units supplied shall meet the following UL categories: UUKL, PAZX, UDTZ, QVAX as well as the requirements of NFPA 90A, HVAC, and NFPA 92A & 92B, Smoke Control. The control System shall be field programmable for either 90A operation or 92A/B operation to allow for future use and system expansion.
B. The OFF LED shall be Yellow, the ON LED shall be green, the Trouble/Fault LED shall be Amber/Orange for each switch. The Trouble/Fault indicator shall indicate a trouble in the control and/or monitor points associated with that switch. In addition, each group of eight switches shall have two LEDs and one momentary switch which allow the following functions: An Amber LED to indicate an OFF-NORMAL switch position, in the ON or OFF position; A Green LED to indicate ALL AUTO switch position; A Local Acknowledge/Lamp Test momentary switch.
C. Each switch shall have the capability to monitor and control two addressable inputs and two addressable outputs. In all modes, the ON and OFF indicators shall continuously follow the device status not the switch position. Positive feedback shall be employed to verify correct operation of the device being controlled. Systems that indicate on/off/auto by physical switch position only are not acceptable.
D. All HVAC switches (i.e., limit switches, vane switches, etc.) shall be provided and installed by the HVAC contractor.
E. It shall be possible to meet the requirements mentioned above utilizing wall mounted custom graphic.

2.22 PROJECTED BEAM DETECTORS
A. The projected beam type shall be a 4-wire 24 VDC device.
B. The detector shall be listed to UL 268 and shall consist of a separate transmitter and receiver capable of being powered separately or together.
C. The detector shall operate in either a short range (30'-100') or long range (100'-330') mode.
D. The temperature range of the device shall be -22 degrees F to 131 degrees F.
E. The detector shall feature a bank of four alignment LEDs on both the receiver and the transmitter that are used to ensure proper alignment of unit without special tools.

F. Beam detectors shall feature automatic gain control which will compensate for gradual signal deterioration from dirt accumulation on lenses.

G. The unit shall be both ceiling and wall mountable.

H. The detector shall have the ability to be tested using calibrated test filters or magnet activated remote test station.

2.23 WATERFLOW SWITCH:

A. Waterflow Switches shall be an integral, mechanical, non-coded, non-accumulative retard type.

B. Waterflow Switches shall have an alarm transmission delay time which is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds.

C. All waterflow switches shall come from a single manufacturer and series.

D. Waterflow switches shall be provided and connected under this section but installed by the mechanical contractor.

E. Where possible, locate waterflow switches a minimum of one (1) foot from a fitting which changes the direction of the flow and a minimum of three (3) feet from a valve.

2.24 SPRINKLER VALVE SUPERVISORY SWITCH:

A. Each sprinkler system water supply control valve riser, zone control valve, and standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.

B. PIV (post indicator valve) or main gate valves shall be equipped with a supervisory switch.

C. The switch shall be mounted so as not to interfere with the normal operation of the valve and adjusted to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.

D. The supervisory switch shall be contained in a weatherproof aluminum housing, which shall provide a 3/4 inch (19 mm) conduit entrance and incorporate the necessary facilities for attachment to the valve.

E. The switch housing shall be finished in red baked enamel.

F. The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting.

G. Valve supervisory switches shall be provided and connected under this section and installed by mechanical contractor.

1. This unit shall provide for each zone: alarm indications, using a red alarm an yellow trouble long-life LEDs and control switches for the control of fire alarm control panel functions. The annunciator will also have an ON-LINE LED, local piezo electric signal, local acknowledge/lamp test switch, and custom slide-in zone/function identification labels.

2. Switches shall be available for remote annunciation and control of output points in the system, system acknowledge, telephone zone select, speaker select, global signal silence, and global system reset within the confines of all applicable standards.

2.25 LCD REMOTE ANNUNCIATOR (FAA):

A. The alphanumeric display annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.

B. The LCD annunciator shall display all alarm and trouble conditions in the system.

C. An audible indication of alarm shall be integral to the alphanumeric display.

D. The display shall be UL listed for fire alarm application.
E. It shall be possible to connect up to 32 LCD displays and be capable of wiring distances up to 6,000 feet from the control panel.

F. The annunciator shall connect to a separate, dedicated "terminal mode" EIA-485 interface. This is a two-wire loop connection and shall be capable of distances to 6,000 feet. Each terminal mode LCD display shall mimic the main control panel.

G. The system shall allow a minimum of 32 terminal mode LCD annunciators. Up to 10 LCD annunciators shall be capable of the following system functions: Acknowledge, Signal Silence and Reset, which shall be protected from unauthorized use by a keyswitch or password.

H. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.

2.26 DIGITAL ALARM COMMUNICATOR (UDACT)

A. The UDACT shall be compact in size, mounting in a standard module position of the fire alarm control cabinet. UDACT shall have the ability for remote mounting, up to 6,000 feet from the fire alarm control panel. The wire connections between the UDACT and the control panel shall be supervised with one pair for power and one pair for multiplexed communication of overall system status. Systems that utilize relay contact closures are not acceptable.

B. The UDACT shall include connections for dual telephone lines (with voltage detect), per UL/NFPA/FCC requirements. It shall include the ability for split reporting of panel events up to three different telephone numbers.

C. The UDACT shall be completely field programmable from a built-in keypad and 4 character red, seven segment display.

D. The UDACT shall be capable of transmitting events in at least 15 different formats. This ensures compatibility with existing and future transmission formats.

E. Communication shall include vital system status such as:
   1. Independent Zone (Alarm, trouble, non-alarm, supervisory)
   2. Independent Addressable Device Status
   3. AC (Mains) Power Loss
   4. Low Battery and Earth Fault
   5. System Off Normal
   6. 12 and 24 Hour Test Signal
   7. Abnormal Test Signal (per UL requirements)
   8. EIA-485 Communications Failure
   9. Phone Line Failure

F. The UDACT shall support independent zone/point reporting when used in the Contact ID format. In this format the UDACT shall support transmission of up to 2,040 points. This enables the central station to have exact details concerning the origin of the fire or response emergency.

2.27 FIELD WIRING TERMINAL BLOCKS

A. For ease of service all panel I/O wiring terminal blocks shall be removable, plug-in types and have sufficient capacity for #18 to #12 AWG wire. Terminal blocks that are permanently fixed are not acceptable.

2.28 COMBUSTABLE GAS DETECTION

A. Device shall detect the presence of combustible gases such as propane and natural gas.

B. Detector shall be compatible with UL Listed Control panel provided.

C. Detector shall supervise an area of 900sf (Minimum)

D. Detector shall be used in conjunction with an addressable monitor module that shall supervise the onboard contact closure.

E. FACP Programming:
   1. Program FACP to annunciate a supervisory condition when gas has been detected.
F. Contractor shall field verify type of gas equipment present:
   1. Where Natural Gas is used: Mount detector(s) 1'-0" from ceiling, and at least 6" away from any wall corner.
   2. Where Propane is used: Mount detector(s) 1'-0" from floor, and at least 6" away from any wall corner.

2.29 CO 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.
F. Equipment shall also be self sounding and shall utilize the Temporal 4 signal style.

2.30 MAGNETIC DOOR HOLDERS
A. Description: The Magnetic door holders shall be supplied by This Contractor. Division 26 contractor shall be required to install and circuit the Magnetic Door Holds. Refer to the contract drawings for locations.
B. Door holders shall be dual listed for 24v/120v operation. Circuited for magnetic door holders is not indicated on the contract drawings. It shall be the responsibility of the Division 26 contractor to furnish and install required circuits, from nearest 120V panelboard. Provide (2)#12 & #12G and 20A/1P breaker where required. Do not connect more than 20 magnetic devices to a single circuit.
C. Single channel surface raceway may be used in exposed areas, and MC cable may be used in concealed areas.

2.31 MISC. CONTROL RELAYS
A. Control relays shall be used for door holder, fire/smoke damper, fire alarm unit shutdown and other similar type branch circuits. Refer to Contract drawings for locations of items. Contacts shall be 120 volt coil, 2-pole, 20 ampere, industrial quality.

2.32 GRAPHIC MAP DISPLAY
A. Provide a Graphic Map Display at each FAA and FACP location.
   1. Graphic map shall be engraved, screened or anodized graphic layout of the annunciated area noted on the drawings.
   2. Show Each floor separately.
B. The Engineer shall approve the graphic layout prior to installation.
C. Where applicable, Identify Zones and other applicable area identification markers using ID names/numbers synonymous with the FA system.

2.33 CONDUIT AND WIRE:
A. Conduit:
   1. Conduit shall be used in accordance with The National Electrical Code (NEC), local and state requirements. Conduit shall be RED in color, no exceptions.
   2. Exposed areas and other areas as required by NEC: Install wiring in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit. Conduit shall be RED in color, no exceptions.
   3. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-55.
4. Wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.

6. Conduit shall be 1/2-inch minimum.

B. Wire:
   1. All fire alarm system wiring shall be new.
   2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits and Signaling Line Circuits, and 14 AWG (1.63 mm) for Notification Appliance Circuits.
   3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
   4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).
   5. Wiring used for the multiplex communication circuit (SLC) shall be twisted and unshielded and support a minimum wiring distance of 12,500 feet. The design of the system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication circuit.
   6. All field wiring shall be electrically supervised for open circuit and ground fault.
   7. The fire alarm control panel shall be capable of t-tapping Class B (NFPA Style 4) Signaling Line Circuits (SLCs). Systems that do not allow or have restrictions in, for example, the amount of t-taps, length of t-taps etc., are not acceptable.

C. Terminal Boxes, Junction Boxes and Cabinets:
   1. All boxes and cabinets shall be UL listed for their use and purpose.

D. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.

B. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:
   1. Factory trained and certified personnel.
   2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
   3. Personnel licensed or certified by state or local authority.

3.02 EQUIPMENT INSTALLATION

A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient control unit(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes, and all other necessary material for a complete operating system.

B. Equipment Removal: After acceptance of the new fire alarm system, disconnect and remove the existing fire alarm equipment and restore damaged surfaces. Package operational fire alarm
and detection equipment that has been removed and deliver to the Owner. Remove from the site and legally dispose of the remainder of the existing material.

C. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor. (Typical for all new duct smoke detectors).

D. Install manual station with operating handle 48 inches (1.22 m) above floor. Install wall mounted audible and visual notification appliances not less than 80 inches (2.03 m) above floor to bottom of lens and not greater than 96 inches (2.44 m) above floor to bottom of lens.

E. Mount outlet box for electric door holder to withstand 80 pounds pulling force.

F. Make conduit and wiring connections to door release devices, sprinkler flow switches, sprinkler valve tamper switches, duct smoke detectors.

G. Where necessary, provide temporary plastic bags or other protective coverings over detectors after installation to maintain protection and cleanliness. Remove prior to completion and system commissioning.

H. Automatic Detector Installation: Conform to NFPA 72.

I. Where modifying existing systems; Inspect and test existing system's operating condition, in it's entirety, prior to start of any modifications and alterations to existing system. Submit inspection and test reports documenting condition of system prior to start of work. Contractor is responsible for a complete fully operating system upon completion of project.

3.03 PREPARATION
A. Coordinate work of this Section with other affected work and construction schedule.

3.04 WIRING INSTALLATION
A. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70 and NFPA 72.

B. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.

C. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.

D. Make all fire alarm wiring continuous from terminal to terminal or from terminal to device pigtail lead.
   1. Circuit splices not permitted.
   2. Wiring joints, only when required at device pigtail leads shall utilize Scotchlok insulate conical spring connectors (or equal).

E. Mount end-of-line device in a separate box adjacent to last device for Class "B" supervision.

3.05 BATTERIES:
A. The battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 5 minutes of alarm upon a normal AC power failure.

B. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.

C. If necessary to meet standby requirements, external battery and charger systems may be used.

3.06 FIRE ALARM UNIT SHUTDOWN
A. Provide all contacts/relays control modules and associated control wiring as required to accommodate closing of Fire/Smoke dampers, smoke hatches and shutdown of HVAC units. Refer to Contract Drawings for details.
B. FSD & Mechanical Unit Shutdown Control:
   1. Provide shutdown control through Fire Alarm Control Panel. Shutdown by the building
      management system is unacceptable.
   2. Upon activation of fire alarm, the associated “shutdown” relay/contactor shall become
      energized and remove power from the equipment.
   3. Upon restoration of fire alarm system, relay/contactor shall become un-energized and
      restore power to the associated equipment.
C. Smoke Hatch Operation:
   1. Smoke hatches shall only be opened when adjacent smoke detector senses smoke. Provide auxiliary contacts as required.

3.07 FIELD QUALITY CONTROL
A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to
   supervise the field assembly and connection of components and the pre testing, testing, and
   adjustment of the system.
B. Service personnel shall be qualified and experienced in the inspection, testing, and
   maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to
   include, but shall not be limited to, individuals with the following qualifications:
   1. Factory trained and certified.
   2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
   3. International Municipal Signal Association (IMSA) fire alarm certified.
   4. Certified by a state or local authority.
   5. Trained and qualified personnel employed by an organization listed by a national testing
      laboratory for the servicing of fire alarm systems.
C. Determine, through pre testing, the conformance of the system to the requirements of the
   Drawings and Specifications. Correct deficiencies observed in pre testing. Replace
   malfunctioning
D. Inspection:
   1. Inspect equipment installation, interconnection with system devices, mounting locations,
      and mounting methods.
   2. Verify that units and controls are properly installed, connected, and labeled and that
      interconnecting wires and terminals are identified.
E. Acceptance Operational Tests:
   1. Perform operational system tests to verify conformance with specifications:
      a. Each alarm initiating device installed shall be operationally tested. Each device shall
         be tested for alarm and trouble conditions. Contractor shall submit a written
         certification that the Fire Alarm System installation is complete including all punch-list
         items. Test battery operated emergency power supply. Test emergency power
         supply to minimum durations specified. Test Supervising Station Signal Transmitter.
         Coordinate testing with Supervising Station monitoring firm/entity.
      b. Test each Notification Appliance installed for proper operation. Submit written report
         indicating sound pressure levels at specified distances.
   2. Provide minimum 10 days notice of acceptance test performance schedule to Owner, and
      local Authority Having Jurisdiction.
F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such
   deficiencies. Verify by the system test that the total system meets the Specifications and
   complies with applicable standards.
G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test
   results in the form of a test log. Use NFPA 72 Forms for documentation.
H. Final Test, Record of Completion, and Certificate of Occupancy:
1. Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy. Provide completed NFPA 72 Record of Completion form to Owner and AHJ.

3.08 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.

B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound pressure levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3.09 TRAINING

A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner’s maintenance personnel as specified below.
   1. Train Owner’s maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 8 hours’ training.
   2. Schedule training with the Owner at least seven days in advance.

END OF SECTION
SECTION 28 3111
BUILDING INTRUSION DETECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Oxford Bus Garage: Provide new intrusion detection system consisting of all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
   1. Intrusion detection system requirements.
   2. Alarm control unit.
   4. Initiating devices.
   5. Alarm notification appliances.
   6. Accessories.

1.02 REFERENCE STANDARDS

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
D. UL 365 - Police Station Connected Burglar Alarm Units and Systems; Current Edition, Including All Revisions.
E. UL 609 - Local Burglar Alarm Units and Systems; Current Edition, Including All Revisions.
G. UL 639 - Intrusion-Detection Units; Current Edition, Including All Revisions.
H. UL 1610 - Central-Station Burglar-Alarm Units; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compatibility of devices for the installed locations with work provided under other sections or by others.
      a. Doors and Windows: See appropriate Division 8 sections.
      b. Fences and Gates: See appropriate Division 32 sections.
   2. Coordinate the placement of sensors and keypads with millwork, furniture, equipment, etc. installed under other sections or by others.
   3. Coordinate the work with other installers to provide communication lines required for alarm control unit connection to central station.
   4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
B. Preinstallation Meeting: Conduct meeting with facility representative and other related equipment manufacturers to discuss intrusion detection system interface requirements.
C. Sequencing:
   1. Do not install sensors and keypads until final surface finishes and painting are complete.

1.04 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 system component. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.
   1. Motion Detectors: Include detailed motion detection coverage range diagrams.
C. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include system interconnection schematic diagrams. Include requirements for interface with other systems.

D. Design Data: Include standby battery calculations.

E. Certify that proposed system design and components meet or exceed specified requirements.

F. Manufacturer’s detailed field testing procedures.

G. Field quality control test reports.

H. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

I. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

J. Maintenance contracts.

K. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

L. Software: One copy of software not resident in read-only memory.

M. 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 Initiating Devices: One for each type installed.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

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

1.06 DELIVERY, STORAGE, AND HANDLING

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

B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.07 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.

PART 2 PRODUCTS

2.01 INTRUSION DETECTION SYSTEM REQUIREMENTS

A. Provide new intrusion detection system consisting of all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Alarm Control Unit: New addressable alarm control panel located as indicated.

C. Combination fire/intrusion systems are not permitted.

D. Keypads: Located as directed by Owner.
1. Within 6 feet (1.8 m) of main building entrance.

E. Initiating Device Requirements:
   1. Protected Premises: Entire building as indicated.
   2. Provide magnetic contacts to monitor opened/closed position for:
      a. All perimeter doors and windows.
      b. All overhead doors.
   3. Provide motion detectors to detect intruder in designated areas.
   4. Provide temperature sensors to detect:
      a. Temperatures below selected setpoint for designated bus wash bay.

F. Alarm Notification and Reporting Requirements:
   1. Activate alarm notification at alarm control unit and associated keypads/annunciators with
      appropriate zone information displayed.
   3. Transmit alarm report to listed remote central station under contract with facility.
      a. Primary Communication Means: Telephone line (digital alarm communicator).

G. Interface with Other Systems:
   1. Provide products compatible with other systems requiring interface with intrusion detection
      system.
   2. Interface with access control system as specified in Section 28 1000.
   3. Interface with video surveillance system as specified in Section 28 2000.
      a. Capable of activating video surveillance system and controlling camera inputs/video
         outputs for selected intrusion detection system events.

H. Provide products listed, classified, and labeled as suitable for the purpose intended.
   1. Local Alarm Units and Systems: Listed and labeled as complying with UL 609.
   2. Central Station Alarm Units: Listed and labeled as complying with UL 1610.
   3. Police Station Connected Alarm Units and Systems: Listed and labeled as complying with
      UL 365.

I. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC
   requirements of 47 CFR 15, for Class B, consumer application.

2.02 ALARM CONTROL UNIT

A. Manufacturers:
   2. Substitutions: See Section 01 6000 - Product Requirements.

B. Alarm Control Panel: Modular construction.
   1. Enclosure: Lockable; provide tamper protection.
   2. Power Supply:
      a. Primary Power: 120 VAC; provide suitable transformer/power supply; supervised for
         loss of AC power.
      b. Secondary Power: Standby battery; provide suitable capacity for minimum standby
         time required by listing requirements, applicable codes, and authority having
         jurisdiction, but not less than four hours; provide suitable battery charger; supervised
         for low battery condition; protected from accidental reversal of battery leads.

C. Alarm Initiating Circuits: Supervised.
   1. Hardwired Zones: Supports both normally closed and normally open conventional
      (non-addressable) initiating devices.
   2. Addressable Zones: Supports addressable initiating devices and modules using
      multiplexed polling loops.

D. Alarm Notification Circuits: Supervised.

E. Communications Interfaces: Supervised.
1. Supports system reporting to central station receivers via integral interface or accessory interface modules using:
   a. Telephone lines.
   b. Digital cellular network.
   c. Internet/intranet (IP addressing).
2. Supported Reporting Format(s): Compatible with central station.

F. Keypads: Supervised.
   1. Minimum Number of Keypads Supported: Equivalent to basis of design.

G. Peripheral Devices: Supervised; provide tamper protection.

H. Output Relays:
   1. Relay Modules: Form C relays (normally open and normally closed); provide tamper protection.
   2. Programmable to respond to system events, according to defined scheduling, or by manual activation from keypad.

I. User Codes:
   1. Each user code to be individually assignable to any defined authority level for configurable access to system features and functions.

J. Partitions:
   1. Each partition to operate independently with individually programmable annunciation, control, and reporting functions.
   2. Each zone to be individually assignable to any partition.
   3. Each keypad to be individually assignable to any partition.
   4. Each user code to be individually assignable to any partition.

K. Scheduling:
   1. Provide time/calendar-based scheduling capability for automated system control.
   2. Supports open/close schedules for control of arming/disarming and reporting.
   3. Supports timed events including, but not limited to:
      a. Point bypass/unbypass.
      b. Relay activate/deactivate.
   4. Supports automatic adjustment for daylight savings time.
   5. Supports holiday schedules.

L. Event Log:
   1. Stores system events including time, date, partition, zone, and user code where applicable.
   2. Supports viewing of event log on keypads.
   3. Supports viewing of event log on remote PC.

M. Features:
   1. Capable of being programmed locally or remotely.
   2. Capable of being armed via key switch.
   3. Supports panic/duress codes.
   4. Supports force arming.
   5. Supports user interface via:
      a. Telephone.
      b. Web browser.
      c. Mobile device.
      d. Personal wireless device.

2.03 KEYPADS

A. Manufacturer: Same as manufacturer of alarm control unit.
B. Provides interface to alarm control unit for system control and remote annunciation.
C. Provides visual notification of system status and zone information.
D. Provides audible notification to indicate system status, entry/exit delay, and alarm situations; provide separate distinguishable sounds for alarm and trouble conditions.

E. Keypad Type: Only LCD or graphic touch screen keypads are acceptable. Do not use LED keypads.

F. Graphic Touch Screen Keypads: Displays system status and zone information using plain English on graphic display; touch screen interface.

G. LCD Keypads: Displays system status and zone information using plain English on alphanumeric display; illuminated keys.

H. Keypad Color: To be selected by Architect from manufacturer's available standard colors.

2.04 INITIATING DEVICES

A. Manufacturers: Same as manufacturer of alarm control units where possible.

B. General Requirements:
   1. Provide devices suitable for intended application and location to be installed.
   2. Outdoor Units: Weather resistant, suitable for outdoor use.
   3. Addressable Systems:
      a. Addressable Devices: Individually identifiable by control unit.
      b. Provide suitable addressable modules for connection to conventional (non-addressable) devices and other components that provide a dry closure output.

C. Contacts:
   1. Listed and labeled as complying with UL 634.
   2. Magnetic Contacts: Encapsulated reed switch(es) and separate magnet; designed to monitor opened/closed position of doors or windows.
      a. Use standard security contacts (not balanced magnetic type) unless otherwise indicated.

D. Motion Detectors:
   1. Listed and labeled as complying with UL 639.
   2. Passive Infrared (PIR) Motion Detectors: Designed to detect intruder by sensing movement of thermal energy between zones.
   3. Dual Technology PIR/Microwave Motion Detectors: Designed to detect intruder using combination of passive infrared technology (by sensing movement of thermal energy between zones) and microwave technology (by sensing frequency shifts in emitted and reflected high frequency microwave signals).

E. Temperature Sensors:
   1. Designed to activate upon detecting temperatures above or below selected setpoints.

2.05 ALARM NOTIFICATION APPLIANCES

A. Manufacturers: Same as manufacturer of alarm control units where possible.

B. Provide alarm notification appliances suitable for connection to control unit outputs.

C. Outdoor Units: Weather resistant, suitable for outdoor use.

2.06 ACCESSORIES

A. Provide components as indicated or as required for connection of alarm control unit to devices and other systems indicated.

B. Provide cables as indicated or as required for connections between system components.

C. Provide end-of-line resistors (EOLR) as required for supervision of hardwired zones.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that ratings and configurations of system components are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive system components.
D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
A. Perform work in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer's instructions.
C. Wiring Method: Unless otherwise indicated, use wiring in conduit.
   1. Use listed plenum rated cables in spaces used for environmental air.
   2. Install wiring in conduit where required for rough-in, where required by authority having jurisdiction, and where exposed to damage.
   3. Conduit: Comply with Section 26 0534.
   4. Conceal all cables unless specifically indicated to be exposed.
   5. Cables in the following areas may be exposed, unless otherwise indicated:
      a. Equipment closets.
D. Provide grounding and bonding in accordance with Section 26 0526.
E. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
F. Identify system wiring and components in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL
A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Prepare and start system in accordance with manufacturer's instructions.
C. Inspection and testing to include, at a minimum:
   1. Test each initiating device for proper response by alarm control unit.
   2. Test for proper operation of alarm notification appliances.
   3. Test for proper operation of output relays.
   4. Test for proper operation of communication interfaces and central station reporting.
   5. Test for proper interface with other systems.
D. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

3.04 ADJUSTING
A. Program system parameters according to requirements of Owner.

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

3.06 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.
4. Location: At project site.

3.07 PROTECTION
   A. Protect installed system components from subsequent construction operations.

3.08 MAINTENANCE
   A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
   B. Provide to Owner, a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of intrusion detection system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
   C. Conduct site visit at least once every three months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.
   D. Provide trouble call-back service upon notification by Owner:
      1. Include allowance for call-back service during normal working hours at no extra cost to Owner.
      2. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

END OF SECTION
SECTION 31 0000
EARTHWORK

PART 1   GENERAL
1.01 SECTION INCLUDES
A. Clearing and grubbing
B. Removal of topsoil
C. Underground utilities
D. Excavation
E. Dewatering
F. Settlement detection
G. Placing engineering fabric
H. Placing fill and backfill
I. Placing fill to support structures
J. Compaction
K. Rough grading
L. Subgrade surface for walks and pavement
M. Finish grading
N. Maintenance and restoration
O. Disposal of excess and unstable materials
P. Field quality control
Q. Protection

1.02 RELATED WORK SPECIFIED ELSEWHERE
A. Section 03 3000 - Cast-in-Place Concrete
B. Section 31 1000 - Site Preparation
C. Section 31 2317 - Site Trenching
D. Section 32 1216 - Asphalt Paving
E. Section 32 1313 - Concrete Paving
F. Section 32 1613 - Concrete Curbs
G. Section 32 9200 - Lawns & Grasses
H. Section 32 9300 - Exterior Plants
I. Division 33 - Utilities

1.03 DEFINITIONS
A. The following terms shall have the meanings ascribed to them in this Article, wherever they appear in this Section.
1. Earth Excavation: The removal of all surface and subsurface material not classified as rock (as defined below).
2. Materials which can be loosened with a pick or backhoe, frozen materials, soft laminated shale or hardpan, pavements, curbs, and similar materials shall be classified as earth excavation.
3. Unclassified Earth Excavation: The excavation and disposal of all surface and subsurface materials of any description necessary to perform the work of this contract. This shall include:
   a. All soil deposits of any description both above and below groundwater levels. These may be naturally deposited or placed by previous construction operations.
b. Ledge rock of all quality. (Limestone, sandstone, shale, granite and similar materials in solid beds or masses in its original or stratified position which can only be removed by drilling, wedging, use of pneumatic tools or heavy ripping equipment.) Blasting operations will not be permitted to loosen any ledge rock necessary to be removed in this contract without prior written permission from the Project Designer and the Owner’s Representative.

c. Boulders of any size.
d. Any materials of man-made origin.

4. Subgrade Surface: Surface upon which gravel base or topsoil is placed.

5. Base: Select granular material which is placed immediately beneath pavement or concrete slabs.

6. Fill: Placement of specified fill materials, in layers, above ground surface to required elevations.

7. Backfill: Placement of specified backfill material, in layers, in excavations to required subgrade elevations.

8. Foundation Bearing Grade: Grade/elevation at which the bottom-of-footings are constructed.

9. Maximum Density: The dry unit weight in pounds per cubic foot of the soil at “Optimum Moisture Content” when determined by ASTM D 698 (Standard Proctor), or ASTM D 1557 (Modified Proctor).

10. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

11. Landscaped Areas: Areas not covered by structures, walks, roads, paving, or parking.

12. Unauthorized Excavation: The removal of material below required elevations indicated on the Drawings or beyond lateral dimensions indicated or specified without specific written direction by the Owner’s Representative.

1.04 SUBMITTALS

A. Comply with requirements of Section 01 3000 and as modified as below.

1. Product Data:
   a. Permanent Sheeting, Shoring, and Bracing: Specifications for materials and accessories.

2. Samples: Submit samples as follows. At the owner’s discretion, take the samples in the presence of the Owner’s Representative, and submit to the Owner’s Representative the laboratory test results for gradation, proctors and soundness tests, when required. These tests shall be performed in accordance with ASTM standards, shall be performed and signed by a certified soils laboratory, and shall be submitted as part of the original submittal. At a minimum, the samples taken shall be of the following quantities:
   a. General Fill: Imported Select Type 1 Granular Material: 40 - 50 lbs.
   b. Select Granular Fill: Type 2 Base Course: 40 - 50 lbs.
   c. Underdrain Filter: 40- 50 lbs, mixed to specification.
   d. Engineering Fabric: 12” X 12” sample.
   e. Drainage Fabric: 12” X 12” sample.

3. Quality Control Submittals:
   a. Base Materials: Name and location of source and the DOT Source Number. If the material is not being taken from an approved DOT Source, the results of the gradation and soundness tests performed by an ASTM certified soils laboratory will be required.
   b. Other Aggregates: Name and location of source and soil laboratory test results.
   c. Excavation Procedure: Submit a lay out drawing or detailed outline of intended excavation procedure for the Owner’s information. This submittal will not relieve the Contractor of responsibility for the successful performance of intended excavation methods.

4. Closeout Procedures: Comply with the requirements of Section 01 7000.
1.05 DELIVERY, STORAGE, AND HANDLING
   A. Protect filter fabric from sunlight during transportation and storage.

1.06 PROJECT CONDITIONS
   A. Protect existing trees and plants during performance of the Work unless otherwise indicated. Box trees and plants indicated to remain within the grading limit line with temporary fencing or solidly constructed wood barricades as required. Protect root systems from smothering. Do not store excavated material or allow vehicular traffic or parking within the branch drip line. Restrict foot traffic to prevent excessive compaction of soil over root systems.

   B. Cold Weather Requirements:
      1. Excavation: When freezing temperatures are anticipated, do not excavate to final required elevations for concrete work unless concrete can be placed immediately.
      2. Backfilling: If backfill is being placed during freezing temperatures, the backfilling operations shall be monitored by the Owner’s Representative and the following procedures shall be followed:
         a. Frozen ground shall be removed in its entirety from beneath and five (5) feet beyond the area of fill placement.
         b. The fill material placed shall consist of Selected Fill and shall be free of all frozen chunks that exceed four (4) inches in size. The material transported to the project site shall only consist of material excavated from below the frost depth.
         c. At the end of the work day, the area of fill placement shall be covered with insulated blankets, or left unprotected. Other means of protection (hay, wood chips etc.) may also be used for protection provided it is approved by the Owner’s Representative.
         d. Following work day - Remove the insulated blankets and/or strip the area of all frozen material as specified previously.
         e. Upon establishing the subgrade elevations, protect the grades with insulated blankets or place additional material that will adequately insulate the exposed earth surface from frost. This additional fill or protective material shall be stripped just prior to pouring concrete.

   C. Subsurface Information/Site Investigation Reports: Site investigation reports including soil boring logs and similar data included in the project documents are intended to represent only conditions found at locations indicated at time investigations were conducted. Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or of continuity of such conditions. The Owner will not be responsible for interpretation or conclusions drawn by the contractor.
      1. The contractor may perform additional test borings and other exploratory operations at no additional cost to the Owner upon approval of the project designer.

   D. Land Survey Information: Field verify provided existing boundary and topographic information prior to beginning site work. Immediately report any discrepancies in boundary locations or topographic elevations affecting site construction to the Owner’s Representative. Provide profile information on existing site conditions and verification of existing topographic information to the Owner’s Representative prior to beginning site construction. Beginning site work construction without this profile information and written notification indicates Contractor’s acceptance of existing land survey data indicated on the drawings as accurate. Adjustments to the contract will not be made for discrepancies brought to the Owner’s attention after site construction has begun.

PART 2 PRODUCTS
2.01 MATERIALS
   A. General Fill: Subsoil excavated from project site and/or supply stockpiled, sound, durable, sand, gravel, stone, or blends of these materials, free from organic and other deleterious materials. Comply with New York State Department of Transportation gradation and material requirements for Select Type 1 as specified below:
Sieve | Percent Passing
---|---
Sieve Size | Size opening (mm)
---|---
3 inch | 76.2 | 100
2 inch | 50.8 | 90-100
1/4 inch | 6.35 | 30-65
No. 40 | 0.425 | 5-40
No. 200 | 0.075 | 0-10

B. Select Granular Fill Base Course Type 2 Crushed Stone: Where indicated supply stockpiled, crushed ledge rock or approved blast furnace slag. Comply with New York State Department of transportation gradation and material requirements modified below:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Size opening (mm)</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 inch</td>
<td>50.8</td>
<td>100</td>
</tr>
<tr>
<td>1/4 inch</td>
<td>6.35</td>
<td>25-60</td>
</tr>
<tr>
<td>No. 40</td>
<td>0.425</td>
<td>5-40</td>
</tr>
<tr>
<td>No. 200</td>
<td>0.075</td>
<td>0-7</td>
</tr>
</tbody>
</table>

C. Underdrain Filter: Unless otherwise indicated on plans, provide an equal blend of No.1 and No.2 washed crushed or uncrushed stone used as drainage fill.

1. No. 1 Coarse Aggregate:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Size opening (mm)</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch</td>
<td>25.4</td>
<td>100</td>
</tr>
<tr>
<td>½ inch</td>
<td>12.7</td>
<td>90-100</td>
</tr>
<tr>
<td>¼ inch</td>
<td>6.35</td>
<td>0-15</td>
</tr>
</tbody>
</table>

2. No. 2 Coarse Aggregate:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Size opening (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2 inch</td>
<td>38.1</td>
</tr>
<tr>
<td>1 inch</td>
<td>25.4</td>
</tr>
<tr>
<td>½ inch</td>
<td>12.7</td>
</tr>
</tbody>
</table>

D. Rip Rap: Light Stone Filling that complies with DOT Article 620-2.02 for stone filling and Figure 620-1 Stone Filling Gradation Requirements.

<table>
<thead>
<tr>
<th>Light Stone</th>
<th>% Mixture by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smaller than 8&quot;</td>
<td>90 – 100%</td>
</tr>
<tr>
<td>Larger than 3&quot;</td>
<td>50 – 100%</td>
</tr>
<tr>
<td>Smaller than No. 8 Sieve</td>
<td>0 – 10%</td>
</tr>
</tbody>
</table>

E. Engineering Fabric: Fabric composed of high tenacity polypropylene yarns woven into a stable network. The fabric is to be inert to biological degradation and resistant to naturally
encountered chemicals, alkalis and acids complying with the following mechanical and physical properties:

<table>
<thead>
<tr>
<th>Mechanical Properties</th>
<th>Test Method</th>
<th>Unit</th>
<th>Minimum. Average Roll Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wide Width Tensile Strength</td>
<td>ASTM D 4595</td>
<td>kN/m \text{m}^2</td>
<td>MD 17.6 (100)/CD 21.0 (120)</td>
</tr>
<tr>
<td>Grab Tensile Strength</td>
<td>ASTM D 4632</td>
<td>kN (lbs)</td>
<td>MD 0.9 (200)/ CD 0.9 (200)</td>
</tr>
<tr>
<td>Grab Tensile Elongation</td>
<td>ASTM D 4632</td>
<td>%</td>
<td>MD 15/CD 10</td>
</tr>
<tr>
<td>Trapezoid Tear Strength</td>
<td>ASTM D 4533</td>
<td>kN (lbs)</td>
<td>MD 0.33 (75)/CD 0.33 (75)</td>
</tr>
<tr>
<td>Mullen Burst Strength</td>
<td>ASTM D 3786</td>
<td>kPa (psi)</td>
<td>2756 (400)</td>
</tr>
<tr>
<td>Puncture Strength</td>
<td>ASTM D 4833</td>
<td>kN (lbs)</td>
<td>0.4 (90)</td>
</tr>
<tr>
<td>Percent Open Area</td>
<td>COE-02215-8</td>
<td>%</td>
<td>1</td>
</tr>
<tr>
<td>Apparent Opening Size</td>
<td>ASTM D 4751</td>
<td>mm (US Sieve)</td>
<td>0.300 (50)</td>
</tr>
<tr>
<td>Permittivity</td>
<td>ASTM D 4491</td>
<td>sec^{-1}</td>
<td>0.05</td>
</tr>
<tr>
<td>Flow Rate</td>
<td>ASTM D 4491</td>
<td>l/min/m\text{m}^2 (gal/min/ft\text{^2})</td>
<td>200 (5.0)</td>
</tr>
<tr>
<td>UV Resistance (at 500 Hours)</td>
<td>ASTM D 4355</td>
<td>% strength retained</td>
<td>70</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th>Test Method</th>
<th>Unit</th>
<th>Typical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>ASTM D 5261</td>
<td>g/m\text{^2} (oz/ydm\text{^2})</td>
<td>136 (4.0)</td>
</tr>
<tr>
<td>Thickness</td>
<td>ASTM D 5199</td>
<td>mm (mils)</td>
<td>0.51 (20)</td>
</tr>
<tr>
<td>Roll Dimensions (Width X Length)</td>
<td>-----</td>
<td>m (ft)</td>
<td>3.8 X 132 or 5.3 X 94.2 (12.5 X 432) or (17.5 X 309)</td>
</tr>
<tr>
<td>Roll Area</td>
<td>-----</td>
<td>m\text{^2} (yd\text{^2})</td>
<td>502 (600)</td>
</tr>
<tr>
<td>Estimated Roll Weight</td>
<td>-----</td>
<td>kg (lb)</td>
<td>95 (210)</td>
</tr>
</tbody>
</table>

1. Manufacturer: For convenience, details have been based on Mirafi 500X as manufactured by Ten Cate/Mirafi, Pendergrast, GA (Tel. #706-693-2226).

F. Drainage Fabric: Non-woven geotextile fabric composed of polypropylene fibers formed into a stable network such that the fibers retain their relative position. The fabric is to be inert to biological degradation, resisting naturally encountered chemicals, alkalis and acids complying with the following mechanical and physical properties:

<table>
<thead>
<tr>
<th>Mechanical Properties</th>
<th>Test Method</th>
<th>Unit</th>
<th>Minimum. Average Roll Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grab Tensile Strength</td>
<td>ASTM D 4632-91</td>
<td>kN (lbs)</td>
<td>MD 0.53 (120)/ CD 0.53 (120)</td>
</tr>
<tr>
<td>Grab Tensile Elongation</td>
<td>ASTM D 4632-91</td>
<td>%</td>
<td>MD 50/CD 50</td>
</tr>
<tr>
<td>Trapezoid Tear Strength</td>
<td>ASTM D 4533-91</td>
<td>kN (lbs)</td>
<td>MD 0.22 (50)/CD 0.22 (50)</td>
</tr>
<tr>
<td>Mullen Burst Strength</td>
<td>ASTM D 3786-87</td>
<td>kPa (psi)</td>
<td>1550 (225)</td>
</tr>
<tr>
<td>Puncture Strength</td>
<td>ASTM D 4833-00</td>
<td>kN (lbs)</td>
<td>0.3 (65)</td>
</tr>
<tr>
<td>Apparent Opening Size (AOS)</td>
<td>ASTM D 4751-99A</td>
<td>mm (US Sieve)</td>
<td>0.212 (70)</td>
</tr>
<tr>
<td>Permittivity</td>
<td>ASTM D 4491-99A</td>
<td>sec^{-1}</td>
<td>1.8</td>
</tr>
<tr>
<td>Permeability</td>
<td>ASTM D 4491-99A</td>
<td>cm/sec^{-1}</td>
<td>0.21</td>
</tr>
</tbody>
</table>
**Flow Rate** | ASTM D 4491-99A | l/min/m² (gal/min/ft²) | 5500 (135)  
---|---|---|---  
**UV Resistance (at 500 Hours)** | ASTM D 4355-02 | % strength retained | 70

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th>Test Method</th>
<th>Unit</th>
<th>Typical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>ASTM D 5261</td>
<td>g/m² (oz/ydm²)</td>
<td>163 (4.8)</td>
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<tr>
<td>Thickness</td>
<td>ASTM D 5199</td>
<td>mm (mils)</td>
<td>1.4 (55)</td>
</tr>
<tr>
<td>Roll Dimensions (Width X Length)</td>
<td>-----</td>
<td>m (ft)</td>
<td>3.8 X 110 or 4.5 X 110 (12.5 X 360) or (15 X 360)</td>
</tr>
<tr>
<td>Roll Area</td>
<td>-----</td>
<td>m² (yd²)</td>
<td>502 (600)</td>
</tr>
<tr>
<td>Estimated Roll Weight</td>
<td>-----</td>
<td>kg (lb)</td>
<td>89 (197)</td>
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</tbody>
</table>

1. Manufacturer: For convenience, details have been based on Mirafi 140N as manufactured by Ten Cate/Mirafi, Pendergrast, GA (Tel. #706-693-2226).

### PART 3 EXECUTION

#### 3.01 EXAMINATION

A. Verification of Conditions: Examine conditions under which earthwork is to be accomplished in coordination with the installer of materials and components specified in this Section and notify affected Prime Contractors, Owner’s Representative and the Project Designer in writing of any conditions detrimental to proper and timely accomplishment. Do not proceed with earthwork until unsatisfactory conditions have been corrected in a manner acceptable to the installer. 1. When the installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to the Project Designer written confirmation from the applicable installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

#### 3.02 PREPARATION

A. Protection

1. Use of explosives: Do not bring explosives onto the site or use in the project without prior written permission from the Project Designer and the Owner’s Representative. The Contractor remains solely responsible for the handling, storage and use of explosive materials when permitted. Use explosives in strict compliance with State, Local and OSHA regulations.

2. Protection of Persons and Property

   a. Barricade open excavations and post with warning lights for safety of persons. Operate warning lights during hours from dusk to dawn each day.

   b. Protect structures, utilities, sidewalks, pavements and other facilities immediately adjacent to excavations from damage caused by settlement, lateral movement, undermining, washout and other hazards.

   c. Take precautions and provide necessary bracing and shoring to guard against movement and settlement of existing improvements or new construction. Contractor remains entirely responsible for strength and adequacy of bracing and shoring, and for safety and support of construction from damage or injury caused by lack of adequate protection or by movement or settlement.

#### 3.03 CLEARING AND GRUBBING

A. Clear and grub the site within the grading limit lines of trees, shrubs, brush, other prominent vegetation, debris, and obstructions except for those items indicated to remain. Completely remove stumps and roots protruding through the ground surface.
1. Use only hand methods for grubbing inside the drip line of trees indicated to be left standing.
2. Where roots and branches of trees indicated to be saved interfere with new construction, carefully and cleanly cut them back to point of branching.

B. Fill depressions caused by the clearing and grubbing operations in accordance with the requirements for filling and backfilling, unless further excavation is indicated.

3.04 REMOVAL OF TOPSOIL
A. Remove existing topsoil from areas within the grading limit lines where excavation or fill is required.
B. Stockpile approved topsoil where directed until required for use. Place, grade, and shape stockpiles for proper drainage. Topsoil shall be tested prior to stockpiling. Stockpile only quantities of topsoil approved in writing for re-use.

3.05 UNDERGROUND UTILITIES
A. Locate existing underground utilities prior to commencing excavation work. Determine exact utility locations by hand excavated test pits. Support and protect utilities to remain in place.
B. Do not interrupt existing utilities that are in service until temporary or new utilities are installed and operational.
C. Utilities to remain in service shall be re-routed as shown on the Contract Drawings.
D. Utilities abandoned beneath and five (5) feet laterally beyond a structure’s proposed footprint shall be removed in their entirety. Excavations required for their removal shall be backfilled and compacted as specified herein.
E. Unless otherwise noted in the Contract Documents, utilities extending outside the limit specified above (5 feet) may be abandoned in place provided their ends are adequately plugged as described below.
   1. Permanently close open ends of abandoned underground utilities exposed by excavations, which extend outside the limits of the area to be excavated.
   2. Close open ends of metallic conduit and pipe with threaded galvanized metal caps or plastic plugs or other approved method for the type of material and size of pipe. Do not use wood plugs.
   3. Close open ends of concrete and masonry utilities with concrete or flow-able fill.
F. Coordinate with other Prime Contractors or with local utility companies, as applicable, for shutoff service if lines are active.
G. Coordinate scheduling of removal to accommodate relocation of lines when necessary.
H. Demolish and remove or relocate additional uncharted underground utilities conflicting with construction operations as directed by the Project Designer. Measure additional removal and relocations as directed by the Project Designer and paid for by the Owner as a Change Order.

3.06 EXCAVATION
A. Excavate earth as required for the work. Remove and dispose of all materials encountered to obtain required subgrade elevations. Remove from property and legally dispose of all excess fill material.
B. Install and maintain all erosion and sedimentation controls during all earthwork operations as specified on the Contract Drawings or as directed by local officials.
   1. Trenches: Deposit excavated material on one side of trench only. Trim banks of excavated material to prevent cave-ins and prevent material from falling or sliding into trench. Keep a clear footway between excavated material and trench edge. Maintain areas to allow free drainage of surface water.
D. Stockpile excavated materials classified as suitable material where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage as approved by the Owner's Representative.

E. Excavation for Structures: Conform to elevations, lines, and limits indicated. Excavate to a vertical tolerance of plus or minus 1 inch. Extend excavation a sufficient lateral distance to provide clearance to execute the work.

F. Footings and Foundations: The foundation bearing grade shall be established just prior to constructing the concrete foundations when concrete is to bear on undisturbed soil.
   1. Stepping Footings: Cut sloping surfaces under footings, foundations, steps, and where required for other work as indicated.
   2. Pile Foundations: Stop excavations 6 to 12 inches above the bottom of pile cap elevation before the piles are placed. After pile installation, remove loose and displaced material and excavate to final grade, leaving a solid base to receive concrete pile caps.
   3. Where footings and other work requiring similar soil support will rest entirely on rock, remove loose soil and loose rock and place concrete to the required elevations. Where footings and other work requiring similar soil support will rest partially on rock and partially on soil, immediately notify the Owner's Representative before any backfilling or concrete placement occurs; the Owner's Representative will determine the correct foundation treatment for the work.

G. Slabs and Floors: Excavate to depths below bottom of concrete for addition of select granular material as indicated on the drawings:

H. Pipe Trenches: Refer to Section 31 2317.

I. Open Ditches: Cut ditches to cross sections and grades indicated.

J. Pavement: Excavate to subgrade surface elevation as indicated on the drawings.

K. Unauthorized Excavations: Unless otherwise directed, backfill unauthorized excavation under footings, foundation bases, and retaining walls with compacted select granular Type 1 material without altering the required footing elevation. Elsewhere, backfill and compact unauthorized excavation as specified for authorized excavation of the same classification, unless otherwise directed by the Owner's Representative.
   1. Unauthorized excavations under structural work such as footings, foundation bases, and retaining walls shall be reported immediately to the Owner's Representative before any concrete or backfilling work commences.

L. Notify the Owner's Representative upon completion of excavation operations. Do not proceed with the work until the excavation is inspected and approved.

M. Removal of Unsuitable Material Beneath Structures and Other Improvements: Excavate encountered unsuitable materials, which extend below required elevations, to additional depth as directed by the Owner's Representative. Have cross sections taken, under the supervision of an independent Land Surveyor, to determine the quantity of such excavation. Do not backfill this excavation prior to quantity measurement.
   1. Such additional excavation and backfilling, not due to error, fault or neglect of the Contractor and exceeding the numeric quantities indicated on the Drawings, will be paid for at a pre-negotiated or pre-established unit price by Change Order.

3.07 DEWATERING

A. Refer to subsurface logs included in the Contract Documents for information regarding subsurface conditions. The Owner shall not be liable for Change Orders resulting from the Contractor's inability to properly dewater the site.

B. Prior to the performance of any excavations provide dewatering methods such that the groundwater table is maintained at an elevation that is beneath the excavated depth.

C. Prevent surface and subsurface water from flowing into excavations and trenches and from flooding the site and surrounding area.
D. Do not allow water to accumulate in excavations or trenches. Remove water from all excavations immediately to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to the stability of subgrades and foundations. Furnish and maintain pumps, sumps, suction and discharge piping systems, and other system components necessary to convey the water away from the Site.

E. Convey water removed from excavations, and rain water, to collecting or run-off area. Cut and maintain temporary drainage ditches and provide other necessary diversions outside excavation limits for each structure. Do not use trench excavations as temporary drainage ditches.

F. Provide temporary controls to restrict the velocity of discharged water as necessary to prevent erosion and siltation of receiving areas.

3.08 SETTLEMENT DETECTION
A. Excavating beneath the bearing grades of an existing structure: Establish a settlement detection method approved by the Owner’s Representative for structures subject to settlement from excavation, sheeting or sheet piling operations. Maintain surveillance to detect any settlement.

B. Surcharging: Establish a settlement monitoring plan to accurately determine the settlements that have occurred and the rate that they occurred to adequately determine when settlement caused by surcharge is complete.

3.09 PLACING ENGINEERING FABRIC
A. Place and overlap engineering fabric in accordance with the manufacturer's installation instructions, unless otherwise shown.

B. Cover tears and other damaged areas with additional engineering fabric layer extending 3 feet beyond the damage.

C. Do not permit traffic or construction equipment directly on engineering fabric.

D. Backfill immediately over engineering fabric. Backfill in accordance with the fabric manufacturer’s instructions and in a manner to prevent damage to the fabric.

3.10 PLACING FILL AND BACKFILL
A. Surface Preparation of Fill Areas: Strip topsoil, remaining vegetation, and other deleterious materials prior to placement of fill. Refer to Section 31 1000 - Site Preparation for additional information.
   1. Remove all asphalt pavement in its entirety from areas requiring the placement of fill.
   2. After topsoil is stripped and other improvements specifically indicated to be removed on the Contract Documents are removed, proof roll the site with a ten ton vibratory compactor (minimum six overlapping passes required) or similar equipment. Excavate soft or loose soils identified during rolling and replace with properly compacted select Type 1 granular material as directed by the Owner's Representative or the Project Designer. Measure additional excavation and backfill as directed by the Owner’s Representative or the Project Designer and paid for by the Owner as a Change Order.
   3. Plow, strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill materials bond with the existing surface.

B. Excavations: Backfill as promptly as work permits, but not until completion of the following:
   1. Acceptance by the Owner’s Representative of construction below finish grade including, where applicable, dampproofing, waterproofing, perimeter insulation, and bearing capacity of supporting soil.
   2. Inspection, testing, approval, and recording locations of underground utilities.
   4. Removal of temporary sheeting (or sheet piling) and backfilling of voids caused by removals.
   5. Cutting off top of permanent sheeting (or sheet piling).
7. Installation of permanent or temporary bracing on horizontally supported walls.

C. Place backfill and fill materials in layers not more than 8 inches thick in loose depth unless otherwise specified. Before compaction, moisten or aerate each layer as necessary to facilitate compaction to the required density. Do not place backfill or fill material on surfaces that are muddy, frozen, or covered with ice.
   1. Place fill and backfill against foundation walls and in confined areas (such as trenches) not easily accessible by larger compaction equipment, in maximum 6 inch thick (loose depth) layers.
   2. For large fill areas, the layer thickness may be modified by the Owner’s Representative, at the Contractor’s written request, if in the Owner’s Representative’s judgment, the equipment used is capable of compacting the fill material in a greater layer thickness. This request shall include the type and specifications of compaction equipment intended for use.

D. Prevent wedging action of backfill against structures by placing backfill uniformly around structure to approximately same elevation in each layer. Place backfill against walls of structures containing basements or crawl spaces only after the first floor structural members are in place.

E. Foundation Drains: Refer to Division 33.

F. Perimeter Insulation: Before the insulation is installed, place and tamp specified backfill to a smooth plane even with the required elevation of the lower surface of the insulation.

G. Under interior concrete slabs, utilize the following fill materials:
   1. Select Type 1 granular material from subgrade to within 6” of the building slab.
   2. Select Type 2 granular material for the next 6”.
   3. Provide vapor barrier above select Type 2 material as indicated on the drawings.

H. Against dampproofed or waterproofed structure faces or structure faces with foundation drains, utilize select Type 1 granular material.

I. Under Pavements and Walks:
   1. Utilize select Type 2 crushed stone as indicated on the construction drawings and in the applicable specification sections in the Project Manual.

J. Landscaped Areas: Place suitable material when required to complete fill or backfill areas up to subgrade surface elevation. Do not use material containing rocks over 4 inches in diameter within the top 12 inches of suitable material.

3.11 ADDITIONAL REQUIREMENTS FOR PLACING FILL TO SUPPORT STRUCTURES

A. Place fill at the perimeter of the structure to be constructed as follows:
   1. Strip the area in accordance with the requirements for Surface Preparation of Fill Areas.
   2. Compact the stripped surface to 95 percent of maximum density.
   3. Place fill in horizontal layers not exceeding 8 inches loose depth and compact layers as specified.

B. Place fill within the perimeter of the structure to be constructed as follows:
   1. Strip the area in accordance with the requirements for Surface Preparation of Fill Areas.
   2. Proof roll the stripped surface with at least 5 passes of a vibratory drum compactor having a minimum unsprung drum weight of 7 tons unless specifically indicated otherwise in the Contract Documents. Notify the Owner’s Representative of the proposed date for beginning proof rolling at least 2 working days prior to commencing proof rolling.
   3. Excavate unsuitable materials (soft and unstable earth) disclosed by the proof rolling operation and replace with compacted selected Type 1 granular material.
   4. Place fill in horizontal layers not exceeding 8 inches loose depth and compact layers as specified.

C. Obtain written approval of fill area compaction before excavating for footing.

D. Excavate for footing width plus 1 foot on each side.
E. Excavate 1 foot below footing elevations where bottom of footings are 2 feet or less above or 4 feet or less below original ground surface.
   1. Compact footing bottom and place a 1 foot bed of select granular material. Compact select granular material in 6 inch layers.
   2. Omit excavation and select granular material below bottom of footings where footing elevations are more than 2 feet above or more than 4 feet below original ground surface.

3.12 COMPACTION
A. Compact each layer of fill and backfill for the following area classifications to the percentage of maximum density specified below and at a moisture content suitable to obtain the required densities, but at not less than 3 percent drier or more than 2 percent wetter than the optimum content as determined by ASTM D 698 (Standard Proctor) or ASTM D 1557 (Modified Proctor).
   1. Structures (entire area within 10 feet outside perimeter): Compact subgrade and each layer of backfill or fill material to 95 percent.
   2. Concrete Slabs and Steps: Compact subgrade and each layer of backfill or fill material to 95 percent.
   3. Landscaped Areas: Compact the top 2'-0" to a maximum of 85% and compact all subgrade areas beneath the upper 2'-0" to 95%.
   4. Pavements and Walks: Compact subgrade and each layer of backfill or fill material to 95 percent.
   5. Pipes and Tunnels: Compact subgrade and each layer of backfill or fill material to 95 percent.
   6. Pipe Bedding: Compact subgrade and each layer of backfill or fill material to 95 percent.
B. Compaction Equipment:
   1. Provide compaction equipment of suitable size and number and in satisfactory working condition to complete construction on schedule.
   2. Use sheepsfoot rollers, pneumatic tired rollers, vibrating tampers, or other compaction equipment capable of obtaining required density throughout the entire layer being compacted.
C. When the existing ground surface to be compacted has a density less than that specified for the particular area classification, break up and pulverize, and moisture condition to facilitate compaction to the required percentage of maximum density.
D. Moisture Control:
   1. Where fill or backfill must be moisture conditioned before compaction, uniformly apply water to the surface and to each layer of fill or backfill. Prevent ponding or other free water on surface subsequent to, and during compaction operations.
   2. Remove and replace, or scarify and air dry, soil that is too wet to permit compaction to specified density. Soil that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing, until moisture content is reduced to a value which will permit compaction to the percentage of maximum density specified.
E. If a compacted layer fails to meet the specified percentage of maximum density, the layer shall be recompacted and retested. If compaction cannot be achieved the material/layer shall be removed and replaced. No additional material may be placed over a compacted layer until the specified density is achieved.

3.13 ROUGH GRADING
A. Interior Grading: Trim unexcavated spaces within the building to levels indicated.
   1. Subgrade for Interior Slabs: Compact as specified to receive fill material. Finish subgrade surface within 1 inch above or below level specified for fill required.
B. Exterior Grading: Trim and grade area within the grading limits of the Contract Documents and excavations outside the limits, required by this Contract, to a level of 6 inches below the finish.
grades indicated unless otherwise specified herein or where greater depths are indicated. Provide a smooth uniform transition to adjacent areas.

1. Grade areas outside building lines for each structure to drain away from structures and to prevent ponding of water. Finish surfaces free from irregular surface changes, large stones.

2. Landscaped Areas: Provide uniform subgrade surface within 1 inch of required level to receive topsoil thickness specified. Compact fill as specified to within 2 inches of subgrade surface. Remove objectionable material detrimental to proper compaction or to placing full depth of topsoil. If the top 4 inches of subgrade has become compacted before placement of topsoil, harrow or otherwise loosen rough graded surface to receive topsoil to a depth of 4 inches immediately prior to placing topsoil.

3.14 SUBGRADE SURFACE FOR WALKS AND PAVEMENT

A. Shape and grade subgrade surface as follows:
   1. Walks: Shape the surface of areas under walks to required line, grade and cross section, with the finish surface not more than ½ inch above or below the required subgrade surface elevation.
   2. Pavements: Shape the surface of areas under pavement to required line, grade and cross section, with the finish surface not more than ¼ inch above or below the required subgrade surface elevation.

B. Grade Control: During construction, maintain lines and grades including crown and cross-slope of subbase course.

C. Thoroughly compact subgrade surface for walks and pavement by mechanical rolling, tamping, or with vibratory equipment as approved to the density specified.

D. Shoulders: Place shoulders along edges of filled subgrades to prevent lateral movement. Construct shoulders of specified fill material, placed in such quantity to compact to thickness of each subgrade course layer. Compact and roll at least a 1'-0" wide additional layer of each subgrade course.

3.15 FINISH GRADING

A. Uniformly grade rough graded areas within the grading limits to finish grade elevations indicated.

B. Grade and compact to smooth finished surface within tolerances specified, and to uniform levels or slopes between points where finish elevations are indicated or between such points and existing finished grade.

C. Grade areas adjacent to building lines so as to drain away from structures and to prevent ponding.

D. Finish surfaces free from irregular surface changes, and as follows:
   1. Grassed Areas: Finish areas to receive topsoil to within 1 inch above or below the required subgrade surface elevations.
   2. Walks: Place and compact base material as specified. Shape surface of areas under walks to required line, grade and cross section, with the finish surface not more than ½ inch above or below the required subbase elevation.
   3. Pavements: Place and compact base material as specified. Shape surface of areas under pavement to required line, grade and cross section, with the finish surface not more than ¼ inch above or below the required subbase elevation.
   4. Building Slabs: Grade base material smooth and even, free of voids, compacted as specified, and to required subbase elevation. Finish final grades within a tolerance of ¼ inch when tested with a 10 foot straightedge.
   5. Surfaces To Receive Vapor Barrier: Provide smooth surfaces graded, tamped and/or rolled, entirely free of obstructions or protruding objects.

E. Spread topsoil directly upon prepared subgrade surface to a depth measuring a minimum of 6 inches after natural settlement of the topsoil has occurred in areas to be seeded or to receive
sod unless specifically indicated otherwise within the Contract Documents. Place to greater depth when necessary to adjust grades to required elevations.

1. Only approved existing topsoil within the grading limits may be used. Provide additional topsoil from outside sources as required.

F. Finish topsoil surface free of depressions which will trap water, free of stones over ½ inch in any dimension, and free of debris.

3.16 MAINTENANCE AND RESTORATION

A. Restore grades to indicated levels where settlement or damage due to performance of the work has occurred. Correct conditions contributing to settlement. Remove and replace improperly placed or poorly compacted fill materials.

B. Restore pavements, walks, curbs, lawns, and other exterior surfaces damaged during performance of the work to match the appearance and performance of existing corresponding surfaces as closely as practicable.

C. Topsoil and seed damaged lawn areas inside and outside the indicated grading limits. Water as required until lawn areas are accepted by the Owner’s Representative.

3.17 DISPOSAL OF EXCESS AND UNSUITABLE MATERIALS

A. Remove from the work site and dispose of excess and unsuitable materials, including materials resulting from clearing and grubbing and removal of existing improvements.

B. If acceptable to the Owner’s Representative, transport excess and unsuitable materials, including materials resulting from clearing and grubbing and removal of existing improvements, to spoil areas on the project site designated by the Owner’s Representative, and dispose of such materials as directed.

C. Transport excess topsoil to areas on the project site designated by the Owner’s Representative. Smooth grade deposited topsoil.

3.18 FIELD QUALITY CONTROL

A. Tests: The Owner may provide soil testing and inspection services during earthwork operations. The Owner reserves the right to test and approve all subgrades and fill layers before construction proceeds.

1. Compaction Testing: Provide the Owner’s Representative adequate notice for all phases of filling and backfilling operations. Compaction testing will be performed by the Owner’s Testing Agency to ascertain the compacted density of the fill and backfill materials. Compaction testing will be performed on certain layers of the fill and backfill as determined by the Owner’s Representative and the Testing Agency. If a compacted layer fails to meet the specified percentage of maximum density, the layer shall be recompacted and retested. No additional material may be placed over a compacted layer until the specified density is achieved.

2. Tests of subgrades and fill layers may, at the Owner’s option, include:
   a. Observation of proof rolling procedures.
   b. Observation and or inspection of unsuitable soil material.
   c. Footing subgrades, for each strata of soil for which footings will be placed, at least one plate bearing test and field density test may be conducted if the subgrade is non-cohesive, or unconfined compression test may be conducted if the subgrade is cohesive, to verify design bearing capacities shown on the drawings. Subsequent verification and approval of each footing subgrade may be based on visual comparison of each subgrade with tested strata when acceptable to the Project Designer.
   d. Paved areas and building subgrade areas, at least one field density test of subgrade for every 2000 square feet of paved area or building slab, but not less than three tests may be made. In addition, in each compacted fill layer, at least one field density test of subgrade for every 2000 square feet of paved area or building slab, but not less than three tests may be made.
e. Foundation wall backfill, field density tests at locations and elevations as directed may be made, with at least one test made for every 50 feet of wall.
f. Fill under footings, in each compacted fill layer; one compaction test for every 30 LF of wall may be taken. One compaction test may be made under each individual footing.

3. If in the opinion of the Project Designer and based on reports of the testing service, completed subgrades or fills are below the specified density, provide additional compaction and testing at no additional expense to the Owner.

3.19 PROTECTION

A. Protect graded areas from traffic and erosion and keep them free of trash and debris.
B. Repair and re-establish grades and seeding in settled and rutted areas to specified tolerances.

END OF SECTION
SECTION 31 1000
SITE PREPARATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes
   1. Protection of trees, shrubs and other vegetation
   2. Clearing and grubbing of site
   3. Implementation of soil erosion and sediment control procedures
   4. Demolition and removal of existing site features
   5. Disposal of waste materials

1.02 DESCRIPTION

A. Design Requirements
   1. The contractor shall clear and grub the site as required to perform the construction shown on the contract documents. Clearing and grubbing of the site shall be confined closely to the limits shown on the contract documents.
   2. Site preparation operations required, but not limited to in the work, include:
      a. Protection of existing trees, shrubs and vegetation.
      b. Removal of existing trees, shrubs and vegetation as indicated on the contract documents.
      c. Clearing and grubbing.
      d. Temporary fencing.
      e. Topsoil stripping.
      f. Removal of above grade improvements and subsurface infrastructure.
      g. Disconnecting and removing all existing utilities except those designated to remain.
      h. Removal of debris.
      i. Dust control.

1.03 SEQUENCING AND SCHEDULING

A. Coordinate site preparation operations with the following:
   1. Work with other prime contractors.
   2. Shut down and relocation of site utilities in field of operations.
   3. Various stages of completion in the project schedule.

PART 2 PRODUCTS

2.01 NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine conditions under which site preparation work is to be accomplished in coordination with the installer components specified in this Section. Notify affected Prime Contractors, the Owner’s Representative and the Project Designer in writing of any conditions detrimental to proper and timely accomplishment of the required work. Do not proceed with site preparation work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.
   1. When the installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to the Project Designer written confirmation from the applicable installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

B. Perform the following prior to starting site preparation work:
   1. Inspect the entire project site including all objects that are designated to remain or to be removed.
2. Locate all underground infrastructure and utilities and determine requirement for their protection.
3. Preserve in operating condition all active utilities traversing the site and designated to remain.
4. Schedule site preparation work in consideration of adjacent public and private property owners.
5. Avoid interference with use of and passage to and from adjacent buildings and facilities.

3.02 PREPARATION
A. Protect existing objects designated to remain, both on and off the project site. In the event of damage, immediately make all repairs and replacements necessary for approval of the Owner’s Representative and the Project Designer.
B. Prevent spread of dust during performance of the work throughout the life of the project. Thoroughly moisten all site areas as required to prevent dust from being a nuisance to the Owner, public, neighbors and performance of other work on the site.
C. Use all means necessary to minimize interference with roads, streets, walks, and other traveled areas. Do not close, obstruct, or cause to make impassable any traveled areas without first obtaining permission from the appropriate agencies.
D. Remove, relocate, store and protect from damage items designated to be savaged.

3.03 PROTECTION OF EXISTING TREES, SHRUBS AND VEGETATION
A. Install temporary fencing as required to protect existing trees, shrubs and other vegetation which are scheduled to remain from above ground damage including smothering of root systems. Do not store construction materials, debris or excavated materials within the drip line of trees. Restrict vehicular traffic, parking and pedestrian traffic from tree drip line areas to prevent excessive compaction of soil over root systems.
B. Trees, shrubs or vegetation scheduled to be saved that are damaged during construction work due to contractor negligence shall be placed under the care of a certified nurseryman or arborist. The Prime Contractor responsible for the damage to the plant material shall be liable for the cost of all required work. Trees, shrubs or vegetation that die as a result of contractor negligence shall be evaluated by a qualified nursery industry professional selected by the Owner's Representative. The removal and replacement of the affected trees, shrubs or vegetation and the associated evaluation expenses shall be the responsibility of the contractor.

3.04 CLEARING AND GRUBBING
A. Remove trees, shrubs and other vegetation that interfere with the installation of new construction or grading work, except for those indicated to remain. Use only hand methods for grubbing inside the drip line of trees indicated to remain. Removal of plant material includes the excavation and off-site disposal of new and old stumps of trees, shrubs and other vegetation and their entire root mass.
B. Depressions caused by clearing operations shall be filled with satisfactory soil material unless further excavation or earthwork is required.

3.05 IMPLEMENTATION OF SOIL EROSION AND SEDIMENT CONTROL PROCEDURES
A. Install temporary and permanent measures to mitigate soil erosion and sediment control issues as directed by the Project Designer or interested State Agencies. Work may include the installation of berms, dikes, dams, sediment basins, fiber mats, netting, gravel, mulches, grasses, sloped drains and other erosion control devices.
B. The temporary soil erosion and sediment control measures indicated on the Contract Documents shall be coordinated with the specified permanent erosion control features to the extent practical to assure economical, effective and continuous erosion control.

3.06 DEMOLITION AND REMOVAL OF EXISTING SITE FEATURES
A. Remove pavements, sidewalks, curbs and other site features noted for removal that are encountered as part of the work.
1. Remove asphalt concrete paving material to full depth and remove from site.
2. Break up and completely remove miscellaneous concrete such as small foundations.
   B. Leave cut edge neat and square where existing material is cut to adjoin new work.

3.07 DISPOSAL OF WASTE MATERIALS
   A. Burning on the Owner’s property of combustible cleared and grubbed material is not permitted.
   B. Remove all combustible cleared and grubbed material, excess excavated subgrade material, broken stone, broken concrete, masonry materials, and debris from the Owner’s property and legally dispose of it. Obtain all permits for off-site disposal and submit a copy of each permit to the Owner’s Representative.

END OF SECTION
SECTION 31 2317
SITE TRENCHING

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Trench excavation, backfill and compaction of underground piping and underdrainage.

1.02 RELATED SECTIONS
A. Section 31 0000 - Earthwork
B. Division 33 - Utilities

1.03 SUBMITTALS
A. Comply with the requirements of Section 01 3000 and as modified below.
B. Backfill Product Data: Submit test reports for each type of gravel and/or stone specified for backfill naming the source of each material. Submit evidence that each backfill material complies with Department of Transportation standard specifications for the materials specified.
C. Quality Control Submittals
   1. Experience Listing: Submit a list of completed projects similar to this project, including owner’s contact information and telephone number for each project.
D. Closeout Procedures: Comply with the requirements of Section 01 7000.

1.04 QUALITY ASSURANCE
A. Regulatory Requirements: 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.

1.05 PROJECT CONDITIONS
A. Field Measurements: Establish and maintain required lines and elevations for grade control.

1.06 SEQUENCING AND SCHEDULING
A. Proceed with and complete trenching operations as rapidly as portions of the site become available, working within seasonal limitations for the work required.

PART 2 PRODUCTS

2.01 MATERIALS
A. Excavated Material: Utilize on-site excavated materials consisting of loam, clay, sand, gravel or other material suitable for backfilling as approved by the Project Designer when the type of backfill material is not indicated on the Contract Documents.
B. Sand: Natural bank sand complying with the following gradation requirements:
   1. 100% passing the ¾” sieve
   2. Less than 5% passing the Number 200 sieve.
C. Bedding Material: Unless specifically noted otherwise on plans, provide a mixture of 50% No. 1 and 50% No. 2 stone complying with the following New York State Department of Transportation Standard Specifications:
   1. No. 1 Stone Gradation Requirements

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Size opening (mm)</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
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<tr>
<td>No. 200</td>
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<td>0-1</td>
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2. No. 2 Stone Gradation Requirements

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</thead>
<tbody>
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<tr>
<td>1 ½ inch</td>
<td>38.1</td>
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<tr>
<td>1/2 inch</td>
<td>12.7</td>
</tr>
<tr>
<td>No. 200</td>
<td>0.075</td>
</tr>
</tbody>
</table>

PART 3 EXECUTION

3.01 EXAMINATION
A. Installer Verification of Conditions: Examine conditions under which trenching operations are to occur 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 EXCAVATION
A. Excavate trenches to line and depth as indicated on the Contract Documents. Provide consistent, uniform support for the bottom quadrant of each section of piping, fittings and associated materials.

1. Excavate no more than length of trench that can receive infrastructure installation and backfill.
2. Brace and drain trenches as required. Accumulations of groundwater or storm runoff shall be immediately discharged by dewatering pumps to siltation basins or protected channels, drains or storms sewers.
3. Provide adequate trench width to permit successful laying and joining of pipe, proper placement of backfill and clearance of at least 8" on either side of the pipe barrel.
4. Prepare the finish grade of the trench bottom with hand tools. Where elevations are not shown on the Contract Documents, excavate the trench to place a minimum of 18" of fill above the top of the pipe. Provide “bell holes” at each pipe joint for proper joining to eliminate point bearing. Stones of 2" or greater in any dimension or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.
5. Where trench excavation is carried below the specified elevation as a result of Contractor error or negligence, backfill the trench with Select Type 1 Granular Material and compact to required densities at no cost to the Owner.
6. When trenching is required within the dripline of trees, tunnel under or around roots by hand digging. Do not cut tap roots or main lateral roots.

B. Excavated Materials
1. Materials satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench sufficient to avoid overloading and to prevent slides and cave-ins.
2. Adequate drainage shall be provided for the stockpiles and surrounding areas by means of ditches, dikes and other approved methods.
3. Stockpiles shall be protected from contamination with unsatisfactory excavated material or other material that destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles and any material becomes unsatisfactory as a result, such material shall be removed and replaced with satisfactory on site or imported materials from approved sources at no additional cost to the Owner.
4. Excavated material not required or not satisfactory for backfill shall be removed from the site.

3.03 BACKFILLING

A. Trench Backfill: Trenches shall be backfilled to grade upon completion of required testing work.

B. Bedding and Initial Backfill: Bedding shall be of the type and thickness as indicated on the Contract Documents or as recommended by the pipe manufacturer.
   1. Initial backfill material shall be placed in layers of a maximum of 6” loose thickness and compacted with approved tampers to the density of the adjacent in-situ soil, and to a height of at least one foot above the utility pipe, conduit or other infrastructure item. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe.
   2. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe.

C. Final Backfill: The remainder of the trench shall be backfilled with satisfactory material removed from the trench. Backfill material shall be deposited and compacted as follows:
   1. Under building slabs, roads, walks, parking lots and other structural areas, backfill shall be deposited in maximum 8” loose thickness layers and compacted to 95% maximum dry density at +/-2% of optimum moisture content.
   2. Under general landscape and natural turf playfield areas, backfill shall be deposited in maximum 12” loose thickness layers and compacted to 95% maximum dry density at +/-2% of optimum moisture content.

3.04 FIELD QUALITY CONTROL

A. Testing
   1. The Owner may provide soil testing and inspection services during the backfill of trenches as outlined in Project Manual Section 01 4000 - Quality Requirements.
   2. Prime Contractors shall employ the services of an independent testing agent to observe and test backfill operations performed by other Prime Contractors that may affect their work. An independent testing laboratory shall certify that the backfill is suitable for finish construction to be installed over trenches.
   3. Prime Contractors shall submit copies of testing laboratory reports to the Owner’s Representative and the Project Designer for information only.
   4. The General Work and Site Work Prime Contractors shall accept in writing any trench backfill and compaction by other prime contractors before installing the remaining finish construction over trench work.

END OF SECTION
SECTION 32 1216
ASPHALT PAVING

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Aggregate base for asphalt paving
B. Asphalt paving installation over aggregate base
C. Installation of asphalt topcourse over existing paving
D. Joining new asphalt pavement to adjacent construction
E. Traffic marking of asphalt pavement
F. Field quality control

1.02 RELATED SECTIONS
A. Section 31 0000 - Earthwork
B. Section 32 1313 - Concrete Paving
C. Section 32 1613 - Concrete Curbs
D. Division 33 - Utilities

1.03 SUBMITTALS
A. Comply with the requirements of Section 01 3300 and as modified below.
B. Product Data: Submit manufacturer’s name, specifications and installation instructions for each item specified.
C. Job Mix Formulas: Submit job mix formulas for asphalt paving indicating compliance with the requirements of each asphalt type specified including the name and location of the supplier.
D. Quality Control Submittals
   1. Certificates: Submit one copy of all permits obtained from local regulatory agencies and the New York State Department of Transportation.
   2. Qualifications Certification: Submit written certification or similar documentation signed by the applicable subcontractor, prime contractor and/or manufacturer (where applicable) indicating compliance with the requirements specified below in the “Quality Assurance” section of this specification.
   3. 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 requirements specified in the “Quality Assurance” section of this specification.
E. Closeout Procedures: Comply with the requirements of Section 01 7800.

1.04 QUALITY ASSURANCE
A. Asphalt Producer Qualifications: Use only materials furnished by bulk asphalt producer regularly engaged in the production of hot-mix, hot laid asphalt.
B. Regulatory Requirements
   1. Conform to the requirements of local regulatory agencies, or if applicable, the New York State Department of Transportation, which ever is more stringent for methods and materials in work areas subject to applicable agency’s review and approval. Provide materials complying with referenced New York State Department of Transportation Standard Specifications where indicated.
   2. 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.
1.05 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Do not apply tack coats when ambient temperature is below 50 degrees F., and when the
temperature has not been above 35 degrees for 12 hours immediately prior to the
application. Do not apply a tack coat when an asphalt base is wet or contains an excess
of moisture.
   2. Do not construct asphalt surface courses when the atmospheric temperature is below 40
degrees F., and when base material is not dry. Asphalt may only be placed when air
temperatures are a minimum of 40 degrees F. and rising.

B. Field Measurements: Establish and maintain required lines and elevations for grade control.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate Base: Comply with the New York State Department of Transportation Standard
Specification, Section 304, Paragraph 304-2, as modified in Section 31 0000 - Earthwork.
   1. Foundation Course (Course of fill below the specified stone base course): Select Type 1
granular fill. On site material may be acceptable as fill under the gravel base portion of the
asphalt pavement profile should the on site material be deemed acceptable by the Owner’s
Testing Agency or the Project Designer.
   2. Base Course: Type 2 crushed stone as modified in Section 31 0000 - Earthwork unless
specifically noted otherwise on the Contract Documents.

B. Asphalt Pavement: Paving materials shall comply with the New York State Department of
Transportation Standard Specification. Section 400 for the materials indicated.
   1. Binder Course: Hot plant mixed asphalt, complying with the New York State Department
of Transportation Standard Specification, Section 401 and 403 for Asphalt - Type 3 Binder.

<table>
<thead>
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</tr>
<tr>
<td>No. 200 Sieve</td>
<td>.075</td>
<td>2 – 8</td>
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</tbody>
</table>

   a. The PGB content shall be 4.5 - 6.5%, +/-0.4%.
   b. The mixing and placement temperature range shall be 120 - 165 degrees C.

   2. Topcourse: Hot plant mixed asphalt, complying with the New York State Department
of Transportation Standard Specification, Section 401 and 403 for Asphalt - Type 6
Topcourse.

<table>
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<th>Sieve Size</th>
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<td>¼&quot;</td>
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<td>3.2</td>
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<tbody>
<tr>
<td>.075</td>
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<td>+/-2</td>
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a. The PGB content shall be 5.4 - 7.0%.
b. The mixing and placement temperature range shall be 120 - 165 degrees C.

c. Coatings: Comply with the New York State Department of Transportation Standard Specification, Section 702 for material designations indicated.
   1. Tack Coat: Emulsified asphalt, slow setting type, New York State Department of Transportation designation 702-3601 (SS-1h) or 702-4501 (CSS-1h).

d. Pavement Marking Paint: Utilize pavement marking paint complying with the New York State Department of Transportation Standard Specification for White, or Yellow, and Blue Marking Paints.
   1. Manufacturer: For convenience, specifications have been based on “Setfast Acrylic Latex Traffic Paint” by Sherwin Williams, Co., Cleveland, OH (Tel. #216-566-2902).

#### 2.02 EQUIPMENT

A. Paving Equipment: Spreading, self propelled asphalt paving machines capable of maintaining the line, grade and minimum surface thickness specified. Spreader boxes may be used in areas where specifically approved by the Project Designer.

B. Compacting Equipment: Self-propelled tandem roller with a minimum 10 ton weight. Hand held vibrator compactor may be used in areas not accessible to rollers when specifically approved by the Project Designer.

#### PART 3 EXECUTION

#### 3.01 EXAMINATION

A. Installer Verification of Conditions: Examine conditions under which pavement is 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. Final Preparation of Subgrades: Upon completion of preparation of subgrades as specified in Section 31 0000, thoroughly scarify the entire area to be paved and compact by rolling to smooth, hard, even surface. Finish to required grades with allowance for pavement courses above.

#### 3.03 INSTALLATION

A. Aggregate Base: Comply with the requirements of the New York State Department of Transportation Standard Specification, Section 304-3, for aggregate gradations specified, unless otherwise indicated.
   1. Foundation Course: Place foundation course in maximum 8” layers to the thickness indicated. Compact the material with a 10 ton roller with the material at optimum moisture content for maximum compaction.
   2. Base Course: Completely fill voids with grits and roll with a 10 ton roller, eliminating movement of the material ahead of the roller. After rolling, verify grading with a minimum ten foot long straight edge. Satisfactorily eliminate any depression over ¼” deep. Obtain approval of base prior to installing asphalt courses above.
B. Asphalt Paving: Pave finished surface free from depressions that may collect water. The Contractor shall remove any depressions at their own expense over 1/8” deep when tested with a six foot straight edge without evidence of patching.
   1. Pave over aggregate base in two courses, topcourse over binder course. Comply with the New York State Department of Transportation Standard Specification, paragraph 401-3 and paragraph 403-3 for asphalt types specified.

C. Installation of Topcourse over Existing Paving
   1. Surface Preparation: Condition existing paving in accordance with the New York State Department of Transportation Standard Specification, Section 633, prior to applying tack coat.
      a. Tack Coat: Spray tack coat to the surface of the existing paving in accordance with the New York State Department of Transportation Standard Specification, paragraph 407-3. Apply tack coat ahead of paving equipment to allow for proper “breaking” of the material prior to the application of the new asphalt topcourse. Spray only the amount of tack coat that can be paved over in one day.
   2. Paving Topcourse: Pave topcourse graded to existing drainage basins. The thickness of the topcourse may vary to 3” to provide a smooth, evenly graded surface, but shall never be less than minimum thicknesses stated on plans. Topcourse paving shall comply with the New York State Department of Transportation Standard Specification, paragraph 401-3 and paragraph 403-3 for the asphalt type specified.

D. Joining New Asphalt Pavement to Adjacent Construction
   1. Carefully construct joints between old and new pavements, or between successive days work to ensure continuous bond between adjoining paving. Construct joints with the same texture, density and smoothness as adjacent sections of asphalt courses. Clean sand, dirt and other deleterious material from contact surfaces and apply tack coat.
   2. Offset traverse joints a minimum of 24” between succeeding courses. Cut back pavement to the edge of previously placed courses to expose an even, vertical surface for the full course thickness.
   3. Offset longitudinal joints a minimum of 6” between succeeding courses. When edges of longitudinal joints are irregular, honeycombed or inadequately compacted, cut back all unsatisfactory sections to expose an even, vertical surface for the full course thickness.
   4. In horizontal joints between the binder and the topcourse, clean all contact surfaces and spray a tack coat prior to the installation of the topcourse if the binder has been in place for longer than seven days or if the pavement is determined to be excessively dirty by the Project Designer.
   5. Seal joints with the application of asphalt cement filler, a minimum of 2” to each side of the joint.

E. Traffic Marking: Apply pavement marking paint in accordance with the manufacturer’s recommended procedures and in accordance with the New York State Department of Transportation Standard Specification, paragraph 640-3.

3.04 FIELD QUALITY CONTROL

A. Flood Tests: Perform a flood test in the presence of the Owner’s Representative or the Project Designer utilizing a water tank truck. If a depression ponding water more than 1/8” in depth is found, provide corrective measures to provide proper drainage.

END OF SECTION
SECTION 32 1313
CONCRETE PAVING

PART 1 - GENERAL
1.01 SECTION INCLUDES
   A. Preparation for concrete paving
   B. Placement of fabric reinforcement
   C. Placement of concrete
   D. Placement of joints and sealants
   E. Placement of detectable warning surface
   F. Finishing and curing

1.02 RELATED SECTIONS
   A. Section 31 0000 - Earthwork
   B. Section 32 1216 - Asphalt Paving
   C. Section 32 1613 - Concrete Curbs
   D. Division 33 - Utilities

1.03 SUBMITTALS
   A. Comply with the requirements of Section 01 3300 and as modified below.
   B. Product Data
      1. Concrete Mix Design: Submit proposed concrete design mix together with the name and
         location of the batching plant.
      2. Portland Cement: Brand and manufacturer's name.
      3. Air Entraining Admixture: Brand and manufacturer's name.
      4. Water Reducing or High Range Water Reducing Admixture: Brand and manufacturer's
         name.
      5. Curing and Anti-Spalling Compound: Manufacturer's specifications and application
         instructions.
      6. Welded Wire Mesh and Reinforcing Bars and Dowels: Manufacturer's name.
      7. Joint Fillers and Sealants: Catalog sheets, specifications and installation instructions for
         each product specified.
      8. ADA Detectable Warning Surface: Manufacturer's specifications, product data, test
         reports, method of installation, and maintenance instructions.
   C. Closeout Procedures: Comply with the requirements of Section 01 7800.

1.04 QUALITY ASSURANCE
   A. At location directed by the Project Designer, construct concrete flatwork sample panel
      approximately 5' wide by 15' long.
   B. Concrete batching plants shall be currently approved as concrete suppliers by the New York
      State Department of Transportation.
   C. Regulatory Requirements
      1. Conform to the requirements of local regulatory agencies, or if applicable, the New York
         State Department of Transportation, which ever is more stringent for methods and
         materials in work areas subject to applicable agency’s review and approval. Provide
         materials complying with referenced New York State Department of Transportation
         Standard Specifications where indicated.
      2. Obtain written permission from applicable agencies prior to the start of construction.
1.05 PROJECT CONDITIONS

A. Maintain access for vehicular and pedestrian traffic as required for other construction activity. Provide barricades, warning signals, warning lights, and similar items as required.

B. Environmental Conditions
   1. Humidity and Moisture: Do not install the work under this specification section under conditions that are detrimental to the installation, curing and performance of the specified materials.
   2. Temperature: Unless otherwise approved or recommended in writing by the sealant manufacturer, do not install sealants below 40 degrees F. or above 85 degrees F.

C. Protection: Protect all newly poured concrete surfaces from damage. Protect all surfaces adjacent to sealants with non-staining, removable tape or other approved covering to prevent soiling or staining.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cast-In-Place Concrete: Normal weight, air entrained concrete with a minimum compressive strength of 5,000 psi at the end of 28 days.
   1. Design Air Content: ASTM C 260, and on the New York State Department of Transportation’s current “Approved List”; 6% by volume +/- 1.5%.
   2. Cement: ASTM C 150 Type I or II portland cement. Minimum 6.5 bags or 611 pounds per cubic yard.
   4. Slump: Between 2 and 4 inches except when a water reducing admixture is used, the maximum slump shall be 6 inches. When a high range water reducing admixture is used, the maximum slump shall be 8 inches.
   5. Water Reducing Admixture: ASTM C 494, Type A and on the current New York State Department of Transportation’s current “Approved List”.
   6. High Range Water Reducing Admixture: ASTM C 494, Type F and on the current New York State Department of Transportation’s current “Approved List”.

B. Chemical Curing and Anti-Spalling Compound: ASTM C-309, Type 1D, Class B, clear, styrene acrylate type liquid compound with fugitive dye, minimum 18% total solids (by weight of compound), ready to use by spray apparatus.
   1. For convenience, details and specifications have been based on the following manufacturers and their products:
      b. Cure and Seal by Symons Corp., DesPlaines, IL.
      c. Kure-N-Seal 0800, Sonneborn Building Products/Chemrex, Inc., Shakopee, MN.
      d. Day-Chem Cure and Seal 26% (J-22), Dayton Superior Corp., Miamisburg, OH.
      e. Acrylseal HS, Master Builders, Inc., Cleveland, OH.

C. Reinforcement
      a. Rolled wire will not be acceptable for installation as part of the project.
   2. Reinforcing Bars and Dowels: Deformed steel bars, ASTM A 615, Grade 60.

D. ADA Detectable Warning Surface: Precast and prefabricated paving units with a non-slip texture on the travel surface. Color shall be a shade of brick red. There shall be a minimum of 70% contrast in light reflectance between the detectable warning surface and the adjoining surfaces. Material used to provide visual warning shall be an integral part of the detectable warning surface. Visual contrast to meet the existing ADAAG A4.2.9.2.
   1. For convenience, details and specifications have been based on the following manufacturers and their products:
      a. ADA Pavers: Whiteacre-Greer, Alliance, OH.
b. Detecto-Tile: Mexcon, Worcester, NY

c. Detectable Warning Pavers: Oaks Concrete Products, Bartlett, IL.

d. Granite Truncated Dome Pavers: Cold Spring, MN.

E. Joint Sealants
1. For horizontal joints, two part self leveling polyurethane sealant for traffic bearing construction.
   a. For convenience, details and specifications have been based on the following manufacturers and their products:
      1) Vulkem 255 by Mameco International, Inc., Beachwood, OH.
      2) Urexpan NR-200 by Pecora Corp, Harleysville, PA.
      3) Chem-Calk 550 by Bostik Inc., Middleton MA.
      4) Sealight Porthane Sealant by W.R. Meadows, Elgin, IL.
      5) Sonolastic SL-2 Joint Sealant Slope Grade by Sonneborn Building Products Inc., Minneapolis, MN.

2. For vertical joints, two part non-sag polyurethane sealant.
   a. For convenience, details and specifications have been based on the following manufacturers and their products:
      1) Vulkem 227 by Mameco International, Inc., Beachwood, OH.
      2) Dynatrol II by Pecora Corp, Harleysville, PA.
      3) Chem-Calk 500 by Bostik Inc., Middleton MA.

F. Joint Fillers
1. Closed Cell Polyurethane Joint Filler: Resilient, compressible, semi-rigid, closed cell isometric polymer foam material, minimum ½” thick similar to Ceramar Joint Filler as manufactured by W.R. Meadows, Inc., Elgin IL.
   a. Open cell fiber board or cork joint filler material is not acceptable for use in concrete expansion joint work.

2.02 EQUIPMENT

A. Forms: Steel of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Coat forms with non-staining, clear, paraffin based form oil that will not discolor or otherwise stain concrete surfaces.

PART 3 EXECUTION

3.01 EXAMINATION

A. Installer Verification of Conditions: Examine conditions under which pavement is 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. Surface Preparation: Remove all loose material from the compacted sub-base surface prior to placing concrete.

B. Forms: Set forms for 5” thick sidewalks unless specifically noted otherwise true to line and grade and anchor rigidly into position.

C. Space expansion joints equally at not more than 30’-0” on center.

D. Place joint filler at expansion joints and where new concrete abuts existing concrete paving and fixed structures and appurtenances. Protect the top edge of the joint filler during concrete placement with a temporary cap and remove after concrete has been placed. Fill expansion
joint with joint sealant after the concrete has been cured complying with the sealant manufacturers installation instructions.

### 3.03 PLACEMENT OF FABRIC REINFORCEMENT

A. Prior to placement of woven wire mesh, clean thoroughly of mill and rust scale and of coatings that could destroy or reduce bond.

B. Install fabric reinforcement midway between the top and bottom of the concrete slab. Prior to placing concrete, place fabric reinforcement midway between the top and bottom of the slab and secure against displacement with the use of chair carriers or other approved materials.

C. 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” from edges.

### 3.04 PLACING CONCRETE

A. Moisten the concrete subgrade as required to provide a uniform dampened condition at the time that concrete is placed.

B. Do not place concrete around manholes or other structures until these items are brought to the required grade and alignment.

C. Consolidate concrete by spading, rodding, forking or using an approved vibrator eliminating all air pockets, stone pockets and honeycombing. Work and float concrete surface so as to produce a uniform texture.

D. Locate construction joints (if any) at expansion joint locations.

E. Deposit and spread concrete in a continuous operation between control joints.

### 3.05 PLACING DETECTABLE WARNING SURFACE

A. Detectable warning surfaces shall be installed 6 inches behind the edge of the curb.

B. Domes shall be aligned on a square grid in the predominant direction of travel to permit wheels to roll between the domes.

C. Install pre-cast units in accordance with the manufacturer’s instructions.

D. The curb, detectable warning surface, and sidewalk shall be flush with the elevation of the road surface.

### 3.06 FINISHING AND CURING

A. After striking off and consolidating poured concrete, smooth the surface by screeding and floating. Adjust floating to compact the surface and produce a uniform texture.

B. After floating, test the surface for trueness utilizing a 10’ steel straight edge. Distribute concrete as required to remove surface irregularities and refloat repaired areas to provide a continuous smooth finish.

C. Provide broom finish for walk surfaces.

D. Finish edges of walk and expansion joints with a ½” radius edging tool. Space tool joints equally between expansion joints at approximately 5′-0” on center, unless specifically detailed otherwise on the construction documents.

E. Apply curing and anti-spalling compound in accordance with the manufacturer’s printed instructions.

F. Saw control joints one inch deep after the concrete has set. Space control joints equally between expansion joints at approximately 5′-0” on center, unless specifically detailed otherwise on the construction documents.

### 3.07 FIELD QUALITY CONTROL

A. Testing by Owner of Concrete Sidewalks
   1. Contractor Requirements
a. Provide access to concrete construction and concrete supplier’s facilities for representatives of the testing agency employed by the Owner to perform concrete testing and facility inspections as described below.

b. Notify the Owner’s Representative at least 48 hours in advance of each concrete placement to allow notification of the Owner’s Testing Agency.

2. Concrete Testing During Construction by the Owner’s Testing Agency
   a. Sampling Method: ASTM C 172 modified for slump to comply with ASTM C94.
   b. Slump Testing (ASTM C143): One test for each concrete load at the point of discharge. One test for each set of compressive strength test specimens, and one test from the middle of each load.
   c. Air Content Testing (ASTM C231, Pressure Method): One of each set of compressive strength test specimens; air content checked on every fourth load of “ready-mix” concrete delivered.
   d. Compressive Strength Testing
      1) Specimen Preparation: In compliance with ASTM C31 requirements to prepare one set of standard cylinders (minimum six each) for each compressive strength test.
      2) Specimen Testing: In compliance with ASTM C39 requirements for testing of one set of specimens for each 100 cubic yards (or fraction thereof) of each type of concrete placed in each day as follows
         (a) Two specimens at seven days after concrete completion.
         (b) Three specimens at 28 days after concrete placement.
         (c) One specimen retained for later testing, if required.
   e. Reporting: Reports containing the following information shall be provided in writing by the Owner’s Testing Agency to the Project Designer and the Prime Contractor the same day the tests are accomplished.
      1) Project identification name and number.
      2) Name of prime contractor, concrete supplier and testing agency.
      3) Number (or other designation) of truck delivering the concrete.
      4) Concrete type and class, date of placement, and location of concrete batch within the project.
      5) Design compressive strength at 28 days.
      6) Concrete mix proportions and materials.
      7) Compressive breaking strength and type of break for both 7 day test and 28 day test.
   f. Concrete Temperature: Test hourly when air temperature is 40 degrees F. or lower, or when the air temperature is 80 degrees F. or above, and each time compression testing specimens are prepared.
   g. Inspection of Supplier Facilities: The Owner’s Testing Agency may inspect the concrete supplier’s batch plant and review batching procedures as deemed necessary by the Owner, including inspecting the aggregate washing facility, concrete heating system, and concrete transportation equipment.
   h. Inspection of Reinforcing Steel: The Owner’s Testing Agency may inspect placement of reinforcing steel. Do not begin concrete placement on any pour unless the Owner’s Representative and the Project Designer have been notified at least one day preceding the pour to allow reasonable time for inspection of the reinforcing steel.

3.08 ADJUSTING AND CLEANING

A. Repairs and Protection of Concrete Sidewalks
   1. Repair or replace broken or defective concrete as directed by the Project Designer.
   2. Protect concrete from damage until acceptance of concrete sidewalk construction. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain walks as clean as possible by removing surface stains as they occur.
3. Sweep concrete walks and wash them free of stains, discoloration, dirt, and other foreign materials just prior to final acceptance.

B. Patching Existing Construction: Repair or patch adjacent existing concrete or other surfaces damaged from concrete sidewalk construction.

END OF SECTION
SECTION 32 1613
CONCRETE CURBS

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Curb installation
B. Curb cut installation

1.02 RELATED SECTIONS
A. Section 31 0000 - Earthwork
B. Section 32 1216 - Asphalt Paving
C. Section 32 1313 - Concrete Paving

1.03 REFERENCES
A. Comply with ACI 301-89 for all work specified as part of this section unless specifically indicated otherwise within the Contract Documents.

1.04 SUBMITTALS
A. Comply with the requirements of Section 01 3300 and as modified below.
B. Product Data: Submit manufacturer’s name, specifications and installation instructions for each item specified.
C. 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.
D. Closeout Procedures: Comply with the requirements of Section 01 7800.

1.05 QUALITY ASSURANCE
A. 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.

1.06 PROJECT CONDITIONS
A. Field Measurements: Establish and maintain required lines and elevations for grade control.
B. Existing Conditions: Maintain access for vehicular and pedestrian traffic as required for other construction activity. Provide barricades, warning signals, warning lights and similar items as required.

1.07 SEQUENCING AND SCHEDULING
A. Proceed with and complete concrete curb construction as rapidly as portions of the site become available, working within seasonal limitations for the work required.

PART 2 PRODUCTS

2.01 MATERIALS
A. Concrete: Normal weight, air entrained concrete with a minimum compressive strength of 5,000 psi at the end of 28 days. Design air content shall be 6% by volume, with an allowable tolerance of plus or minus 1%. Concrete shall contain a minimum of 6.5 bags of cement per cubic yard. Slump shall be between 2 and 4 inches.
B. Joint Fillers: Closed Cell Polyurethane Joint Filler: Resilient, compressible, semi-rigid, closed cell isometric polymer foam material, minimum ½” thick similar to Ceramar Joint Filler as manufactured by W.R. Meadows, Inc., Elgin IL.
   1. Fiber board or cork joint filler material is NOT acceptable for use in concrete expansion joint work.

C. Joint Sealants: Two part non-sag polyurethane sealant. For convenience, details and specifications have been based on the following manufacturers and their products:
   2. Dynatrol II by Pecora Corp, Harleysville, PA.
   3. Chem-Calk 500 by Bostik Inc., Middleton MA.

D. Reinforcing Bars and Dowels: Deformed steel bars, ASTM A 615, Grade 60.

2.02 EQUIPMENT
A. Forms: Steel of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Bent, twisted, split or defective form materials are not acceptable. Use flexible spring steel forms to form radius bends. Coat forms with non-staining, clear, paraffin base form oil that will not discolor or otherwise deface the surface of concrete.

PART 3 EXECUTION
3.01 EXAMINATION
A. Installer Verification of Conditions: Examine conditions under which concrete curbs 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. Surface Preparation: Remove all loose material from the compacted sub-base surface immediately before placing concrete. Establish and maintain required lines and grades.

3.03 INSTALLATION
A. Form Construction
   1. Set approved forms true to line and grade, rigidly braced and secured. Cast curb in 30 foot long sections.
   2. If curbs will abut existing pavement, locate joints opposite existing pavement joints.
   3. Profile of curb to be 18” high by 6” wide with a tooled 1½” radius on the top corner unless specifically detailed otherwise on the Contract Documents.
   4. Allow forms to remain in place a minimum of 24 hours after concrete placement.
B. Joint Filler Installation: Provide joint fillers cut to size between the 30 foot sections, at the start and end of curved sections and where curbs abut existing concrete paving, fixed structures or appurtenances. Protect the top edge of the joint filler during concrete placement with a temporary cap and remove after concrete has been placed.
C. Reinforcement Placement: Reinforce curbs as indicated on the Contract Drawings. Maintain a minimum 3” cover on all reinforcing bars.
D. Concrete Placement: Do not place concrete until line and grade of subgrade and forms have been verified. Moisten subgrade as required to a uniform dampened condition at the time concrete is placed. Do not place concrete around structures until these items are brought to the required grade and alignment. Deposit and spread concrete in a continuous operation between joints.
E. Concrete Consolidation: Consolidate concrete by spading, rodding, forking or using an approved vibrator eliminating all air pockets, stone pockets and honeycombing. Consolidate with care to prevent dislocation of dowels and joints.

F. Remove forms and rub exposed face of the curb to a smooth rubbed finish. Plastering is not permitted.

G. Control Joints: Saw cut control joints at 15’ O.C.

H. Concrete Curing: Cover and cure newly poured concrete curbs for a minimum of seven days in accordance with ACI 301.

I. Joint Sealant Installation: Remove temporary joint filler cap and install joint sealant per the manufacturer’s recommendations.

3.04 ADJUSTING AND CLEANING

A. Repairs and Protection of Concrete Curbing
   1. Repair or replace broken or defective concrete curbing as directed by the Project Designer.
   2. Protect concrete curbing from damage until acceptance of the curb construction.

END OF SECTION
SECTION 32 3113
CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 SECTION INCLUDES
A. Excavation for fence post bases
B. Concrete anchorage for posts
C. Installation of chain link fences
D. Installation of chain link gates

1.02 RELATED SECTIONS
A. Section 32 1216 - Asphalt Paving
B. Section 32 1313 - Concrete Paving
C. Section 32 9200 - Lawns and Grasses
D. Section 32 9300 - Exterior Plants

1.03 REFERENCES
A. Comply with ASTM A 53 for requirements of Schedule 40 piping.

1.04 DEFINITIONS
A. Height of Fence: Distance measured from the top of the concrete footing to the top of the fabric.

1.05 SUBMITTALS
A. Comply with the requirements of Section 01 3300 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 and gate 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 01 7800.

1.06 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 Specification for Fence Rails, Posts, Gates and Accessories
B. Qualifications
   1. Provide metal fences and gates as a complete unit produced by a single manufacturer, including necessary erection accessories, fitting and fasteners. Products shall be provided
ALTERATIONS TO OACSD & NEW BUS GARAGE  
CHAIN LINK FENCES AND GATES
PROJECT NO. 2018-099

PART 2   PRODUCTS

2.01 MATERIALS

A. Framework Standards
   1. Steel 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 ASTM 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 6'-0" High
   1. End Posts, Corner Posts and Pull Posts.
      a. Pipe: 2.50" 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 4'-0" deep.
   2. Line Posts
      a. Pipe: 2.00" O.D.
      b. Space line posts at a maximum of 10 feet on center unless specifically noted otherwise on the contract documents.
      c. Footing Size: 12" O.D. by 4'-0" deep.

C. 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.
   1. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

D. 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.
   1. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.
E. Swing Gate Posts
   1. Single leaf of gate: 4.00” O.D. pipe, 9.11 pounds per linear foot.

F. Swing Gate Framework
   1. 1.90” O.D. pipe, 2.72 pounds per linear foot.
   2. Assemble gate frames by welding. Install mid-height horizontal rails on gates to prevent sag or twist.

G. 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 1½ pair of hinges for each leaf over 6’ high.
   2. Latch: Forked type for single gates 10 feet wide or less. Drop bar type with keeper for double gates and single gates over 10 feet wide complete with flush plate set in concrete. Drop bar length shall be 2/3 the height of the gate. A padlock eye shall be an integral part of the latch construction.
   3. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

H. Sliding Gate Framework: See details on plans for product and manufacturer information.
   1. Install sliding gates at proper heights to ensure that bottom of gates maintains a minimum of 4” clear from finish grade, or other obstruction, at any point along its movement.

I. Chain Link Fabric
   1. PVC Coated Fabric: Unless otherwise specified, provide 2” mesh, 9 gauge steel wires, with one piece fabric widths for fencing up to 12 feet high. The PVC coating is to be fused and adhered to galvanized wire in accordance with Federal Specification RR-F-191 H/ID, ASTM F-668 Class 2B, and ASTM F934. Coating thickness to be 7 mils.
      a. Softball and Baseball Backstops: 9 gauge, 2” mesh fabric roof system with 6 gauge, 2” mesh wire back and sides.
      b. Tennis Courts: 9 gauge, 1½” mesh.
      c. Manufacturer: Brighton Colorbond Fence System by Merchant Metals, Brighton, Michigan or similar.
      d. 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.
      a. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

J. 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.
   4. PVC Coated: Complying with the requirements of Brighton Colorbond Fence System by Merchant Metals, Brighton, Michigan.

K. Stretcher Bars: One piece equal to the full length of the fabric, minimum cross section 3/16” by ¾”. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

L. Metal Bands (for securing stretcher bars): Steel, wrought iron or malleable iron. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

M. 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.
   1. Aluminum Coated Hardware: Aluminum coating to be minimum of 0.40 ounces per square foot in accordance with ASTM F 626-96.
   2. PVC Coated Hardware: Complying with the requirements of Brighton Colorbond Fence System by Merchant Metals, Brighton, Michigan to match color of adjacent fence components.
N. Tension Wire: Manufacturer’s standard 7 gauge coiled spring steel wire. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

O. Wire Ties: PVC finish complying with ASTM A809, 0.40 ounces per square foot.
   1. For tying fabric to line posts, rails, tension wires and braces: 9 gauge steel wire installed at 12” O.C.

P. Truss Rods: 3/8” diameter. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

Q. Bolts and Nuts: ASTM A 307, Grade A. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

R. Concrete: Portland cement concrete having a minimum compressive strength of 3000 psi at 28 days.

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 grub plant material along the fence line as required to eliminate growth interfering 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 equidistant in the fence line at a maximum of 10 feet on center unless specifically noted otherwise on the Contract 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 at corners and at changes in direction. Use pull posts at all abrupt changes in grade and at intervals no greater than 500 feet. On runs over 500 feet, space pull posts evenly 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.
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. Install gates plumb and level and adjust for full opening without interference. Install ground set items in concrete for anchorage as recommended by the fence manufacturer. Adjust hardware for smooth operation and lubricate where necessary.

K. Wire brush and repair welded and abraded areas with one coat of cold galvanizing compound.

L. 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 and gates as directed by the Project Designer.
   2. Protect chain link fences and gates from damage until acceptance of the fencing construction.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Subsoil preparation
B. Placement of topsoil
C. Seeding and application of soil amendments and fertilizers
D. Mulching
E. Protection of seeded areas
F. Turf maintenance during warranty period
G. Cleanup and protection
H. Inspections and final acceptance

1.02 RELATED SECTIONS
A. Section 31 0000 - Earthwork
B. Section 32 9300 - Exterior Plants

1.03 SUBMITTALS
A. Comply with the requirements of Section 01 3300 and as modified below.
B. Quality Control Submittals
   1. Experience Listing: Submit a list of completed projects 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.
   2. Topsoil Analysis Report: Submit topsoil analysis report for on-site stockpiled or imported topsoil. Do not mix or utilize topsoil until a soil analysis report is approved by the Project Designer.
      a. Provide required representative samples of topsoil and organic or inorganic amendment materials proposed for use in the project to the independent testing agency noted below for analysis and recommended treatment. The Contractor shall pay for all costs incurred for testing and analysis of the soil material. Test reports shall be from current year.
         1) All soil samples and proposed amendments shall be sent to the Owner’s Testing Agent:
            (a) Hummel & Company, Inc.
            (b) 35 King Street
            (c) Trumansburg, New York 14886
            (d) Telephone Number: 607-387-5694
      b. All reports shall be sent to the Project Designer for approval.
      c. Samples of imported topsoil to be brought to the site must be approved prior to delivery.
      d. Deficiencies in the topsoil shall be corrected by the Contractor, as directed by the Project Designer, after review of the testing agency report.
      e. Ensure test reports include specific recommendations regarding exact types, times and rates of application of soil additives and fertilizers based upon soil test results and type of seed mix to be planted. Follow soil additive recommendations before and during topsoil respread operations. Include the following in the topsoil analysis:
         1) pH factor
         2) Percent organic matter as determined by a Loss on Ignition or Walkey/Black Test (ASTM F-1647).
         3) Proctor testing per ASTM D698.
4) Chemical analysis testing nitrogen, phosphorus, potassium, calcium, magnesium, cation exchange capacity, base saturation percentages, micronutrients and acidity (pH).

5) Particle size analysis of the topsoil as determined by ASTM F-1632, performed and compared to the USDA Soil Classification System.

f. Include in the recommendations the type, composition, rate and means of application of soil amendments and fertilizer necessary to establish the required pH factor, organic matter content and supply of nutrients satisfactory for planting.

g. All materials and procedures regarding soil amendments and fertilizers specified in this section are approximate; adjust all soil amendments to comply with the test reports.

3. Submit seed vendor’s certified statement for each grass seed mixture required, stating botanical and common name, percentage by weight, and percentages of purity, germination, and weed seed for each grass seed species.

C. Contract Closeout Submittals: Comply with the requirements of Section 01 7800.

1.04 QUALITY ASSURANCE

A. Worker’s Qualifications: The person’s performing the planting and their direct supervisor shall be personally experienced in the construction and caring of lawn areas. On site supervisory personnel shall have been employed by the company engaged in the installation and care of lawn areas for a minimum of five years. All other individuals on the landscape crew must have a minimum of six months experience in the landscape contracting industry.

1.05 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping: Ship seed and associated materials with certificates of inspection required by governing authorities.

B. Do not make substitutions. If specified seed material is not obtainable, submit to the Project Designer proof of non-availability and a proposal for use of equivalent material.

C. Store all seed at the site in a cool, dry place as approved by the Owner’s Representative. Replace any seed damaged during storage.

D. Deliver seed in vendor’s unopened packages bearing labels showing the vendor’s name and seed analysis by weight.

E. Deliver fertilizer in the manufacturer’s standard sized bags showing the weight, analysis, and manufacturer’s name. Store all fertilizer under a waterproof cover or in a dry place as approved by the Owner’s Representative.

1.06 PROJECT CONDITIONS

A. Water: If available on the site, water will be supplied for the purpose of watering newly planted lawn areas at no cost to the contractor. If water is not available on site, the contractor shall supply water at their own cost as required to maintain the health of the newly planted material.

B. Provide irrigation materials capable of adequately watering new lawn areas until acceptance.

1.07 PESTICIDE APPLICATIONS

A. Any contractor applying pesticides must notify the Owner’s designated pesticide representative and all property neighbors not less than 48 hours in advance of any pesticide application including herbicides, insecticides and fungicides in accordance State Regulations and the School Pesticide Neighbor Notification Law, Section 409-H of the New York State Education Law and Commissioner’s Regulation 155.24.

1.08 SEQUENCING AND SCHEDULING

A. Proceed with and complete lawn planting as rapidly as portions of the site become available, working within seasonal limitations for the work required.
B. Seed lawn areas during a period between August 15 and October 1. Seeding during unseasonable conditions must be reviewed and approved with the Project Designer at the sole risk of Contractor.

C. The Contractor shall complete a minimum of three mowings before requesting the Project Designer review for acceptance of seeding work.

PART 2 PRODUCTS

2.01 SEED

A. Grass seed shall be certified "Blue Tag" seed composed of a blend of varieties mixed in proportion by weight and tested for minimum percentages of purity and germination. Submit the proposed mixture to the Project Designer for approval.

1. Seed blend shall consist of 80% Kentucky Bluegrass and 20% Perennial Ryegrass on a weight basis.

2. The seed shall contain a blend of at least two Kentucky Bluegrass varieties.

3. The Perennial Ryegrass shall have a minimum germination percentage of 85%.

4. The percentage of weed seed shall not exceed 1% and other crop seed shall not exceed 0.5% by weight of the mixture.

5. Any variety substitutions or deviations from these specifications must be approved by the Project Designer.

2.02 TOPSOIL

A. Use either approved topsoil imported to the project site, or approved on-site topsoil stripped, stockpiled and amended to meet these required specifications.

1. On-site topsoil shall be from existing stockpiles stripped from the project site, tested by the Contractor, and amended to meeting these specifications.

2. Where quantity of topsoil required exceeds that available from on-site stockpiles, provide imported topsoil from local sources or from areas having similar soil characteristics to that found on the project site which are producing or have produced fair to good yield farm crops without unusual fertilization for a minimum period of ten years or from arable or cultivable areas supplied with good natural drainage. Do not obtain topsoil from bogs or marshes or from farmland that has utilized "Atrazine" or similar herbicide within the past five years.

B. Provide topsoil conforming to the following:

1. Original loam topsoil, well drained homogeneous texture and of uniform grade, without the admixture of subsoil material and entirely free of dense material, hardpan, sod, or any other objectionable foreign material.

2. Containing not less than four percent nor more than 20 percent organic matter in that portion of a sample passing a ¼" sieve when determined by the wet combustion method on a sample dried at 105 degrees F.

3. Containing a pH value within the range of 6.3 and 7.0 on that portion of the sample which passes a ¼" sieve.

4. On-site and imported topsoil shall be mechanically screened prior to respreading to comply with the following gradation:

<table>
<thead>
<tr>
<th>SIEVE DESIGNATION</th>
<th>PERCENT PASSING</th>
</tr>
</thead>
<tbody>
<tr>
<td>¾ inch</td>
<td>100</td>
</tr>
<tr>
<td>¼ inch</td>
<td>97 – 100</td>
</tr>
<tr>
<td>No. 200</td>
<td>20 - 65</td>
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</tbody>
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2.03 FERTILIZER

A. Mixed commercial fertilizers containing total nitrogen, available phosphoric acid and soluble potash in the ratio of 10-6-4 (50% N/UF). 50% of the total nitrogen shall be derived from a urea form 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.

2.04 LIME
A. Dolomitic Limestone: Approved agricultural dolomitic limestone containing no less than 50% of total carbonates and 25% total magnesium with a neutralizing value of at least 100%. The material shall be ground to such a fineness that 40% will pass through a number 100 U.S. standard sieve, and 98% will pass through a number 20 U.S. standard sieve. The lime shall be uniform in composition, dry and free flowing and shall be delivered to the site in the original, unopened containers, each bearing the manufacturer’s guaranteed analysis. Any lime which becomes caked or otherwise damaged making it unsuitable for use will be rejected.
B. Calcitic Limestone: Approved agricultural calcitic limestone containing a minimum of 86% calcium carbonate expressed as CaCO3. The material shall be ground to such a fineness that 40% will pass through a number 100 U.S. standard sieve, and 98% will pass through a number 20 U.S. standard sieve. The lime shall be uniform in composition, dry and free flowing and shall be delivered to the site in the original, unopened containers, each bearing the manufacturer’s guaranteed analysis. Any lime which becomes caked or otherwise damaged making it unsuitable for use will be rejected.

2.05 MULCH
A. Dry Application Straw: Stalks of oats, wheat, rye or other approved crops which are free from noxious weeds. Weight shall be based on 15% moisture.
B. Hydro-Application: Colored wood cellulose fiber product specifically designed for use as a hydro-mechanical applied mulch.

1. For convenience, details and specifications have been based on the following manufacturers and their products:
   a. Conwed Hydro Mulch as manufactured by Conwed Fibers, Hickory NC.

PART 3 EXECUTION
3.01 EXAMINATION
A. Installer Verification of Conditions: Examine conditions under which lawn installation is to be completed 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. Strip and stockpile full depth of existing topsoil. Screen topsoil to comply with gradation specifications prior to respread of the material.
B. Perform earthwork operations to accomplish design elevations as indicated on the Contract Documents. Loosen subgrade of lawn areas to a minimum depth of four inches. Remove stone and any other deleterious matter encountered over 1½” in any dimension within the subgrade.
C. Respread screened topsoil in lawn areas to a minimum depth of six inches as required to meet lines, grades, and elevations shown after light rolling and settlement.
D. Provide lime or sulfur as required to adjust pH of the screened topsoil to be 6.3 to 7.0. Apply lime or sulfur materials at a rate of 80 pounds per 1000 square feet (final application rate to be determined by the soil test report). Cultivate soil amendments to a four inch depth.
E. Grade lawn areas to a smooth even surface with loose, uniformly fine texture. Roll, rake, remove ridges and fill depressions as required to meet finish grades. Limit fine grading operations to areas which can be planted immediately after grading.

F. Moisten prepared lawn areas before seeding if soil is dry. Water thoroughly and allow surface moisture to dry before planting lawns. Do not create a muddy soil condition.

G. Restore lawn areas to specified condition if eroded or otherwise disturbed after fine grading and prior to seeding.

H. Preparation of Unchanged Grades: Where lawns are to be seeded in areas that have not been altered or disturbed by excavating, grading, or stripping operations, prepare the soil bed for lawn planting as follows:
   1. Prior to preparation of unchanged grades, remove existing grass, vegetation and turf. Dispose of such material outside of the Owner’s property; do not turn over into the soil being prepared for lawns unless specifically indicated to do so on the Contract Drawings.
   2. Till soil to a depth of not less than six inches.
   3. Apply soil amendments and initial fertilizers as recommended.
   4. Remove high areas and fill in depressions.
   5. Till soil to a homogeneous mixture of fine texture, free of lumps, clods, stones, roots and other extraneous matter.

3.03 SEEDING
   A. Do not use wet seed or seed which is moldy or otherwise damaged in transit or storage.
   B. Application Rate: Six pounds of seed per 1000 square feet.
   C. Dry Mechanical Application of Seed: Sow seed with Brillion seeder with notched rollers in three passes, second pass at 90 degrees to the first and the third at 45 degrees to the second. Sow at a rate of two pounds per 1000 square feet for each pass for a total of six pounds per thousand square feet. Incorporate the seed into the upper one inch of the prepared soil bed and water with a fine spray.
   D. Hydroseeding
      1. Apply seeding material 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. Maintain constant agitation to keep the contents in a homogeneous suspension. Prolonged delays in application or agitation that may cause injury to the seed will be the basis for rejection of the material remaining in the tank.
      3. Distribute uniformly a slurry mixture of water, seed, fertilizer and mulch at a minimum rate of 57 gallons per 1000 square feet. (2500 gallons per acre). The Owner’s Representative may order the amount of water increased if distribution of seeding materials is not uniform.

3.04 MULCHING
   A. Dry Application: Immediately following seeding operations cover seeded areas with a uniform blanket of shredded straw mulch mechanically blown at a rate of 100 pounds per 1000 square feet of seeded area.
   B. Hydro Application: Apply approved mulch in accordance with the manufacturer’s written instructions and recommended rates of application.

3.05 PROTECTION OF SEEDED AREAS
   A. Where grade is less than 3:1, mechanically spread mulch material and crimp into soil utilizing approved disc type machinery with rows at a 6” spacing.
   B. Where grade is 3:1 or greater, cover seeded areas with jute matting and roll matting down over the slopes without stretching or pulling.
      1. Lay the jute matting smoothly on the soil surface, burying the top end of each section in a narrow six inch trench. Leave a 12 inch overlap from the top roll over the bottom roll. Leave a four inch overlap over the adjacent section.
2. Staple outside edges and overlaps at 36 inch intervals.
3. Lightly dress slopes with topsoil to ensure close contact between the matting and the soil layer below.
4. In ditches, unroll matting in the direction of flow. Overlap ends of strips six inches with the upstream section on the top.

3.06 MAINTENANCE
A. Begin maintenance immediately after seeding. If seeded in the fall, continue maintenance the following spring until acceptable lawn conditions are established.
B. Water to ensure proper seed germination and to keep the surface of the seed bed damp. Continue watering new seeding until acceptance by the Owner. Apply water slowly so that the surface of the soil will not puddle or crust.
C. Cut grass for the first time when it reaches a height of 2½” and maintain a minimum height of 2”. Do not cut more than 1/3 of the blade at any one mowing. Remove clippings.
D. Apply herbicide as soon as weeds germinate, during calm weather when the air temperature is above 50 degrees F. using a licensed applicator to apply the herbicide. When using herbicides, apply in accordance with the manufacturer’s instructions.
E. Replant damaged grass areas showing root growth failure, deterioration, bare spots and eroded areas.
F. Refertilize newly seeded areas 28 days after the initial seeding. Apply a minimum of one pound of nitrogen per 1000 square feet of athletic field area. Use a complete fertilizer with a 2-1-1 ratio or as recommended by soil test results.

3.07 CLEANUP AND PROTECTION
A. During landscape construction work, keep pavements clean and the project area in an orderly condition.
B. Protect landscape construction and materials from damage due to landscape operations, operations by other contractors, trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged landscape construction as directed.

3.08 INSPECTIONS AND FINAL ACCEPTANCE
A. When seeding work and lawn establishment is completed, (including maintenance), request the Project Designer to make an inspection to determine acceptability. Final acceptance of lawn areas will be granted when a uniform stand of acceptable grass is obtained with a minimum of 95% coverage.
B. Where inspected lawn installation does not comply with the requirements of the Contract Documents, repair rejected work. The Contractor’s maintenance responsibility shall continue until reinspected by the Project Designer and found acceptable. Maintenance responsibilities shall include refertilization, overseeding, watering and mowing of seeded areas.

END OF SECTION
SECTION 32 9300
EXTERIOR PLANTS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Inspection of plant material
B. Preparation for planting
C. Installation of plants
D. Follow-up inspections and replacements of plants

1.02 RELATED SECTIONS
A. Section 31 0000 - Earthwork
B. Section 32 9200 - Lawns and Grasses

1.03 REFERENCES
A. Plant Nomenclature: Conform to the latest edition of “Standardized Plant Names” as adopted by the American Joint Committee of Horticultural Nomenclature.

1.04 DEFINITIONS
A. Weeds: Vegetative species other than specified species to be established in given area.
B. Plants: Living trees, shrubs, perennials, ground cover, and other plant material specified in this section.

1.05 SUBMITTALS
A. Comply with the requirements of Section 01 3300 and as modified below.
B. List of plants: Before plant material is shipped to the project site, submit a complete itemized list of all plants including the source of supply.
C. Product Data: Furnish the following with each planting material delivery:
   1. Invoice indicating sizes and varieties of plant material.
   2. Certificates of inspection required by State and Federal agencies.
   3. Labels for each plant or bundles of plants indicating name and size.
D. Quality Control Submittals
   1. Experience Listing: Submit a list of completed projects 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.
   2. Planting Soil Analysis Report: Submit planting soil analysis report for on-site stockpiled or imported planting soil. Do not mix or utilize planting soil until a soil analysis report is approved by the Project Designer.
      a. Provide required representative samples of planting soil materials proposed for use in the project to an independent testing agency for analysis and recommended treatment. Contractor shall pay for all costs incurred for testing and analysis of the soil material.
      b. Ensure test reports include specific recommendations regarding exact types, times and rates of application of soil additives and fertilizers based upon soil test results and type of material to be planted. Follow soil additive recommendations during all planting operations. Include the following in the planting soil analysis:
         1) pH factor
         2) Percent organic matter
         3) Soluble salts
4) Available macro and micro nutrients
5) Percent clay, sand and silt particles
c. Include in recommendations the type, rate and means of application of soil amendments and fertilizer necessary to establish the required pH factor, organic matter content and supply of nutrients satisfactory for planting.
d. All materials and procedures regarding soil amendments and fertilizers specified in this section are approximate; adjust all soil amendments to comply with the test reports.

E. Contract Closeout Submittals: Comply with the requirements of Section 01 7800.

1.06 QUALITY ASSURANCE

A. Worker’s Qualifications: The person’s performing the planting and their direct supervisor shall be personally experienced in the planting and caring of plant material. On site supervisory personnel shall have been employed by the company engaged in the planting and caring for a minimum of two years. All other individuals on the landscape crew must have a minimum of six months experience in the landscape contracting industry.

B. Tree Caliper
   1. Trees up to four inches in caliper shall be sized at a point six inches above the top of the root ball.
   2. Trees over four inches in caliper shall be sized at a point 12 inches above the top of the root ball.

C. Inspection: The Project Designer reserves the right to inspect plant material either at the nursery or on the project site before planting for compliance with the requirements for name, variety, size and quality.

1.07 DELIVERY, STORAGE AND HANDLING

A. Notify the Owner’s Representative a minimum of 48 hours in advance of delivery of plant material.

B. Do not make substitutions. If specified plant material is not obtainable, submit to the Project Designer proof of non-availability and a proposal for use of equivalent material. When authorized, adjustment of the contract amount will be made.

C. Protect plant material against climatic and mechanical injury.

D. Acceptance of Plant Material at the Project Site
   1. Provide freshly dug trees and shrubs. Do not prune prior to delivery. Do not bend or bind tie trees or shrubs in such a manner as to damage bark, break or destroy the natural shape of the plant material. Provide protective covering during delivery.
   2. Deliver trees and shrubs after preparations for planting have been completed and plant immediately. If planting is delayed more than six hours after delivery, set trees and shrubs in the shade, protect from weather and mechanical damage and keep roots moist.
   3. Label at least one tree and shrub of each variety with a securely attached waterproof tag bearing a legible description of the botanical and common name of the plant material.
   4. Reject plants when the ball of earth surrounding the roots has cracked or broken prior to or during the planting process.
   5. Reject plants when burlap, staves, and ropes required in connection with transplanting have been displaced prior to acceptance.

E. Deliver fertilizer in the manufacturer’s standard sized bags showing the weight, analysis, and manufacturer’s name. Store all fertilizer under a waterproof cover or in a dry place.

1.08 PROJECT CONDITIONS

A. Water: If available on the site, water will be supplied for the purpose of watering newly planted material at no cost to the contractor. If water is not available on site, the contractor shall supply water at their own cost as required for to maintain the health of the newly planted material.
B. Utilities: Determine the location of underground utilities and perform work in a manner avoiding possible damage, including required hand excavation. Maintain grade stakes set by others until removal is mutually agreed upon by all parties concerned.

C. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Owner’s Representative before planting.

1.09 PESTICIDE APPLICATIONS

A. Any contractor applying pesticides must notify the Owner’s designated pesticide representative and all property neighbors not less than 48 hours in advance of any pesticide application including herbicides, insecticides and fungicides in accordance State Regulations and the School Pesticide Neighbor Notification Law, Section 409-H of the New York State Education Law and Commissioner’s Regulation 155.24.

1.10 PLANTING GUARANTEE

A. The plant guarantee shall extend for a period of one full year from the date of substantial completion of the work. Substantial completion for the work of this section is the date when all planting operations or seasonal portions of the planting operations or replacement operations have been completed and are accepted by the Owner’s Representative or the Project Designer.

1. The Contractor shall arrange for and conduct a final inspection with the Owner or the Owner’s Representative at the end of the one year guarantee period.

2. Replace plant materials found dead or in an unhealthy or unsightly growing condition and that have lost their natural shape due to dead branches or other causes due to the Contractor’s negligence at the Contractor’s expense.

3. Replace with plant materials of the same size and species and with a new guarantee period commencing on the date of replacement.

4. Provide maintenance and additional watering for an additional 12 month period.

PART 2 PRODUCTS

2.01 PLANT MATERIALS

A. Shrubs and Trees: The Contractor shall provide plant material complying with the following:

1. Nursery grown stock as indicated in the itemized plant list or on the Contract Documents complying with the recommendations and requirements of ANSI Z60.1 “Standard for Nursery Stock” and as specified.

2. Acclimated plants true to genus and species grown in recognized nurseries in accordance with good horticultural practices.

3. Well developed root and branch systems. Do not prune branches before delivery.

4. Free of disease, insect eggs, bark abrasions, frost cracks, dead or broken branches and disfiguring knots.

5. Buds intact and reasonably closed at the time of planting.

6. Balled and burlapped from soil which will hold a natural ball. Manufactured balls are unacceptable.

7. Conform to size indicated or larger, or within the minimum/maximum size when so indicated. Larger plants cut back to specified dimensions will not be acceptable.

8. Specified trees shall have a single erect leader from ground to top, surrounded with uniformly arranged branches unless specifically noted otherwise.

9. Transplanted or root pruned 360 degrees at least once during the previous three years.

B. Ground Covers: Provide plants established and well rooted in removable containers with not less than the minimum length and number of runners required by ANSI Z60.1 for pot size shown and listed.

2.02 PLANTING SOIL

A. Use either approved planting soil imported to the project site or approved on-site topsoil stripped, stockpiled and amended to meet the required specifications.

1. Topsoil for Planting Soil meeting the following specifications: Sand 35%-60%, Silt 30%-35%, and Clay 10%-25%.
B. Soil Amendments (For every 4CY of topsoil):
   1. Peat Moss: 7½ CF bale (Approved compost material may be used as a substitute to peat moss).
   2. Fertilizer: 5lbs.

2.03 FERTILIZER
   A. 10-6-4 Commercial Fertilizer: Containing not less than 10% nitrogen, 6% available phosphoric acid and 4% water soluble potash. (Existing topsoil analysis shall be utilized to verify the actual fertilizer analysis to be used in this project)

2.04 MULCH
   A. Shredded Hardwood Mulch: Wood fiber produced from hardwood trees, free of tannic acid, leaves, young green growth, wood shavings, sawdust or other objectionable foreign material.

2.05 MISCELLANEOUS MATERIALS
   A. Stakes, Deadmen and Guy Stakes: Sound, durable white or red cedar or other approved wood, free of insect and fungus infestation.
   B. Guy Wire or Cable: No. 12 galvanized wire or cable.
   C. Tree Wrapping: 4 inch wide strips of jute burlap or waterproof paper.
   D. Protective Hose: Two-ply garden hose cut to required lengths to protect tree trunks from damage from wire.
   E. Anti-Desiccant: Emulsion type, film forming agent designed to permit transpiration but retard excessive loss of moisture from plants. Deliver in manufacturer’s fully identified containers and mix in accordance with the manufacturer’s instructions; similar to “Wilt-Pruf” by Wilt-Pruf products, Essex, CT.
   F. Landscape Fabric: Weather resistant, polypropylene sheeting complying with the permeability coefficient 0.0028 or 2.845 gal./sf/minute, minimum 30 mil thick; similar to “Weed Barrier” by DeWitt Co., Inc., Sikeston, MO.
   G. Edging
      1. Steel Edging: Commercial steel edging of size shown on the drawings fabricated in sections with loops pressed from or welded to the face of sections to receive stakes. Provide tapered steel stakes 16” long. Finish edging sections and stakes with manufacturer’s standard green-black paint; similar to Joseph T. Ryerson & Son Co., Inc., Chicago, IL.
      2. Polyethylene Edging: Heavy duty, commercial grade, pure black polyethylene, weighing 5 pounds per 20 foot length; 5¼” depth. Provide connecting plugs, steel spikes and overlap connections. Similar to “Edg-King Lawn Edging” by Oly-Ola Sales, Inc., Villa Park, IL.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Installer Verification of Conditions: Examine conditions under which landscape planting is to be completed 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. Planting Layout:
      1. Stake out all tree locations and planting areas.
2. Obtain layout approval from the Owner’s Representative prior to excavations of plant pits and beds.

B. Plant Pit Dimensions:
1. Balled and Burlapped Plants: Pit depth should not exceed the ball depth. The pit width measured at the ground surface shall be three times the width of the ball or as indicated.
2. Container Grown Plants: Two times the diameter of the container measured at the ground surface.
3. Ground Cover Beds: Excavate the entire planting bed to a depth of 4” and replace with amended planting soil.
4. Bare Root Plants: Diameter equal to the width of the roots spread to their natural position plus 24 inches, measured at the ground surface.
5. Hedge Trenches: 18 inches wide and 18 Inches deep.

C. Excavation: Excavate pits to the dimensions specified. Dispose of excavated material of the site unless otherwise directed.

3.03 PLANT INSTALLATION

A. Setting Plants
1. Backfill pits with planting soil and firm to the level upon which plants were previously growing. Set plants plumb. Plant budded or grafted plants two inches below the bud or graft line. Complete backfilling with planting soil and settle continually with water.
2. Balled Plants: Set plants in position and backfill 1/3 depth of ball. Remove burlap from the top and adjust to eliminate air pockets. Remove all metal caging and synthetic twine. Complete backfill and settle with water.
3. Bare-Root Plants: Set plant in position and place planting soil around roots settling with water. Use care to avoid bruising or breaking roots when firming the soil. Prune bruised or broken roots.
4. Ground Covers: Dig holes large enough for installation of ground cover material. Work soil around roots to eliminate air pockets. Water thoroughly after planting, taking care not to cover crowns of plants with wet soils. Mulch ground cover areas with a 2” layer of mulch.

B. Wrapping: Wrap deciduous trees within four days after planting from the ground line to the height of the second branches. Wrap in a single layer wound spirally starting from the base and overlapping 1½ inches. Secure wrapping in place by use of approved staples or other approved methods and materials.

C. Staking: Set tree stakes into solid ground below the bottom of the plant before backfilling. Place stakes at the outer edge of the roots or ball in line with the prevailing wind at a ten degree angle from the tree trunk.

D. Anti-Desiccant: Apply anti-desiccant spray to broadleaved ericaceous plants installed in the Fall season, as directed.

E. Landscape Fabric: Install over the planting area to the limits indicated. Cut fabric as required to avoid plants.

F. Surface Finish: Form saucer as indicated on drawings or as directed. Grade soil to form a basin on the lower side of sloped plantings, which will catch and retain water. Topdress basins with fertilizer spread evenly at a rate of 1½ pounds per square yard of plant pit surface.

G. Mulching: Spread a minimum of 4” of shredded hardwood mulch over the finished surface of each plant, plant bed or hedge trench. Water plants thoroughly after mulching is complete.

H. Pruning: Prune plant material immediately after planting using sharp tools approved by the Owner’s Representative. Remove approximately 1/3 of the wood of deciduous plants, maintaining the natural habit of the plant. Cut no leaders.

I. Guying: Secure deciduous trees two inches and over in caliper, multi-stemmed trees six feet and over in height, and evergreen trees six feet and over in height with minimum three guys.
Attach guy wires with protective hosing to stakes and trees as indicated. Connect multi-stemmed trees with protected wires maintaining each stems relationship to one another.

J. Establishment of Planting: Maintain plantings immediately following planting operations and continue throughout the warranty period. Establishment of plantings shall consist of keeping plants in healthy growing conditions by watering, weeding, cultivating, pruning, spraying, tightening of guys, remulching and by any other necessary operations for establishment. Water all plants at least once a week between April 1 and October 31 with approximately five gallons of water per square yard (one inch layer of water) per watering unless otherwise directed by the Owner’s Representative. Provide additional water during periods of dry weather when required or when directed. Treat plants with sound horticultural preventative or remedial measures to control insects, diseases and rodents.

K. Weeding: Schedule maintenance work at least three times during the growing season of the 12 month warranty period to keep planting areas free from weeds. Coordinate maintenance work with the Owner’s Representative.

3.04 CLEANUP AND PROTECTION

A. During landscape construction work, keep pavements clean and the project area in an orderly condition.

B. Protect landscape construction and materials from damage due to landscape operations, operations by other contractors, trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged landscape construction as directed.

3.05 INSPECTIONS AND REPLACEMENTS

A. Substantial Completion Inspection and Replacements: Notify the Owner’s Representative in writing at least ten days prior to the requested date of planting substantial completion inspection. Remove and replace dead, unhealthy, or badly impaired plants according to the original specification, if so directed. Replace plants during the next planting season if this inspection is not within a planting season.

B. End of Warranty Inspection and Replacements: Remove stakes, guy wires and tree wrapping at the end of the one year warranty period unless otherwise directed. Remove and replace dead, unhealthy or impaired plants according to the original specifications, as directed. Replace plants during the next planting season if this inspection is not within a planting season.

END OF SECTION
SECTION 33 0513
MANHOLES AND STRUCTURES

PART 1 GENERAL

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

1.02 PRICE AND PAYMENT PROCEDURES
A. See Section 01 2200 - Unit Prices, for additional unit price requirements.
B. Manhole: By the unit. Includes excavating, concrete base pad, concrete manhole sections, FRP manhole sections, brick masonry manhole construction, brick masonry transition to cover frame, cover frame and cover, to indicated depth, forming and sealing pipe inlets and outlets.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manhole covers, component construction, features, configuration, and dimensions.
C. Shop Drawings: Indicate manhole locations, elevations, piping sizes and elevations of penetrations.
D. Manufacturer’s Qualification Statement.

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

PART 2 PRODUCTS

2.01 MATERIALS

2.02 COMPONENTS
A. Lid and Frame: ASTM A48/A48M, Class 30B Cast iron construction, machined flat bearing surface, removable lockable lid, closed lid design; H-20 load rated; sealing gasket; lid molded with identifying name. Provide Weather tight Lid and Frame manufactured by EJ, Nina or Approved Equal.
B. Manhole Steps: Formed galvanized steel rungs; 3/4 inch (19 mm) diameter. Formed integral with manhole sections.

2.03 CONFIGURATION
A. Shaft Construction: Concentric with concentric cone top section; lipped male/female dry joints; sleeved to receive pipe sections.
PART 3 EXECUTION

3.01 EXAMINATION

A. Verify items provided by other sections of Work are properly sized and located.
B. Verify that built-in items are in proper location, and ready for roughing into Work.
C. Verify excavation for manholes is correct.

3.02 MANHOLES

A. Place concrete base pad, trowel top surface level.
B. Place manhole sections plumb and level, trim to correct elevations, anchor to base pad.
C. Cut and fit for pipe.
D. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour as required.
E. Set cover frames and covers level without tipping, to correct elevations.
F. Coordinate with other sections of work to provide correct size, shape, and location.

END OF SECTION
SECTION 33 1116
SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Pipe and fittings for site water lines including domestic water lines and fire water lines.
B. Valves, Fire hydrants, and Domestic water hydrants.

1.02 REFERENCE STANDARDS
A. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
D. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.
F. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service; 2009.
G. AWWA C502 - Dry-Barrel Fire Hydrants; 2014.
H. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances; 2010.
I. UL 246 - Hydrants for Fire-Protection Service; Current Edition, Including All Revisions.

1.03 SUBMITTALS
A. See Section 01 3300 for submittal procedures.
B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.
C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
D. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.
E. Hydrostatic test results.
F. Fluorocarbon coated T-bolts.
G. Concrete mix design for thrust restraint at HDPE-to-DIP connections.
H. Reinforcing shop drawing for thrust restraint at HDPE-to-DIP connections.
I. PE wall anchor.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Deliver and store valves in shipping containers with labeling in place.
B. Pipe and accessories shall be handled in such manner as to insure delivery to the trench in sound, undamaged condition. If coating or lining of any type of pipe or fitting is damaged, repairs shall be made as necessary. No other pipe or material shall be placed inside of a pipe or fitting after coating has been applied. Rubber gaskets that are not to be installed immediately, shall be stored in a cool, dark place.
C. Polyethylene piping shall be handled carefully with any gouge larger than 10% of the pipe wall removed from the trench and taken off site.

PART 2 PRODUCTS

2.01 WATER PIPE
A. Ductile Iron Pipe: AWWA C151:
   1. Ductile Iron Water Pipe: Ductile iron pipe shall conform to the latest revision of AWWA Specifications C151 cement lined with slip-type single rubber gasket joints or mechanical joints, as follows:
      a. 4 in. Class 51.
b. 6 in. Class 50.
c. 8 in. Class 50.
d. 10 in. Class 50.
e. 12 in. Class 50.

2. Joints and Fittings: Use ANSI/AWWA C110 and C153 fittings except ductile iron only, ANSI/AWWA rubber gasket joints. Use flanged joint bolts, nuts, and gaskets conforming to ANSI/AWWA C110, Appendix A.

3. Use ring gaskets for pipe sizes 14 inches and larger. Do not use flanged joints for underground installation unless so specified. Unless otherwise specified, use fittings with a standard cement mortar lining per ANSI/AWWA C 104.

4. Unless otherwise specified, use ductile iron fittings with a rated working pressure of at least 250 psi.

5. Restrained joints (those types which provide thrust restraint without the use of the rods or thrust blocks) may be used provided that:
   a. The joints conform to ANSI/AWWA C111 and ANSI/AWWA C151.
   b. The rated working pressure of the restrained joint is at least 250 psi for 24 inch diameter and smaller or 200 psi for 30 inch diameter and larger.
   c. Joint restraint is adequate to resist the maximum hydrostatic force developed at the full working pressure specified above.
   d. The wall thickness of any pipe or fitting which is grooved to accept a lock ring is increased to compensate for the depth of the groove.

6. Unless otherwise specified use Fluorocarbon T-bolts.

B. Polyethylene Encasement for Ductile Iron Pipe
   1. Polyethylene encasement for use with ductile iron pipe shall meet all the requirements for ANSI/AWWA C105/A21.5, Polyethylene Encasement for Ductile Iron Pipe Systems.
   2. In addition, polyethylene encasement for use with ductile iron pipe systems shall consist of three layers of co-extruded linear low density polyethylene (LLDPE), fused into a single thickness of not less than 8 mils.
   3. The inside surface of the polyethylene wrap to be in contact with the pipe exterior shall be infused with a blend of anti-microbial biocide to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion.
   4. Ductile iron pipe and the polyethylene encasement used to protect it shall be installed in accordance with AWWA C600 and ANSI/AWWA C105/A21.5 and also in accordance with all recommendations and practices of the AWWA M41, Manual of Water Supply Practices - Ductile Iron Pipe and Fittings. Specifically, the wrap shall be overlapped one foot in each direction at joints and secured in place around the pipe and any wrap at tap locations shall be taped tightly prior to tapping and inspected for any needed repairs following the tap.
   5. All installations shall be carried out by personnel trained and equipped to meet these various requirements.

C. Copper Tubing: ASTM B88, Type K, annealed:
   2. Joints: Compression connection or AWS A5.8M/A5.8, BCuP silver braze.

D. HDPE Piping:
   1. HDPE piping shall conform to AWWA C901 and 906 and be PE 3608 in accordance with ASTM D 3350 (minimum 160 psi rating)
   2. The pipe shall be color coded for intended use. A blue stripe shall be used for water pipe and a green stripe for sanitary sewer pipe.
   3. All fittings, butt fusion connections, and electrofusion connections must be of equal or greater pressure rating than pipe.
   4. HDPE services shall be installed using fusion saddle tapping tees. The tapping tees shall have integral brass corporation cutters.
   5. Compression connections of polyethylene pipe shall be constructed using stainless steel inserts for reinforcement.
6. All fabricated piping and fittings shall be from the same pipe manufacturer.

7. Fusion Joining:
   a. Pipe shall be joined by the fusion welding process. The welders must use the manufacturers instructions and procedures.
   b. Electro-fusion couplings shall be allowed where typical fusion welding is impractical. Mechanical joints can be used at the direction of the Engineer.
   c. All fusion welders must be qualified per the Department of Transportation, Code of Federal Regulations Title 49 Part 192.285.
   d. The alignment and profile of the main shall be as shown on the Contract Drawings. All tees and valves shall be level and correctly installed not causing undo stress on the fitting. If fitting is oriented incorrectly due to improper installation or contraction and expansion of the polyethylene pipe, fitting shall be removed and correctly installed.

8. Tracer Wire:
   a. Tracer wire shall be required on all non-ferrous water mains and services.
   b. Tracer wire shall be 12 AWG copper wire coated with 30 mil polyethylene jacketed designed specifically for buried use.
   c. Tracer wires shall be interconnected at all pipe tees, pipe crosses, and pipe services. Splices in the tracer wire shall be connected by means of a split bolt or compression type connector to ensure continuity. Wire nuts shall not be used. A waterproof or corrosion proof connector shall be used.
   d. Tracer wire shall be placed outside the curb stop riser and be wrapped around the top of the riser. At all 6" gate valves to hydrants, SDR-35 PVC shall be installed to protect the tracer wire as shown on the details.
   e. Tracer wire shall be attached to the top of the pipe at 10 feet intervals and at all crosses, tees, and elbows.
   f. After backfill and compaction, but prior to paving, continuity testing of the tracer wire will be required. Any detected damages to tracer wire shall be repaired.

2.02 VALVES

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Gate Valves:
   1. Resilient seated gate valves for sizes 3 inches through 16 inches shall be manufactured and tested to the requirements of AWWA Standards C509 (cast iron), C515 (ductile iron), and C500 (most recent revisions) as applicable for a design working pressure of 250 psi. This pressure rating shall be cast on the outside of the valve.
   2. Gate valves are to be manufactured by Kennedy, Mueller, U.S. Pipe, or approved equal.

C. Lateral Valves
   1. Shall be compression type conforming to AWWA C800.
   2. Corporation stops: Model B-25008N by Mueller or approved equal.
   3. Curb stops with riser boxes: Model H 15209N by Mueller, Ford, A.Y. McDonald, or approved equal.
   4. Household PRV Model 25AUB (option 23 for meter pit installations) by Watts, B7-12 by Bell & Gossett, or approved equal.

D. Pressure Reducing Valves
   1. 8" Diameter
      a. Operation: The 8" diameter pressure reducing valve with cushioned check feature and low differential design shall reduce a high incoming pressure to a lower, constant discharge pressure regardless of variations in upstream pressure or flow rate. In addition, the cushioned check feature in the external control piping shall cause the valve to close at a controlled rate on pressure reversal.
      b. Design:
         1) The pressure reducing valve shall be flanged body, fully mounted, external pilot operated, with free floating piston (operated without springs, diaphragm or levers), single seat with seat bore equal to size of valve. The minimum travel of
the piston shall be equal to 25% of the diameter of the seat. For true alignment, the piston shall be guided above and below the seat a distance equal to no less than 75% of the diameter of the seat to correct lateral thrust and stem binding. Piston shall be cushioned and so designed as to insure positive closure. The main valve shall be packed with leather (or other soft material) to insure tight closure and prevent metal-to-metal friction and seating. Furnished with indicator rod and stuffing box to show position of piston opening. The design shall be such that repairs and dismantling internally of main valve may be made without its removal from the line.

2) The hydraulic pilot(s) with a range for adjustment and controlling the operation of main valve, shall be easily accessible, and so arranged with isolation ball valves to allow for its removal from the control circuit while the main valve is under pressure. An external strainer with flushing cock shall be provided in the control circuit to protect the pilot and speed control valve(s).

3) The external controls and associated rigid brass piping/fittings necessary for proper operation (except the separate static pressure sensing line if required), shall be factory assembled and furnished with the main valve. Brass bushings with gauge cock on inlet and outlet of main valve to receive pressure gauges for testing purposes.

c. Physical and Chemical Properties:
1) Valve body and caps shall be constructed of gray iron castings that conform to ASTM Specification A 126 Class B, ductile iron castings that conform to ASTM Specification A536-84, or steel castings that conform to ASTM Specification A216 Grade WCB.

2) Bronze parts shall conform to ASTM Specification B-62. Stainless parts shall conform to ASTM Specification A743 Grade CF-8 or CF-8M. The main cylinder (Main Bushing - Part #14) shall be Teflon coated bronze. Teflon coated parts shall receive two coats of Teflon TFE with a minimum thickness of 10 mils.

3) The flanged assemblies shall conform to ANSI standards for wall thickness of body and caps, and flange thickness and drilling, subject to other specified standards.

d. Tests: A hydrostatic test shall be performed at the factory prior to shipment. The valve shall be tested to two (2) times the working pressure, maximum 500 psi testing pressure, subject to contract. The valve performance and hydrostatic tests may be witnessed by the Customer/Engineer or Representative.

e. Painting:
1) Ferrous surfaces of valve shall be coated with NSF Certified Epoxy (Tnemec Series FC20) in accordance with ANSI/NSF Std. 61, and conforms to AWWA D102 Inside System No. 1.

2) Valve shall be equal in all respects to the Model 40WR-CR-LD Figure 9 as manufactured by the Ross Valve Mfg. Co., Inc. or equal.

2. 2" Diameter
a. Operation: The 2" diameter pressure reducing valve with cushioned check feature shall reduce a high incoming pressure to a lower, constant discharge pressure regardless of variations in upstream pressure or flow rate. In addition, the cushioned check feature in the external control piping shall cause the valve to close at a controlled rate on pressure reversal.

b. Design:
1) The pressure reducing valve shall be globe body with flanged FNPT end connections, fully mounted, external pilot operated, with free floating piston (operated without springs, diaphragm or levers), single seat with seat bore equal to size of valve. The minimum travel of the piston shall be equal to 25% of the diameter of the seat. Piston shall be cushioned and so designed as to insure positive closure. The main valve shall be packed with leather (or other soft material) to insure tight closure and prevent metal-to-metal friction and seating.
Furnished with indicator rod to show position of opening of the piston, and pet-cocks for attachment to valve body for receiving gauges for testing purposes. The design shall be such that repairs and dismantling internally of main valve may be made without its removal from the line.

2) The hydraulic pilot, controlling operation of main valve, shall have a range for adjustment, be easily accessible, and so arranged to allow for its removal from the main valve while the main valve is under pressure. An external strainer with flushing cock shall be provided in the control circuit to protect the pilot and speed control valve(s).

3) The external controls and all associated rigid brass piping and fittings necessary for proper operation (except the separate static pressure sensing line if required), shall be factory assembled and furnished with the main valve.

c. Physical and Chemical Properties:
1) Valve shall be constructed of gray iron castings that conform to ASTM Specification A 126 Class B.
2) Bronze parts shall conform to ASTM Specification B-62. Stainless parts shall conform to ASTM Specification A743 Grade CF-8 or CF-8M. Teflon coated parts shall receive two coats of Teflon TFE with a minimum thickness of 10 mils.
3) The flanged assemblies shall conform to ANSI standards for wall thickness of body and caps, and flange thickness and drilling, subject to other specified standards.

d. Tests: A hydrostatic test shall be performed at the factory prior to shipment. The valve shall be tested to two (2) times the working pressure, maximum 500 psi testing pressure, subject to contract. The valve performance and hydrostatic tests may be witnessed by the Customer/Engineer or Representative.

e. Painting:
1) Ferrous surfaces of valve shall be coated with NSF Certified Epoxy in accordance with ANSI/NSF Std. 61, and conforms to AWWA D102 Inside System No. 1.
2) Valve shall be equal in all respects to the Model 40 WR-CR-LD Figure 9 as manufactured by the Ross Valve Mfg. Co., Inc., an equivalent product as manufactured by Watts, or an approved equal.

2.03 HYDRANTS

A. Hydrants: AWWA C502, UL 246, dry barrel type.
1. Inside dimension: 7 inches (175 mm) minimum, with minimum 5 inches (125 mm) diameter valve seat opening.
2. Minimum net water area of barrel not less than 190 percent of valve opening.
3. 6 inch (150 mm) bell or mechanical joint inlet connection with accessories, gland bolts, and gaskets.
4. Product: K81 by Kennedy, Super Centurion by Mueller, Medallion by Clow, or approved equal.

B. Hydrant Extensions: Fabricate in multiples of 6 inches (150 mm) with rod and coupling to increase barrel length.

C. Hose and Streamer Connection: Two hose nozzles, one pumper nozzle.

D. Finish: Primer and two coats of enamel in red.

E. Blow Off Hydrant
1. Blow-off hydrants shall be Eclipse No. 2 Post Hydrants as manufactured by John C. Kupferle Foundry Company, St. Louis, MO, MT 200 as manufactured by Murdock Inc., Cincinnati, Ohio, or approved equal.
2. Hydrants shall be self-draining, non-freezing, compression type with 2-3/16" main valve opening. Inlet connection shall be 3" MJ. Outlet shall be 2-1/2" NST.
3. Hydrants shall have a 3" ductile iron pipe riser with a cast iron stock top, and non-turning operating rod. Principal interior operating parts shall be brass and removable from the hydrant for servicing without excavating the hydrant.

4. Hydrants shall be set in 4 cubic feet of crushed stone to allow for proper drainage of the hydrant. Recommendations of the AWWA should be followed when installing the hydrants.

2.04 INSERTION VALVES FOR PIPE SIZES 4" THROUGH 12"

A. Scope
1. This specification covers the furnishing, complete valve insertion system.

B. Equipment Capability
1. The equipment shall be capable of installation, without shutdown, at one location, of pipe sizes, in the range of 4" to 12" diameters. The capabilities specified herein are minimum requirements that must be met by any insertion equipment or insertion valve offered.

C. The valve shall be capable of pressure-tight assembly to exterior of the pipe in which flow is to be stopped at a working pressure not to exceed 250 psi.

D. The valve assembly shall be designed as to be easily rotated 120 degrees, perpendicular across the top of the pipe, while riding on two (2) separate rubber gaskets, constructed of EPDM or SBR, by using a perpendicular rotary feed mechanism, driven by a chain.

E. The valve shall be constructed of a two (2) piece, ductile iron casting (top and bottom), to be bolted together, using ductile iron bolts with zinc alloy anodes (corrosion protection), manufactured to the ductile iron specification of ASTM 536 65-45-12.

F. The valve shall meet or exceed AWWA Specification C509 for resilient seal valves suitable for potable water service.

G. The ductile iron gate shall have a resilient rubber seal 360 degrees around the gate and is expandable to the ID (inside diameter) of the pipe.

H. The valve stem shall be made of stainless steel 1 CR 12, with a tensile strength of 60,000 psi.

I. The valve body shall have an epoxy/E coating of no less than 8 mils.

J. The valve shall use stainless steel fasteners joining the valve bonnet to the valve top casting.

K. The final restraint fasteners (360 degree) around the valve casting shall be constructed of stainless steel 304.

L. Design of the valve shall be such that the valve shall have a satisfactory seal against the pipe exteriors in the following ranges, by using multiple gaskets if necessary:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Diametrical Range</th>
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</thead>
<tbody>
<tr>
<td>4&quot;</td>
<td>4.40 - 4.60</td>
</tr>
<tr>
<td>4&quot;</td>
<td>4.80 - 5.00</td>
</tr>
<tr>
<td>6&quot;</td>
<td>6.40 - 6.80</td>
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<td>6&quot;</td>
<td>6.70 - 7.10</td>
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<td>8.35 - 8.75</td>
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<td>8.95 - 9.35</td>
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<td>12.65 - 12.85</td>
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<tr>
<td>12&quot;</td>
<td>13.20 - 13.50</td>
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2.05 STAINLESS STEEL TAPPING SLEEVES

A. The stainless steel band flange shall be manufactured in compliance with AWWA C207, Class D ANSI B.16.1 drilling, recessed for tapping valve MSS-SP60. Mechanical joint tapping sleeve outlet shall meet or exceed all material specifications as listed below and be suitable for use
with standard mechanical joint by mechanical joint resilient wedge gate valves per ANSI/AWWA C509-94 and be NSF 61 approved.

B. Stainless steel tapping sleeves are not permitted for size on size tapping applications. Ductile iron tapping sleeves must be used.

C. Tapping sleeves to be attached to 4" through 12" nominal pipe diameter shall meet the following minimum requirements.
   1. The entire fitting shall be stainless steel type 304 (18-8). The body, lug, and gasket armor plate shall be in compliance with ASTM A240. The flange shall be cast stainless steel in compliance with ASTM A743. The MJ outlet shall be one-piece casting made of stainless steel. The test plug shall be 3/4" NPT in compliance with ANSI B2.1 and shall be lubricated or coated to prevent galling. All metal surfaces shall be passivated after fabrication in compliance with ASTM A-380.
   2. The gasket shall provide a 360-sealing surface of such size and shape to provide an adequate compressive force against the pipe after assembly, to affect a positive seal under the combinations of joint and gasket tolerances. The materials used shall be vulcanized natural or vulcanized synthetic rubber with antioxidant and antiozonant ingredients to resist set after installation. No reclaimed rubber shall be used. A heavy-gauge-type 304-stainless armor plate shall be vulcanized into the gasket to span the lug area.
   3. The lugs shall be heliarc welded (GMAW) to the shell. The lug shall have a pass-through-bolt design to avoid alignment problems and allow tightening from either side of the main. Bolt shall NOT BE integrally welded to the sleeve. Finger lug designs are not approved; it is the intent of these specifications to allow a tapping sleeve that has a lug design similar to the approved models.
   4. Bolts and nuts shall be type 304 (18-8) stainless steel and Teflon coated or as specified in the bolt section below at the discretion of the Engineer. Bent or damaged units will be rejected.
   5. Quality control procedures shall be employed to insure that the shell, lug, (4" and larger nominal pipe diameter) armor plate, gasket and related hardware are manufactured to be free of any visible defects. Each unit, after proper installation, shall have a working-pressure rating up to 250 psi.
   6. The sleeve construction shall provide a positive means of preventing gasket cold flow and/or extrusion.
   7. Each sleeve shall be stenciled, coded or marked in a satisfactory manner to identify the size range. The markings shall be permanent type, water resistant, that will not smear or become illegible.

2.06 BEDDING AND COVER MATERIALS
   A. Bedding: As specified in Section 31 2316.13.
   B. Cover: As specified in Section 31 2316.13.

2.07 JOINT RESTRAINT: THE CONTRACTOR HAS THE OPTION OF UTILIZING TIE ROD AND CLAMP OR CONCRETE THRUST BLOCK FOR JOINT RERAINTS.
   A. Tie Rods and Clamps: Use tie rod and clamp system conforming to Series 1300/1390 as manufactured by Uni Flange, MEGA LUG, or approved equal.
   B. Concrete Thrust Blocks: Use concrete conforming to ASTM C94 having a maximum slump of 4 inches and a minimum compressive strength of 2000 psi at 28 days.
   C. Connections to hydrant shoe when using polyethylene pipe shall utilize mechanical joint adapter butt fused on 6" PE main. Standard mechanical joints with stainless steel inserts will not be allowed for hydrants.
2.08 WATER FOR HYDROSTATIC TESTING, FLUSHING AND DISINFECTION:

A. The Contractor shall be responsible for providing potable water for cleaning and testing. The contractor shall coordinate with the Owner prior to the use of on-site water source and be responsible for all costs associated with the use of on-site water should the Owner allow its use.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

3.02 PREPARATION

A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

B. Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise recommended by the manufacturer and authorized by the engineer, cutting shall be done with an approved type mechanical cutter. Wheel cutter shall be used when practicable.

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

D. Prepare pipe connections to equipment with flanges or unions.

3.03 TRENCHING

A. As specified in Section 31 2316.13.

3.04 INSTALLATION - PIPE

A. Handling: Pipe and accessories shall be handled so as to insure delivery to the trench in sound, undamaged condition. Particular care shall be taken not to injure the pipe coating or lining. If the coating or lining of any pipe or fitting is damaged, the repair shall be made by the Contractor at his expense in a satisfactory manner. No other pipe or material of any kind shall be placed inside a pipe or fitting after the coating has been applied. Pipe shall be carried into position and not dragged. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects.

B. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Owner. Rubber gaskets that are not to be installed immediately shall be stored in a cool and dark place.

C. Sewer Lines: Where the location of the water pipe is not clearly defined in dimensions on the drawings, the water pipe shall not be laid closer horizontally than 10 feet from a sewer pipe.

D. Where water lines cross gravity-flow sewer lines, the water pipe shall be laid with a minimum separation distance of 18 inches for 10 feet each side of sewer pipe.

E. Install ductile iron piping and fittings to AWWA C600.

F. Route pipe in straight line.

G. Install pipe to allow for expansion and contraction without stressing pipe or joints.

H. HDPE Piping by directional drill - Installation of all pipe, fittings, specials, adapters, and appurtenances shall conform to the manufacturer's recommendations and the following summary of installation recommendations. Where specifications and recommendations conflict, the strictest shall apply.

1. Documented qualifications of the Contractor performing the directional drilling shall be submitted for review, including a list of completed projects within the last five years with names, addresses, telephone and facsimile numbers for these reference projects. Contractor shall have construction experience of at least five years in directional drilling. Construction experience shall be for drills of similar size as to the ones planned, including
water crossings. Owner reserves the right to reject without penalty the proposed Contractor that does not meet the prior experience requirement.

2. Proper implements, tools, and facilities satisfactory to the Engineer shall be provided and used by the Contractor for the safe and convenient prosecution of the work.

3. All butt fusion and extrusion welding of HDPE pipe and fittings shall be accomplished by proper equipment and operated in a thoroughly workman manner and shall be in conformance with ASTM D 3261. All equipment must be in good repair and shall have manufacturer's written instructions and fusion pressures.

4. The Contractor shall employ only skilled welders capable of meeting the qualifications set forth by the manufacturer's specifications or technical training department.

5. All fabricated piping and fittings (shall be the same pipe manufacturer) shall be the product of a well equipped fabricating shop employing skilled tradesman.

6. No field fabricating of fittings will be allowed.

7. The alignment and profile of the main shall be as shown on the contract plans. The vertical profile as shown on the drawings is the minimum depth to which the pipe line shall be installed. The Contractor may at his option and with the permission of the Engineer elect to install the pipe at greater depth at no additional cost to the Owner.

8. The rig side work space and the pipe side work space shall be determined subject to the approval of the Engineer. The working areas should not encroach on private property or interfere with existing schedule.

9. Prior to beginning construction, the Contractor shall submit to the Engineer a detailed drilling procedure for installation of the crossing, a drill site layout drawing and a proposed work schedule.

10. The Contractors attention is directed to the environmental constraints and restrictions in the permits and elsewhere herein. He is advised that all of his operations must be conducted in strict conformance and adherence thereto, all to the satisfaction of the Engineer.

11. Special care in handling shall be exercised during delivery and distribution of pipe to avoid damage. Damaged pipe shall be rejected and replaced at the Contractor's expense. The pipe shall be stored prior to use in such a manner as to keep the interior free from dirt and foreign matter. Any pipe that becomes contaminated shall be hand cleaned and washed before it is incorporated in the work.

12. The Contractor shall haul, heat fuse joints and hydrostatically test the pipeline in one section.

13. The drilling operation shall be directed using steering and tracking systems capable of producing the required alignment. The control system shall provide an angle of inclination reading and the direction in which the cutting tool is pointed. The Engineer shall have access at all times to measuring or gauging devices used for the horizontal drill including drilling logs maintained by the Contractor. Drilling logs are to be submitted to the Engineer as part of the Record Drawings. The Contractor shall mobilize the drilling equipment, erect the rig, drill a pilot hole, enlarge the hole as necessary and pullback the prefabricated pipe string through the borehole. The pipeline shall be adequately supported on rollers during pullback of the pipeline into the pre-drilled hole. The rollers and cradles shall be of a type that will prevent damage to the pipeline and will be of sufficient number to prevent over stressing during the pullback procedure. Pullback equipment shall be adequate for the required thrust. Procedures should be taken to avoid bentonite leakage. The Contractor shall supply water for mixing drilling fluid, and shall supply portable mud tanks or construct temporary mud pits to contain excess drill fluids during construction. Upon completion of the crossing, the Contractor shall dispose of any drill cuttings and excess drill fluids in a manner consistent with the local and state regulations.

14. In the event that the Contractor must abandon the drill hole before completion of the crossing, the Contractor shall seal the borehole and redrill the crossing at the Contractors expense.

15. Reinforced concrete anchors used as thrust restraints at HDPE-to-DIP connections shall be constructed utilizing the following:
a. Concrete shall have a minimum 28-day compressive strength of 3,000 psi, an air content of 5% (+/-1%), and a slump of 4” or less. Type I cement shall be used and the maximum water to cementitious material ratio shall be 0.50.
b. Reinforcing steel shall be ASTM A615, Grade 60 uncoated deformed bars tied down with 16 gage tie wire and supported using plastic chairs.
c. Formwork: The sides and bottom of the trench may be used as the forms for these locations. Formwork perpendicular to the pipe shall be good quality plywood or prefabricated forms.

3.05 INSTALLATION - VALVES AND HYDRANTS
A. Set valves on solid bearing.
B. Center and plumb valve box over valve. Set box cover flush with finished grade.
C. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway.
D. Set hydrants to grade, with nozzles at least 20 inches (500 mm) above ground.
E. Provide a drainage material consisting of 2 inches washed gravel to 6 inches above drain opening. Do not connect drain opening to sewer.

3.06 FIELD QUALITY CONTROL
A. Leakage Test: All pipe line shall be tested hydrostatically for 2 hours at a pressure 50 percent in excess of the pressures to which the pipe will normally be subjected, unless different test pressures are outlined in the Special Requirements; but in no case less than 150 pounds per square inch (psi). Any obvious leaks or ruptured piping disclosed by the tests shall be repaired or replaced, and the test repeated to the engineer's satisfaction.
1. The contractor shall accomplish the required tests on the pipeline by individually testing each component section of main designed by the Engineer. The Maximum length of section permitted to be tested at any one time will be approximately one mile, and normally will be less. All water for tests shall be furnished and disposed of by the Contractor at his expense. Source and/or quality of water which the contractor proposes to use in testing the lines shall be acceptable to the Engineer.
2. Leakage tests shall be conducted concurrently with the pressure tests. The duration of each test shall be at least two hours in length to coincide with the time of the pressure test. Leakage test shall be repeated as often as necessary until the leakage requirement is met.
3. Leakage is defined as the quantity of water that must be supplied into a newly laid pipe or any valved section thereof to maintain the pressure within 5 psi of the test pressure after all the air in the pipeline has been expelled and the pipeline filled with water.
   a. Allowable leakage will be determined by the formula:
      1) \[ L = \frac{SD(P)^{1/2}}{148,000} \]
      in which L is the allowable leakage in gallons per hour (gph); S is the length of pipeline tested in feet; D is the nominal pipe diameter in inches; and P is the average test pressure during the leakage test in pounds per square inch gage (psig).
   b. Pressure testing for HDPE mains shall be per manufacturer's recommendations or as follows:
      1) Gradually pressurize the test section to test pressure. Initial test pressure shall be allowed to stand without makeup pressure for three (3) hours, to allow for diametric expansion or pipe stretching to stabilize.
      2) After this equilibrium period, apply the specified test pressure. The final test pressure shall be held for 2 hours, monitoring the amount of make-up water required to maintain test pressure.
      3) Allowable leakage shall be determined from the chart below, Make-up Water Allowance, Technical Note 802, published by Performance Pipe.

<table>
<thead>
<tr>
<th>Nominal Pipe Size (in.)</th>
<th>Make-Up Water Allowance - 2 Hour Test (US Gal/100 ft of pipe)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. When testing against closed metal-seated valves, an additional leakage per closed valve of 0.0078 gal/hr/inch of nominal valve size shall be allowed. Also, where hydrants occur within a test section, the hydrant valve shall be closed.

5. Acceptance of individual sections shall be determined upon the basis of allowable leakage. If any tests disclose leakage in excess of the allowable, the contractor shall repair each deficient section and retest them until they fall within the allowable range. The cost of repairs and retesting shall be an expense of the Contractors.

6. All visible leaks are to be repaired regardless of the amount of leakage in the section.

7. Time for Making test: Except for joint material setting or where concrete reaction backing necessitates a 5-day delay, pipe lines jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected and tested for leakage at any time after partial completion of backfill.

8. Hydrostatic tests and disinfection may be conducted concurrently, using the water treated for disinfection to accomplish the hydrostatic tests. For disinfection requirements, see Section 33 1300.

9. If water is lost when treated for disinfection and air is admitted to the unit being tested, or if any repair procedure results in contamination of the unit, disinfection shall be re-accomplished.

B. Test shall be performed in accordance with AWWA C600.

3.07 QUALITY CONTROL

A. The Contractor shall establish and maintain quality control for operations under this section to assure compliance with contract requirements and maintain records of his quality control for all materials, equipment and construction operations including but not limited to the following:

1. Hydrostatic tests
2. Jointing
3. Prevention of damage to pipe coating and lining.

B. Temporary Plugging: At all times when pipe laying is not actually in progress, the open ends of the pipes shall be closed temporarily with pipe plugs or by other means. If water is in the trench when work is resumed, the plugs shall not be removed until all danger of water entering the pipe has passed.

C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

3.08 CLEANING

A. Cleanup: Upon completion of the installation of the water distribution lines and water service lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.

B. Cleaning Pipeline: At the conclusion of the work and prior to disinfection of the water main, the Contractor shall thoroughly clean all new pipes by flushing with water or other means to remove all dirt, stones, pieces of wood, etc., which may have entered during the construction period. If, after this cleaning, any obstructions remain, they shall be corrected to the satisfaction of the Engineer. Pipes shall be flushed at a rate of 2.5 feet per second for a duration suitable to the Engineer.

END OF SECTION
SECTION 33 1300
DISINFECTING OF WATER UTILITY DISTRIBUTION

PART 1 GENERAL
1.01 SECTION INCLUDES
A. Disinfection of site domestic water lines and site fire water lines specified in Section 33 1116.
B. Testing and reporting results.

1.02 RELATED REQUIREMENTS
A. Section 33 1116 - Site Water Utility Distribution Piping.

1.03 REFERENCE STANDARDS
A. AWWA B300 - Hypochlorites; 2011.
B. AWWA B301 - Liquid Chlorine; 2010.
C. AWWA C651 - Disinfecting Water Mains; 2005.

1.04 SUBMITTALS
A. See Section 01 3300 for submittal procedures.
B. Test Reports: Indicate results comparative to specified requirements.
C. Disinfection report:
   1. Type and form of disinfectant used.
   2. Date and time of disinfectant injection start and time of completion.
   3. Test locations.
   4. Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
   5. Date and time of flushing start and completion.
   6. Disinfectant residual after flushing in ppm for each outlet tested.
D. Bacteriological report:
   1. Date issued, project name, and testing laboratory name, address, and telephone number.
   2. Time and date of water sample collection.
   3. Name of person collecting samples.
   4. Test locations.
   5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
   6. Coliform bacteria test results for each outlet tested.
   7. Certification that water conforms, or fails to conform, to bacterial standards of New York State Department of Health.

1.05 QUALITY ASSURANCE
A. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this Section with minimum three years documented experience.
C. Submit bacteriologist’s signature and authority associated with testing.

PART 2 PRODUCTS
2.01 DISINFECTION CHEMICALS
A. Chemicals: AWWA B300, Hypochlorite and AWWA B301, Liquid Chlorine.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that piping system and water well has been cleaned, inspected, and pressure tested.
B. Schedule disinfecting activity to coordinate with start-up, testing, adjusting and balancing, demonstration procedures, including related systems.

3.02 DISINFECTION
A. Use method prescribed by the applicable state or local codes, or health authority or water purveyor having jurisdiction, or in the absence of any of these follow AWWA C651.
B. Provide and attach equipment required to perform the work.
C. Inject treatment disinfectant into piping system using the continuous feed method at minimum 50 mg/L free chlorine residual.
D. Maintain disinfectant in system for 24 hours. Free chlorine residual shall be no less than 25 mg/L at the conclusion of the 24 hour disinfection.
E. Operate all valves in the section being tested to ensure disinfection of the appurtenances.
F. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.
G. Collect samples for bacteriological analysis in accordance with AWWA C651.
H. Repeat procedure if minimum free chlorine residual or bacteriological results are not satisfactory.
I. Dispose of chlorinated water in accordance with local, state and federal regulations.
J. Replace permanent system devices removed for disinfection.

3.03 FIELD QUALITY CONTROL
A. Test samples in accordance with AWWA C651.
SECTION 33 3111
SITE SANITARY UTILITY SEWERAGE PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Sanitary sewerage drainage piping, fittings, and accessories.
   B. Connection of building sanitary drainage system to municipal sewers.
   C. Cleanout Access.

1.02 RELATED REQUIREMENTS
   A. Section 03 3000 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.
   B. Section 31 2316 - Excavation: Excavating of trenches.
   C. Section 31 2316.13 - Trenching: Excavating, bedding, and backfilling.
   D. Section 31 2323 - Fill: Bedding and backfilling.

1.03 DEFINITIONS
   A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.04 REFERENCE STANDARDS

1.05 SUBMITTALS
   A. See Section 01 3300 for submittal procedures.
   B. Product Data: Provide data indicating pipe, pipe accessories.
   C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
   D. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
   E. Project Record Documents:
      1. Record location of pipe runs, connections, manholes, cleanouts, and invert elevations.
      2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.01 SEWER PIPE MATERIALS
   A. SDR-35 PVC, Plastic Pipe: ASTM D3034, Type PSM, Poly Vinyl Chloride (PVC) Material; inside nominal diameter as indicated on the Contract Drawings, bell and spigot style push on ring joint end.
      1. Minimum wall thickness for 4", 6", 8" and 10" sizes are as follows:
         a. Size: 4"; 0.12" min. wall thickness
         b. Size: 6"; 0.18" min. wall thickness
         c. Size: 8"; 0.24" min. wall thickness
         d. Size: 10"; 0.30" min. wall thickness
      2. Standard lengths shall be 20' and 12'-6" + 1 inch.
      3. Pipe Stiffness - Minimum "pipe stiffness" (F/y) at 5% deflection shall be 46 for all sizes when tested in accordance with ASTM Designation D2412, "External Loading Properties of Plastic Pipe by Parallel-Plate Loading".
   B. HDPE Forcemain: DR-11; ASTM F714; inside nominal diameter as indicated on Contract Drawings.
2.02 PIPE ACCESSORIES
   A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required
tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.03 BEDDING AND COVER MATERIALS
   A. Pipe Bedding Material: As specified in Section 31 2316.13.
   B. Pipe Cover Material: As specified in Section 31 2316.13.

PART 3 EXECUTION

3.01 GENERAL
   A. Perform work in accordance with applicable code(s).

3.02 TRENCHING
   A. See Section 31 2316.13 for additional requirements.
   B. Hand trim excavation for accurate placement of pipe to elevations indicated.
   C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then
      complete backfilling.

3.03 INSTALLATION - PIPE
   A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are
      as indicated on layout drawings.
   B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal
      watertight.
   C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of
      1/8 inch (3 mm) in 10 feet (3 m).
   D. Make watertight connection to building sanitary sewer outlet.
   E. Extreme care shall be taken to provide proper pipe foundations and pipe sidefills in accordance
      with this section of the specifications and the recommendations of pipe manufacturer,
      maintaining accurate alignment of the pipe at all times. The installed sewer must meet the
      leakage test as specified in Part 3.03
   F. Deflection Test for Installed Pipe - Thirty (30) days (or greater) after installation of PVC pipe and
      backfill of trench is completed, the Contractor shall manually pull a rigid ball or mandrel
      (GO-NO-GO device) through all PVC mainline pipes, the size to be 95% of the diameter of the
      installed sewer. Any section of pipe not able to pass this test shall be replaced with new pipe
      and the test, including leakage test, shall be repeated until successful.

3.04 TESTING
   A. SDR-35 PVC Gravity Sewer Leakage Testing:
      1. Unless otherwise stated or ordered by the Engineer, all gravity sewers, including
         manholes, service connections and sewer laterals constructed under this contract, shall be
         tested for leakage and shall satisfactorily meet the test requirements prior to final
         acceptance of the work. No connections to existing sewer laterals shall be made until the
         leakage requirements are met. The Contractor shall furnish all labor, testing materials and
         equipment and shall perform the tests described herein to the satisfaction of the Engineer.
         The Contractor shall make all necessary repairs or replacement, and shall repeat the final
         leakage test(s), until the minimum leakage requirements are met.
      2. The proper procedure for air testing of sanitary sewers is described in the ASTM F
         1417-92, entitled Standard Test Method For Installation Acceptance of Plastic Gravity
         Sewer Lines Using Low-Pressure Air.
      3. Air testing shall be supported by corroborative hydrostatic testing which shall be conducted
         by filling a manhole to manhole sewer section with water and measuring the loss which
         occurs over a minimum 12 hour period. Minimum positive head shall be maintained at 2
         feet for the test to be valid. Results must not exceed 100 gallons per inch of pipe diameter
per mile of pipe per day. Upon an acceptable hydrostatic test, the same manhole to
manhole sewer section shall be air tested, whereby this air test result shall be reasonable
correlated to subsequent air tests, until additional hydrostatic testing is again performed.

4. Approximately five (5) percent of the mainline sewers shall be hydrostatically tested, the
location of which will be as directed by the Engineer.

5. It is extremely important that the various test plugs be properly installed and braced to
prevent blowouts. It is also important to maintain adequate pressure relief valves to
prevent over-pressurizing the system. A maximum relief pressure of 10 psi is suggested in
most literature.

6. Although line testing may be done at any time during the construction phase, there are two
time periods when testing is of special value (1) prior to placement of paving materials, in
order to avoid unnecessary expense in locating and repairing leaks, and (2) at as late a
date as possible, after work has been completed and some settlement has had a chance
to occur. This later period is the appropriate time for the final line acceptance test, since
significant damage can occur after backfill from subsequent settling.

7. All portions of a new sewage system should be tested, including any building laterals that
may be constructed in conjunction with the main lines.

8. Manholes shall be visually inspected for leakage during high groundwater condition.

9. All sections of new sanitary sewers and sewer laterals shall be tested by low pressure air
testing. Provide temporary bypass piping, pumping and/or temporary lateral connection to
existing sewers to maintain sewage flow during construction of new sewers and testing.

10. Leakage test will not be required on storm sewer lines.

11. Backfill of the sewer trench to ground surface must be in place and completed to the
degree of compaction specified for at least thirty (30) days prior to start of testing of
sewers.

12. For testing of sanitary sewers, groundwater levels must be determined prior to each test as
follows:

13. Determination of Groundwater Level: An accurate determination of groundwater level shall
be obtained at each manhole. The Contractor shall install a 1/2 inch diameter capped pipe
nipple through the manhole wall along the side of the lowest sewer line entering the
manhole. The outer end to be covered with clean crushed stone. This shall be done at
the time the sewer line is installed. Immediately prior to the performance of the Line
Acceptance Test, the groundwater shall be determined by removing the pipe cap, blowing
air through the pipe nipple into the ground so as to clear it, and then connecting a clear
plastic tube to the nipple.

14. The hose shall be held vertically and a measurement of the height in feet of water over the
invert of the pipe shall be taken after the water has stopped rising in this plastic tube. To
the height of the groundwater add 5 feet to arrive at the required test height.

B. Pressure Testing SDR - 21 PVC and HDPE Force Main Sewers:

1. The Contractor in the presence of the Engineer shall conduct on all forcemain sewer pipe
a pressure test.

2. The test shall be repeated until satisfactory to the Engineer.

3. Flushing of Piping: Force mains shall be pigged and flushed thoroughly before connection
is made to system piping in order to remove foreign materials which may have entered the
main during the course of the installation or which may have been present in existing
piping. The minimum rate of flow shall not be less than the pump rate of the system. For
all systems, the pigging and flushing operations shall be continued for a sufficient time to
ensure thorough cleaning.

4. Pressure Test: The Contractor shall provide all necessary equipment and shall perform all
work required in connection with the tests. The pipe shall be tested by hydrostatic
pressure 50 percent in excess of the normal working (system) pressure or 50 psi for a
period of 2 hours, or greater. Each section tested shall be slowly filled with water, taking
care to expel all air from the pipes. Required pressure as measured at the point of lowest
elevation shall be applied for not less than 2 hours and all pipe, fittings, valves, and joints
shall be carefully examined for defects. Leaking joints shall be made watertight. The
Contractor shall at his own expense make the necessary repairs or replacements required to permanently reduce the leakage within the specified limit and the tests shall be repeated until the leakage requirement is met. Any defects found in the system shall be made good at the expense of the Contractor so as to conform strictly to the specifications and to the satisfaction of the Owner's agent. All repairs shown necessary by the tests are to be made, broken or cracked pipe replaced, all deposits removed, and all pipe left true to line and grade, entirely cleaned, free from lumps of cement, protruding gaskets, bulkheads, etc., and ready for use before final acceptance is made by the Owner.

5. Sections of mains under test must be properly secured during testing to prevent damage to system from pipe movement or disturbance.

3.05 PROTECTION

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION
SECTION 33 4111
SITE STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Storm drainage piping, fittings, and accessories.
B. Connection of drainage system to municipal sewers.
C. Catch basins, Trench drains, Plant area drains, Paved area drainage, Site surface drainage, Detention tank, and Detention basin.

1.02 RELATED REQUIREMENTS
A. Section 31 2316 - Excavation: Excavating of trenches.
B. Section 31 2316.13 - Trenching: Excavating, bedding, and backfilling.
C. Section 31 2323 - Fill: Bedding and backfilling.
D. Section 33 0513 - Manholes and Structures.

1.03 SUBMITTALS
A. See Section 01 3300 for submittal procedures.
B. Product Data: Provide data indicating pipe, pipe accessories.
C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
E. Project Record Documents:
   1. Record location of pipe runs, connections, catch basins, cleanouts, and invert elevations.
   2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.04 REGULATORY REQUIREMENTS
A. Conform to applicable code for materials and installation of the Work of this section.

PART 2 PRODUCTS

2.01 STORM SEWER PIPE MATERIALS
A. HDPE Smooth Interior Corrugated Plastic Pipe
   1. Pipe Requirements
      a. Storm sewer pipe (per AASHTO) shall have a smooth interior and annular exterior corrugations.
         1) 4 through 10-inch (100 to 250 mm) shall meet AASHTO M252, Type S.
         2) 12 through 60-inch (300 to 1500 mm) shall meet AASHTO M294, Type S or ASTM F2306.
         3) Manning's "n" value shall be 0.012.
      2. Joint Performance
         a. Pipe shall be joined using a bell-and-spigot joint meeting AASHTO M252, AASHTO M294, or ASTM F2306. The joint shall be soil-tight and gaskets, when applicable, shall meet the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable wrap to ensure the gasket is free from debris. A joint lubricant supplied by the manufacturer shall be used on the gasket and bell during assembly.
      3. Fittings
         a. Fittings shall conform to AASHTO M252, AASHTO M294, or ASTM F2306. Bell and spigot connections shall utilize a spun-on welded bell and valley or saddle gasket meeting the soil-tight joint performance requirements of AASHTO M252, AASHTO
M294, or ASTM F2306. Includes tee, bends, elbows, cleanouts, reducers, traps, and other configurations as required.

b. Couplers shall cover not less than one full corrugation on each section of annular pipe and shall meet or exceed the soil tightness requirements of the AASHTO Standards Specification of Highway Bridges, Section 23, Paragraph 23.3.1.5.4(e).

4. Material Properties
a. Virgin material for pipe and fitting production shall be high-density polyethylene conforming with the minimum requirements of cell classification 424420C for 4 through 10-inch (100 to 250 mm) diameters or 435400C for 12 through 60-inch (300 to 1500 mm) virgin pipe material shall comply with the notched constant ligament-stress (NCLS) test as specified in Sections 9.5 and 5.1 of AASHTO M294 and ASTM F2306, respectively.

5. Corrugated Polyethylene Pipe shall be type ADS N-12 ST IB as manufactured by ADS or approved equal.

6. Pipe Dimensions

<table>
<thead>
<tr>
<th>Pipe I.D. in (mm)</th>
<th>Pipe O.D. in (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 (100)</td>
<td>4.6 (122)</td>
</tr>
<tr>
<td>6 (150)</td>
<td>5.9 (175)</td>
</tr>
<tr>
<td>8 (200)</td>
<td>9.1 (231)</td>
</tr>
<tr>
<td>10 (250)</td>
<td>11.4 (290)</td>
</tr>
<tr>
<td>12 (300)</td>
<td>14.5 (368)</td>
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<tr>
<td>15 (375)</td>
<td>18 (457)</td>
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<td>18 (450)</td>
<td>22 (559)</td>
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<td>24 (600)</td>
<td>28 (711)</td>
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<td>36 (914)</td>
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<tr>
<td>36 (900)</td>
<td>42 (1067)</td>
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<tr>
<td>42 (1050)</td>
<td>48 (1219)</td>
</tr>
<tr>
<td>48 (1200)</td>
<td>54 (1372)</td>
</tr>
<tr>
<td>60 (1500)</td>
<td>67 (1702)</td>
</tr>
</tbody>
</table>

Perforations: Where specified, two (2) perforations shall be provided at 120° below horizontal centerline at a minimum of 6" on center.

B. Flat Drain Underdrain: by Multiflow or approved equal.

2.02 PIPE ACCESSORIES
A. Geotextile Filter Fabric: Non-biodegradable, woven or nonwoven construction and consist of long chain polymeric filaments or fibers composed of polypropylene, polyethylene, or polymide. The filaments and fibers shall be oriented into a stable network whereby they retain their positions relative with each other. The geotextile shall be ultraviolet stabilized and shall be inert to chemicals commonly found in soil. The woven geotextile shall meet or exceed physical properties of WIN-FAB 200W. The non-woven geotextile shall meet or exceed physical properties of Mirafi 140N.

B. Tracing Tape: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Storm Sewer Service" in large letters.

2.03 CATCH BASIN, TRENCH DRAIN, CLEANOUT, AND AREA DRAIN COMPONENTS
A. Lids and Drain Covers: Cast iron, hinged to cast iron frame.
   1. Catch Basin and Cleanout:
      a. Lid Design: Provide standard black finish, supplied as total unit, sized as shown on the drawings or larger sizes except where in pavement area, and with the wording "STORM DRAIN" cast into cover.
   2. Area Drain:
      a. Lid Design: Checkerboard grill. Size as indicated on the Drawings.
2.04 DRAINAGE STRUCTURES

A. General:
   1. Construct manholes, inlets, and junction, structures of reinforced concrete or precast reinforced concrete, complete with metal frames and covers or gratings, and with fixed ladder rungs where indicated on the Drawings or required by codes.
   2. Construct inlets, and junction structures of reinforced concrete or precast reinforced concrete, complete with metal frames and covers or gratings, with fixed ladder rungs where indicated on the Drawings or required by codes.
   3. Individual wall-mounted aluminum, plastic-covered steel, or galvanized steel rungs are acceptable.

B. Materials:
   1. Concrete: Comply with provisions for 3000 psi concrete specified in Section 03 3000.
   2. Mortar for pipe joints and connections to other drainage structures, and manhole construction:
      a. Comply with requirements of ASTM C270, type M, except the maximum placement time shall be one hour.
      b. Hydrated lime complying with ASTM C141, type B, may be added to the mixture of sand and cement in an amount equal to 25% of the volume of cement used.
      c. Provide a quantity of water in the mixture sufficient to produce a stiff workable mortar, which shall be clean and free from harmful acids, alkalis, and organic impurities. Use the mortar within 30 minutes after water is added to the mix.

C. Precast reinforced concrete manholes:
   1. Comply with ASTM C478, precast rings and cone sections.
   2. Fully bed the joints between precast concrete risers and tops in mortar, and smooth both interior and exterior surfaces uniformly.

D. Reinforcement: Provide intermediate grade billet steel complying with ASTM A615, grade 60.

E. Precast Concrete Catch Basins:
   1. Provide reinforced and bottom open for field pouring to ensure slope through the structure.
   2. Contractor may select this option in lieu of cast-in-place concrete catch basins.

2.05 BEDDING AND COVER MATERIALS

A. Bedding: As specified in Section 31 2323.
B. Cover: As specified in Section 31 2323.

PART 3 EXECUTION

3.01 TRENCHING

A. See Section 31 2316.13 for additional requirements.
B. Hand trim excavation for accurate placement of pipe to elevations indicated.
C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.02 INSTALLATION - PIPE

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.
B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
C. Place pipe to grades and alignment indicated, with a tolerance of one in 1000 vertical and one in 500 horizontal, unless otherwise directed by the Engineer.
D. Do not place pipe in water, do not place pipe when trench or weather is unsuitable for such work.
E. Connect to building storm drainage system, foundation drainage system, and utility/municipal sewer system.
F. Install continuous trace wire 6 inches (150 mm) above top of pipe; coordinate with Section 31 2316.13.

3.03 INSTALLATION - CATCH BASINS, TRENCH DRAINS AND CLEANOUTS

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

3.04 PROTECTION

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION