February 16, 2026

PROJECT MANUAL

VOLUME 3 OF 4: Division 22-34

Washingtonville Central School District
2024 Capital Project Phase 3

Washingtonville Middle School — SED No. 44-01-02-06-0-001-023
Washington ville High School — SED No. 44-01-02-06-0-007-033

CSArch Project #
228-2401.03

Registration Expiration: 02/29/2028

The design of this project conforms to applicable provisions of the New York State Uniform Fire Prevention and Building Code, the New York State Energy Conservation Construction Code, the Manual of Planning Standards of the New York State Education Department, and the New York State Department of Labor Code Rule #56.

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SECTION 220500 - BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 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. All materials and equipment shall be installed in accordance with the manufacturer's recommendations.

1.2 LICENSING

A. The Contractor shall hold a license to perform the work as issued by the authority having jurisdiction.

B. Plumbing contract work shall be performed by, or under, the direct supervision of a licensed master plumber.

C. Electrical contract work shall be performed by, or under, the direct supervision of a licensed electrician.

1.3 PERMITS

A. Apply for and obtain all required permits and inspections, pay all fees and charges including all service charges. Provide certificate of approval from the Authorities Having Jurisdiction prior to request for final payment.

B. Provide electrical inspection certificate of approval from Middle Department Inspection Agency, Commonwealth Inspection Agency, or an Engineer approved Inspection Agency prior to request for final payment.

1.4 CODE COMPLIANCE

A. Provide work in compliance with the following Codes and Standards based on the current edition in effect at project location:
   1. Building, Code of New York State.
   2. Existing Building Code of New York State.
   3. Fire Code of New York State.

4. Plumbing Code of New York State.
5. Mechanical Code of New York State.
6. Fuel Gas Code of New York State.
7. Property Maintenance Code of New York State.
8. Energy Conservation Code of New York State
9. Accessible and Usable Buildings and Facilities, ICC A117.1.
10. New York State Department of Labor Rules and Regulations.
11. New York State Department of Health.
12. National Electrical Code (NEC).
13. Occupational Safety and Health Administration (OSHA).
14. Local Codes and Ordinances.
15. Life Safety Code, NFPA 101.
16. Local Plumbing Department.
17. New York State Education Department Manual of Planning Standards.

1.5 GLOSSARY

ACI	American Concrete Institute
AGA	American Gas Association
AGCA	Associated General Contractors of America, Inc.
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AFBMA	Anti-Friction Bearing Manufacturer's Association
AMCA	Air Moving and Conditioning Association, Inc.
ANSI	American National Standards Institute
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing Materials
AWSC	American Welding Society Code
AWWA	American Water Works Association
FM	Factory Mutual Insurance Company
IBR	Institute of Boiler & Radiation Manufacturers
IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Insurers
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association

NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NYS/DEC	New York State Department of Environmental Conservation
SBI	Steel Boiler Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
UFPO	Underground Facilities Protective Organization
UL	Underwriter's Laboratories, Inc.
OSHA	Occupational Safety and Health Administration
XL - GAP	XL Global Asset Protection Services

1.6 DEFINITIONS

Acceptance	Owner acceptance of the project from Contractor upon certification by Owner's Representative.
As Specified	Materials, equipment including the execution specified/shown in the contract documents.
Basis of Design	Equipment, materials, installation, etc. on which the design is based. (Refer to the article, Equipment Arrangements, and the article, Substitutions.)
Code Requirements	Minimum requirements.
Concealed	Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
Coordination Drawings	Show the relationship and integration of different construction elements and trades that require careful coordination during fabrication or installation, to fit in the space provided or to function as intended.
Delegated-Design Services	Performance and Design criteria for Contractor provided professional services. Where professional design services or certifications by a design professional are specifically required of a Contractor, by the Contract Documents. Provide products and systems with the specific design criteria indicated. If criteria indicated is insufficient to perform services or certification required, submit a written request for additional information to the Engineer. Submit wet signed and sealed certification by the licensed design professional for each product and system specifically assigned to the Contractor to be designed or

	certified by a design professional. Examples: structural maintenance ladders, stairs and platforms, pipe anchors, seismic compliant system, wind, structural supports for material equipment, sprinkler hydraulic calculations.
Equal, Equivalent, Equal To, Equivalent To, As Directed and As Required	Shall all be interpreted and should be taken to mean "to the satisfaction of the Engineer".
Exposed	Work not identified as concealed.
Extract	Carefully dismantle and store where directed by Owner's Representative and/or reinstall as indicated on drawings or as described in specifications.
Furnish	Purchase and deliver to job site, location as directed by the Owner's Representative.
Inspection	Visual observations by Owner's site Representative.
Install	Store at job site if required, proper placement within building construction including miscellaneous items needed to affect placement as required and protect during construction. Take responsibility to mount, connect, start-up and make fully functional.
Labeled	Refers to classification by a standards agency.
Manufacturers	Refer to the article, Equipment Arrangements, and the article, Substitutions.
Prime Professional	Architect or Engineer having a contract directly with the Owner for professional services.
Product Data	Illustrations, standard schedules, performance charts, instructions, brochures, wiring diagrams, finishes, or other information furnished by the Contractor to illustrate materials or equipment for some portion of the work.
Provide (Furnish and Install)	Contractor shall furnish all labor, materials, equipment and supplies necessary to install and place in operating condition, unless otherwise specifically stated.
Relocate	Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
Remove	Dismantle and take away from premises without added cost to Owner, and dispose of in a legal manner.

Review and Reviewed	Should be taken to mean to be followed by "for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents".
Roughing	Pipe, duct, conduit, equipment layout and installation.
Samples	Physical full scale examples which illustrate materials, finishes, coatings, equipment or workmanship, and establishes standards by which work will be judged.
Satisfactory	As specified in contract documents.
Shop Drawings	Fabrication drawings, diagrams, schedules and other instruments, specifically prepared for the work by the Contractor or a Sub-contractor, manufacturer, supplier or distributor to illustrate some portion of the work.
Site Representative	Owner's Inspector or "Clerk of Works" at the work site.
Submittals Defined (Technical)	Any item required to be delivered to the Engineer for review as requirement of the Contract Documents. The purpose of technical submittals is to demonstrate for those portions of the work for which a submittal is required, the manner in which the Contractor proposes to conform to the information given and design concepts expressed and required by the Contract Documents.

1.7 EXISTING CONDITIONS

A. Contractor shall review all available record documents of existing construction or other existing conditions and hazardous material information. Owner does not guarantee that existing conditions are the same as those indicated in these documents. Contractor shall record existing conditions via measured drawings and preconstruction photographs or video. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage, removal or construction operations.

B. Owner will occupy portions of the building immediately adjacent to the area(s) of removals. Conduct removals so Owner's operations are not disrupted. Contractor shall locate, identify, disconnect and seal or cap mechanical, plumbing, fire protection and/or electrical systems serving areas of removals, unless noted otherwise in the contract documents. Contractor shall arrange shut-down of systems with the Owner/Construction Manager. Piping and ductwork indicated to be removed shall be removed and capped or plugged with compatible materials. If services/systems are required to be removed, relocated or abandoned, provide temporary services/systems the bypass area(s) of removals to maintain continuity of services/systems to other parts of the building, as required.

1.8 SHOP DRAWINGS/PRODUCT DATA/SAMPLES

A. Provide submittals on all items of equipment and materials to be furnished and installed. Submittals shall be accompanied by a transmittal letter, stating name of project and contractor, name of vendor supplying equipment, number of drawings, titles, specification sections (name and number) and other pertinent data called for in individual sections. Submittals shall have individual cover sheets that 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 under one cover sheet per specification section (e.g. lighting fixtures, valves, plumbing fixtures, etc.). Submittals shall include all required documentation for each product listed in the specification section at the same time as a complete package. Number each submittal by trade. Indicate deviations from contract requirements on Letter of Transmittal. Submittals will be given a general review only. Corrections or comments made on the Submittals 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. If submitting hard copies, submit four (4) copies for review.

B. The Engineer will review up to two (2) submissions of any single submittal. The Contractor will be invoiced on an hourly rate basis for the time spent reviewing the same shop drawing in excess of twice.

C. If submittals are to be submitted electronically, all requirements in Item A apply. Submittals shall be emailed in PDF format to specific email address provided by the Construction Manager, General Contractor, Architect or Project Manager. Name of project shall be in subject line of email. Send emails to mealbasubmittalclerk@meengineering.com

D. Refer to Division 01 for additional requirements.

1.9 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.

1.10 EQUIPMENT ARRANGEMENTS

A. The contract documents are prepared using one manufacturer as the Basis of Design, even though other manufacturers' names are listed. If Contractor elects to use one of the listed manufacturers other than Basis of Design or if the physical size, performance or electrical characteristics for the Basis of Design equipment differs from what is indicated in the contract documents, submit detailed drawings, indicating proposed installation of equipment. Show maintenance clearances, service removal space required, and other pertinent revisions to the design 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 doorframes, access doors, walls, ceilings, or floors required to install. If revised arrangement submittal is rejected, revise and resubmit specified Basis of Design item which conforms to Contract Documents.

1.11 SUBSTITUTIONS

A. If Contractor desires to bid on any other kind, type, brand, or manufacture of material or equipment than those named in specifications, secure prior approval. To request such approval, Contractor shall submit complete information comparing (item-for-item) material or equipment offered with design material or equipment. Include sufficient information to permit quick and thorough comparison, and include performance curves on same basis, capacities, power requirements, controls, materials, metal gauges, finishes, dimensions, weights, etc., of major parts. If accepted, an addendum will be issued to this effect ahead of bid date. Unless such addendum is issued, substitution offered may not be used.

1.12 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 electrical connections and relocations as required to accomplish the above. Obtain approval in writing as to date, time, and location for shutdown of existing mechanical/electrical facilities or services.

1.13 ROUGHING

A. The Contract Drawings have been prepared in order to convey design intent and are diagrammatic only. Drawings shall not be interpreted to be fully coordinated for construction.

B. 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 avoid 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.

C. 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. Provide new materials, including new piping and insulation for relocated work.

D. Coordinate work with other trades and determine exact route or location of each duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Obtain from Owner's Representative exact location of all equipment in finished areas, such as thermostat, fixture, and switch mounting heights, and equipment mounting heights. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers, and other items. Do not rough-in contract work without reflected ceiling location plans.

E. Before roughing for equipment furnished by Owner or in other Divisions, obtain from Owner and other Divisions, 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.

1.14 COORDINATION DRAWINGS

A. Before construction work commences, Divisions for all trades shall submit coordination drawings in the form of CAD drawing files, drawn at not less than 1/4 inch. scale. Such drawings will be required throughout all areas, for all Contracts. 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. Division 23 shall prepare the base plan CAD coordination drawings showing all ductwork, all pertinent heating piping, and equipment. These drawings may be CAD files of the required Ductwork Shop Drawings. The drawings shall be coordinated with lighting fixtures, sprinklers, 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 redrawn.
   2. Division 23 shall provide CAD files and submit the base plan CAD Coordination Drawings to all Divisions.
   3. Divisions 21 and 22 shall draw the location of piping and equipment on the base plan CAD Coordination Drawings, indicating areas of conflict and suggested resolutions.
   4. Divisions 26, 27 and 28 shall draw the location of lighting fixtures, cable trays, and feeders over 1-1/2 inch. on the base plan CAD Coordination Drawings, indicating areas of conflict and suggested resolution.
   5. The General Construction Trade shall indicate areas of architectural/structural conflicts or obstacles on the CAD Coordination Drawings, and coordinate to suit the overall construction schedule.
   6. The Construction Manager shall expedite all Coordination Drawing work and coordinate to suit the overall construction schedule. In the case of unresolved interferences, he shall notify the Owner's Representative. The Owner's Representative will then direct the various trades as to how to revise their drawings as required to eliminate installation interferences.
   7. If a given trade proceeds prior 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 Divisions.

B. The purpose of the coordination drawing process is to identify and resolve potential conflicts between trades, and between trades and existing or new building construction, before they occur in construction. Coordination drawings are intended for the respective trade's use during construction and shall not replace any Shop Drawings, or record drawings required elsewhere in these contract documents.

1.15 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, lead paint, mercury and PCB's shall be in accordance with Federal, State and Local law requirements. Where equipment is called for to be relocated, contractor shall carefully remove, clean and recondition, then reinstall. Remove all abandoned piping, wiring, equipment, lighting, ductwork, tubing, 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.

B. For materials indicated to contain lead, that are being affected by demolition or construction, the contractor shall comply with all Federal, State and Local law requirements regarding worker exposure to lead disturbance and abatement procedures.

C. Refer to the Owner's Lead Paint Survey. The Survey identifies the surfaces within the buildings that were tested for lead by collecting paint samples and performing laboratory analysis. If any unidentified surfaces are to be impacted the lead content shall be tested by analytical determinations conducted by a qualified laboratory approved by the Owner. The contractor shall review the current owner’s lead paint reports on file before starting any work which may disturb existing surfaces.

D. Refer to Division 02 for additional information regarding hazardous materials.

1.16 REFRIGERANT RECOVERY

A. Existing equipment to be removed, as shown on the plans may contain refrigerant and refrigerant oils. This refrigerant and refrigerant oil must be handled in accordance with Federal, State and Local law requirements.

B. Removal and recovery of refrigerant shall be in accordance with the current edition of Section 608 of the Clean Air Act of 1990, including all final regulations.

C. Refrigerant recovery must be performed by a technician, certified by an EPA-approved certification program, using refrigerant recovery and recycling equipment certified by an EPA-approved testing organization.

D. Owner "reserves the right of first refusal" on ownership of recovered refrigerant. Should Owner choose to maintain ownership of refrigerant, refrigerant shall be reclaimed, cleaned by this Contractor to ARI 700-1993 Standard of Purity, by an EPA certified refrigerant reclaimer. Refrigerant shall be turned over to the Owner in suitable marked containers to be stored on site, at a place of the Owner's choosing.

1.17 EQUIPMENT AND MATERIAL REQUIREMENTS

A. 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. 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. All electrical equipment and systems, as a whole, shall be tested and listed by an OSHA approved Nationally Recognized Testing Laboratory (NRTL) for the intended use in accordance with the applicable standards and have a physical label indicating such.
   6. Fire protection equipment shall be UL listed and FM approved.

B. Exterior and wet locations shall utilize materials, equipment supports, mounting, etc. suitable for the intended locations. Metals shall be stainless steel, galvanized or with baked enamel finish as a minimum. Finishes and coatings shall be continuous and any surface damaged or cut ends shall be field corrected in accordance with the manufacturer's recommendations. Hardware (screws, bolts, nuts, washers, supports, fasteners, etc.) shall be:
   1. Stainless steel where the associated system or equipment material is stainless steel or aluminum.
   2. Hot dipped galvanized or stainless steel where the associated system or equipment is steel, galvanized steel or other.

1.18 CUTTING AND PATCHING

A. Each trade shall include their required cutting and patching work unless shown as part of the General Construction Contract. 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 cut or abandoned holes left by removals of equipment or fixtures. 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.

1.19 PAINTING

A. Paint all insulated and bare piping, pipe hangers and supports exposed to view in mechanical equipment rooms, penthouse, boiler rooms and similar spaces. Paint all bare piping, ductwork and supports exposed to the out-of-doors with rust inhibiting coatings. Paint all equipment that is not factory finish painted (i.e. expansion tanks, etc.).

B. All painting shall consist of one (1) prime coat and two (2) finish coats of non-lead oil base paint, unless otherwise indicated herein. Provide galvanized iron primer for all galvanized surfaces. All surfaces must be thoroughly cleaned before painting. Review system color coding prior to painting with the Owner's Representative or Architect.

C. All items installed after finished painting is completed and any damaged factory finish paint on equipment furnished under this contract must be touched up by the Contractor responsible for same.

D. 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 Specifications.

E. All primers and paint used in the interior of the building shall comply with the maximum Volatile Organic Compound (VOC) limits called for in the current version of U.S. Green Building Council LEED Credits EQ 4.1 and EQ 4.2.

F. Refer to Division 9 - Finishes, for additional information.

1.20 EXISTING CEILING REMOVAL AND RE-INSTALLATION

A. In a renovation project, any existing ceiling removal and re-installation work required for the completion of a Contractors or Subcontractors work, shall be removed and re-installed by that Contractor or Subcontractor. This applies in any areas not called for to have a new ceiling installed.

B. The ceiling removal and re-installation shall include lay-in ceiling tile and grid, to the extent necessary to accomplish the work. Removed ceiling tile and grid shall be safely stored during the course of the work, and it shall be re-installed to the original existing condition.

C. The ceiling removal and re-installation shall include gypsum board or plaster ceilings and the associated suspension systems. Removed ceiling areas shall be patched with materials to match the existing ceiling, and painted to match. If paint cannot be matched exactly, paint the entire ceiling a similar color.

1.21 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 their review.
In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

1.22 CHASES

A. New Construction:
1. Certain chases, recesses, openings, shafts, and wall pockets will be provided as part of General Construction Trade. Mechanical and Electrical trades 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 Construction trade.

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 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 inch. 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.

1.23 PENETRATION FIRESTOPPING

A. Refer to Division 07 for project-wide fire stopping information.

1.24 NON-RATED WALL PENETRATIONS

A. Each trade shall be responsible for sealing wall penetrations related to their installed work, including but not limited to ductwork, piping, conduits, etc. See individual specification sections for requirements.

1.25 SUPPORTS

A. Provide required supports, beams, angles, hangers, rods, bases, braces, and other items to properly support contract work. 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.

B. For precast panels/planks and metal decks, support mechanical/electrical work as determined by manufacturer and the Engineer. Provide heavy gauge steel mounting plates for mounting contract work. Mounting plates shall span two or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

C. For finished areas without a finished ceiling system such as classrooms, offices, conference rooms, etc., where decking and structure is exposed, and ductwork/piping/conduit is exposed: All mounting brackets, channel support systems and mounting hardware for ductwork, piping, lighting, etc. shall be concealed and approved by the Architect/Engineer prior to the installation. AirCraft cable style hanging for ductwork is required. It is recommended that room mockups be done and receive Architect/Engineer approval prior to proceeding with installation.

D. Equipment, piping, conduit, raceway, etc. supports shall be installed to minimize the generation and transmission of vibration.

E. Materials and equipment shall be solely supported by the building structure and connected framing. Gypboard, ceilings, other finishes, etc. shall not be used for support of materials and equipment.

1.26 APPLIED FIREPROOFING

A. Scope: Provide encapsulation of surfaces where applied fireproofing materials have been disturbed, removed, or left missing by the removal of hangers or upper attachments, or when new hangers or upper attachment are installed.

B. Fire Resistance Rating: Fireproofing shall meet the original hourly rating when applied to the construction assembly where materials have been removed or disturbed, or is missing.

C. Fire Hazard Classification: Fireproofing shall be listed in the Underwriters Laboratories Building Materials Directory with the following performance properties:
   1. Flame Spread: 10 or less.
   2. Smoke Developed: 5 or less.

D. Product Data: Provide manufacturer's product descriptions for each required fireproofing material. Include application instructions, including primer/adhesive requirements and recommended minimum thickness and density for each required hourly rating.

E. Fire Proofing Manufacturer:
   1. Retro-Guard cementitious replacement fireproofing by Grace Construction Products, or equivalent Cafco Blaze Shield, and Cafco 300 by Isolatek.
   2. Physical Properties:
      a. Dry Field Density (ASTM E 605): 15 lb/cu ft minimum average.
      b. Cohesion/Adhesion (Bond Strength) (ASTM E 736): 200 lb/sq ft minimum average.
      c. Compressive Strength (ASTM E 761): 500 lb/sq ft minimum.
      d. Impact (Bond Impact) Resistance (ASTM E 760): Shall not crack or delaminate.
      e. Effect of Deflection (ASTM E 759): Shall not crack or delaminate.
      f. Corrosion Resistance (ASTM E 937): No evidence of corrosion.
      g. Air Erosion (ASTM E 859): Maximum 0.025 g/sq ft weight loss.
      h. Provide primer or adhesive recommended by the fireproofing manufacturer to obtain required bond strength for the specific fireproofing and substrate.

F. Apply fireproofing prior to installation of ductwork, piping, conduits, and other suspended items. Hangers, clips and other supports for these items shall be installed before application of fireproofing.

G. Examine the substrate and conditions under which fireproofing is to be applied. Do not proceed with the fireproofing work until unsatisfactory conditions have been corrected. Verify that hangers, clips, sleeves, and other items that will penetrate the fireproofing are in place. Check paint on substrate for compatibility with primer/fireproofing and adequacy of bond strength in accordance with fireproofing manufacturer's instructions.

H. Surface Preparation: Remove dirt, dust, oil, grease, loose paint and rust, mill scale, and other foreign matter that may impair the bonding of the fireproofing to the substrate. Clean substrate free of contamination from chemicals and solvents. Apply primer/adhesive where necessary to obtain bond strength of fireproofing to steel shop paint and where recommended by the fireproofing manufacturer.

I. Apply the fireproofing in accordance with UL fire test report and the manufacturer's application instructions. Thickness and density of fireproofing shall be in accordance with the approved product data and as required to produce the hourly fire resistance rating required.

1.27 ACCESS PANELS

A. Provide access panels for required access to respective trade's work. Location and size shall be the responsibility of each trade. Access panels provided for equipment shall provide an opening not smaller than 22 inch. by 22 in. Panels shall be capable of opening a minimum of 90 degrees. 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 cam locks. 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 Construction trade with a set of architectural plans with size and locations of access panels.

1.28 CONCRETE BASES

A. Provide concrete bases for all floor mounted equipment. Provide 3,000 lb. concrete, chamfer edges, trowel finish, and securely bond to floor by roughening slab and coating with cement grout. Bases 4 inch. high (unless otherwise indicated); shape and size to accommodate equipment. Provide anchor bolts in equipment bases for all equipment provided for the project, whether mounted on new concrete bases or existing concrete bases.

1.29 HVAC 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 final hot water, drain, vent, and gas connections to all equipment as required by the equipment. Provide final connections, including domestic water piping, wiring, controls, and devices from equipment to outlets left by other trades. Provide equipment waste, drip, overflow and drain 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.

1.30 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, gas connections to all equipment. Provide loose key stops, sanitary "P" traps, tailpiece, adapters, gas or air cocks, and all necessary piping and fittings from roughing point to equipment. Provide installation of sinks, faucets, traps, tailpiece furnished by others. Provide cold water line with gate valve and backflow prevention device at locations called for. Provide continuation of piping and connection to equipment that is furnished by others. Provide relief valve discharge piping from equipment relief valves.

C. Provide 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 and 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, as required.

1.31 ELECTRICAL EQUIPMENT CONNECTIONS

A. Provide complete power connections to all electrical equipment. Provide control connections to equipment. Heavy duty NEC rated disconnect ahead of each piece of equipment. Ground all equipment in accordance with NEC.

B. Provide for Owner furnished and Contractor furnished equipment all power wiring, electric equipment, control wiring, switches, lights, receptacles, and connections as required.

1.32 STORAGE AND PROTECTION OF MATERIALS AND EQUIPMENT

A. Store Materials on dry base, at least 6 inch. 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.

B. Refer to Division 01 for additional information.

1.33 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 change in contract, any such damage to equipment, systems, and building. Perform first seasons winterizing in presence of Owner's operating staff.

1.34 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. Divisions 22 and 26 shall add contract items to the chart provided by Division 23 or provide separate charts.

1.35 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.

1.36 OPERATION AND MAINTENANCE MANUALS

A. Submit by email (preferred) or digital media, thru the normal project submittal process. Include a copy of each final approved Shop Drawing, wiring diagrams, piping diagrams, spare parts lists, final testing and balancing report, 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 installing contractor and of supplier manufacturer Representative and service agency for all major equipment items. Provide a table of contents page and dividers based upon specification section numbers. Submit in a compiled and bookmarked PDF format as outlined below. Each item listed in the table of contents shall include a hyperlink to the associated section of the O&M Manual, in addition to the bookmarking.

B. Provide content for Operation and Maintenance Manuals as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
   1. Engineer will comment on whether content of operation and maintenance submittals is acceptable.
   2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

C. Submit Operation and Maintenance Manuals in the following format:
   1. Submit by uploading to web-based project software site, or by email to Architect, as a formal project submittal in conformance with the project specific submittal procedures. Enable reviewer comments on draft submittals.
   2. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
   3. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in the table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

D. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing Owner training. Engineer will comment on whether general scope and content of manual are acceptable.

E. Final Manual Submittal: Submit O&M manual in final form prior to requesting inspection for Substantial Completion and at least 2 weeks before commencing Owner training. Engineer will return copy with review comments.

1. Correct or revise O&M manual to comply with Engineer's comments. Submit copies of each corrected manual within 2 weeks of receipt of Engineer's comments.

F. Refer to Division 01 for additional requirements.

1.37 RECORD DRAWINGS

A. The Contractor shall obtain at his expense one (1) set of construction Contract Drawings, (including non-reproduction black and white prints or electronic files) for the purpose of recording as-built 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 contract documents in red 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, the complete set of red marked contract documents, plus all approved field sketches and diagrams shall be submitted to the engineer and used in preparation of the record drawings.

D. A complete set of red marked contract drawings shall be submitted, at one time, as the "Record" set. If there are no changes to a specific drawing, the contractor shall indicate "NO CHANGES" on that drawing. ALL drawings shall be included in the "Record" set.

E. The complete set of red marked Contract Documents or electronic files shall be certified by the Contractor as reflecting record conditions and submitted to the engineer for review.

F. The Contractor shall have the marked up set scanned, if they are not already electronic files, and then submit them to the Engineer as the "Record Set".

G. Refer to Division 01 for additional requirements.

1.38 FINAL INSPECTION

A. Upon completion of all Engineering Site Observation list items, the Contractor shall provide a copy of the Engineering Site Observation Report back to the Engineer with each items noted as completed or the current status of the item.

1.39 COMMISSIONING

A. Refer to General Commissioning Requirements in Division 01 for additional requirements.

1.40 TEMPORARY HEATING AND COOLING

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

B. Systems and equipment installed as part of this project shall not be used for temporary heating or cooling.

1.41 MAINTENANCE OF HVAC SYSTEMS DURING TEMPORARY USE PERIODS

A. Provide each air handling system with a set of prefilters in addition to the permanent filters. Furnish four 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 MERV-8 filters in all open ended ducts, return grilles and registers to keep dust out of ductwork. Change as often as necessary. Remove all such temporary filters upon completion. Use supply fans 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 and install new set. 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.

1.42 TEMPORARY FACILITIES

A. Refer to the Division 01 Sections, General Conditions and Supplemental General Conditions.

1.43 TEMPORARY LIGHT AND POWER

A. Refer to the Division 01 Sections, General Conditions and Supplemental General Conditions.

1.44 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:
   1. Thoroughly clean entire installation, both exposed surfaces and interiors.
   2. Remove all debris caused by work.
   3. Remove tools, surplus, materials, when work is finally accepted.

1.45 SYSTEM START-UP AND TESTING

A. All new heating and ventilating systems 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% outside air during the bake-off for an additional eight hours to purge the building. This work shall be completed prior to fall school occupancy or 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 one week prior to and one week after the commencement of school except upon written approval by the Owner.

C. Prior to commencement of work, the Division(s) effecting such system shall survey all building mechanical, plumbing, fire protection and electrical systems and components and make written notice to the Owner's Representative regarding any damage, missing items and/or incomplete systems. Prior to the conclusion of this project, the Contractor shall verify with the Owner's Representative that all building systems have been returned to their original conditions.

D. Start-up and testing of HVAC systems shall occur while the building is not occupied by students and only after notice to the Owner's Representative is made at least 24 hours in advance. Division 23 shall be responsible for providing temporary filter media over all supply air registers and diffusers during the HVAC system start-up procedure. Division 23 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 Owner's Representative.

1.46 TRANSFER OF ELECTRONIC FILES

A. Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering) will provide electronic files for the Contractor's use in the preparation of sheet metal shop drawings, coordination drawings, or record drawings related to the project, subject to the following terms and conditions:
   1. The Contractor shall submit a formal request for electronic drawing files on the Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering) website, by utilizing the following website link: http://www.meengineering.com/contact-pages/contractor-request
   2. Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering) makes no representation as to the compatibility of these files with the Contractor's hardware or the Contractor's software beyond the specific release of the referenced specifications.
   3. Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering) can only provide CAD files of M/E/P/FP drawing levels for which we are the Engineer of Record. CAD files of Architectural backgrounds, reflected ceiling plans, structural plans, etc. must be obtained separately from the Architect of Record.
   4. Data contained on these electronic files is part of Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering) instruments of service shall not be used by the Contractor or anyone else receiving data through or from the Contractor for any purpose other than as convenience in the preparation of shop drawings for the referenced project. Any other use or reuse by the Contractor or by others will be at the Contractor's sole risk and without liability or legal exposure to Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering). The Contractor agrees to make no claim and hereby waive, to the fullest extent permitted by law, any claim or cause of action of any nature against Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering), its officers, directors, employees, agents or sub-consultants which may arise out of or in connection with the Contractor's use of the electronic files.

5. Furthermore, the Contractor shall, to the fullest extent permitted by law, indemnify and hold harmless, Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering) from all claims, damages, losses and expenses, including attorney's fees arising out of or resulting from the Contractor's use of these electronic files.
6. These electronic files are not contract documents. Significant difference may arise between these electronic files and corresponding hard copy contract documents due to addenda, change orders or other revisions. Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering) makes no representation regarding the accuracy or completeness of the electronic files the Contractor receives. In the event that a conflict arises between the signed contract documents prepared by Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering) and electronic files, the signed contract documents shall govern. The Contractor is responsible for determining if any conflicts exist. By the Contractor's use of these electronic files the Contractor is not relieved of the Contractor's duty to comply with the contract documents, including and without limitation, the need to check, confirm and coordinate all dimensions and details, take field measurements, field verify conditions and coordinate the Contractor's work with that of other contractors for the project.

1.47 VIDEO RECORDING OF TRAINING SESSIONS

A. The contractor shall video record all training sessions required by their discipline. Video shall be in Windows Media Player video format saved on flash drives. Two (2) copies on flash drives are to be provided as a formal submittal. . Flash drives are to be tagged with project name, training session name(s), installing Contractor and date of training. The flash drive shall include a scanned version of the training session sign in list(s), including the presenter and the owner's participants.

1.48 ENERGY INCENTIVES

A. The Contractor, his Subcontractors and Suppliers shall provide to the Owner all paperwork necessary to support the Owners pursuit of incentives related to energy conservation as offered by the utility company or state sponsored incentive programs. This shall include at a minimum, receipts, and quantities and data sheets for energy efficient equipment such as: lighting, motors, variable frequency drives, etc.

1.49 INFECTION CONTROL

A. Construction procedures, temporary partitions, negative air systems, cleaning procedures, HVAC system isolation, dust control, etc. shall be in accordance with the infection control standards set forth by the Facility. A copy of the facilities standards are available from the Owner upon request.

SECTION 220523 - VALVES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Document.

1.2 SUBMITTALS

A. Submit manufacturer's data in accordance with Basic Mechanical and Electrical Requirements. Obtain approval prior to ordering material.

B. Provide submittals for all items specified under Part 2 of this section.

PART 2 - PRODUCTS

2.1 VALVES - GENERAL

A. Valves shall have following requirements:
   1. Working pressure stamped or cast on bodies.
   2. Stem packing serviceable without removing valve from line.
   3. All items here-in used to convey water for potable use shall be lead free in accordance with NSF Standard, Standard 61, Section 9 - Standard for Drinking Water and Lavatory Faucets and NSF Standard 372 - Maximum Lead Requirements. Compliance shall be via third party testing and certification.

B. Acceptable Manufacturers:
   1. Balance Valves: Armstrong, Bell & Gossett, Red White, Taco, Tour and Anderson.
   2. Thermostatic Balance Valves: Caleffi, Bell & Gossett, ThermOmegaTech
   3. Ball Valves: Apollo, Hammond, Milwaukee, Nibco, Red White, Watts.
   4. Butterfly Valves: Bray, Jamesbury, Keystone, Milwaukee, Red White, Watts.
   5. Gate and Check Valves: Hammond, Milwaukee, Nibco, Red White, Stockham, Watts.
   6. To establish a standard of quality and identify features, certain manufacturer's numbers are given in the following paragraphs.

2.2 DOMESTIC WATER VALVES

A. Ball Valves:

1. 3in. and Smaller: Lead-free, forged copper silicon alloy 2-piece body, chrome-plated lead-free brass ball, full port, teflon seats and stem packing, separate packing and handle nut, blowout proof stem extended for insulation, vinyl insulator for handle, 400 WOG, 125 WSP; Watts LFFBV-3C-M1 Series (threaded ends) or Watts LFFBVS-3C-M1 series (sweat ends).

2.3 GAS VALVES

A. Ball Valves:
   1. 2 inch. and Smaller: Ball type, two-piece, full port, brass body with chrome plated brass ball, teflon seats, threaded ends, 600 psi WOG, UL listed for natural gas, Watts FBV-3C-UL.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide all shutoff, check, balancing and other type valves as indicated, as required by Code and as required for proper system maintenance, isolation and safety. Provide at major building and systems sections. Provide shutoff valves on all branch lines serving two fixtures or more, at all equipment, fixtures, before and after automatic control valves, and at future connections.

B. Locate valves for easy access and provide separate support where necessary. Install valves with stems at or above the horizontal position. Install swing check valves in horizontal position with hinge pin level.

C. Provide drain valves with hose thread connections on all equipment. Provide hose thread drain valves at all low points to enable complete drainage of all piping systems including, water mains, branches, at base of vertical risers and at strainers.

D. Provide shutoff valve and wye-strainer before all automatic control valves and pressure reducing valves.

E. Inspect valves for proper operation before installation. Install underground valve boxes vertically over each valve. Adjust top of box to proper grade. Immediately backfill with crushed stone and carefully tamp into place. Unless otherwise noted, leave in the open position.

3.2 NATURAL GAS SYSTEM

A. Ball valves shall be UL listed for use in natural gas systems, or certified by another acceptable third-party testing agency.

END OF SECTION 220523

SECTION 220593 - ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for complete adjusting and balancing Work as required in Contract Documents.

1.2 SUBMITTALS

A. Provide information in report form listing items required by specifications. Report shall be typed and three copies submitted for review. Results shall be guaranteed. Contractor shall be subject to recall to site to verify report information before acceptance of the report by the Owner's Representative.

B. Report format shall consist of the following:
   1. Title sheet with job name, contractor, engineer, date, balance contractor's name, address, telephone number and contact person's name and the balancing technician's name.

1.3 QUALIFICATIONS

A. Follow procedures and methods published by one or more of the following:
   1. Individual manufacturer requirements and recommendations.

B. Maintain qualified person at project for system operation, trouble shooting and perform mechanical adjustments in conjunction with balancing procedure.

C. Balancing contractor shall be current member of AABC or NEBB.

1.4 GENERAL REQUIREMENTS

A. Before concealment of systems visit the job site to verify and advise on type and location of balancing devices and test points. Make changes as required to balancing facilities.

B. Place systems in satisfactory operating condition.
   1. Adjusting and balancing shall be accomplished as soon as the systems are complete and before Owner takes possession.
   2. Prior to balancing adjust balancing devices for full flow; fill, vent and clean hydronic systems, replace temporary strainers.
   3. Initial adjustment and balancing to quantities as called for or as directed by the engineer, to satisfy job conditions.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide tools, ladders, recording meters, gauges, thermometers, velometers, anemometers, inclined gauge manometers, magnehelic gauges, amprobes, voltmeters, psychrometers and tachometers required. Instruments used should be accurately calibrated as per AABC or NEBB requirements.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine Bid Documents and notify Owner's Representative of any questions regarding balancing, within thirty (30) days after receipt of bid and prior to starting work.

3.2 WATER SIDE

A. Test, adjust and record the following:
   1. Thermostatic Balancing Valves:
      a. Ensure every valve set to 5°F below supply temperature, unless otherwise noted.

END OF SECTION 220593

SECTION 220700 - INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 SUBMITTAL

A. Shall include product description, manufacturer's installation instructions, types and recommended thicknesses for each application, and location of materials.

PART 2 - PRODUCTS

2.1 GENERAL

A. Insulation, jackets, adhesive, and coatings shall comply with the following:
   1. Treatment of jackets or facing for flame and smoke safety must be permanent. Water-soluble treatments not permitted.
   2. Insulation, including jackets, finishes and adhesives on the exterior surfaces of pipes and equipment, shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less.
   3. Asbestos or asbestos bearing materials are prohibited.
   4. 2020 Energy Conservation Code of New York State
   5. All adhesives and sealants used for insulation in the interior of the building shall comply with the maximum Volatile Organic Compound (VOC) limits as called for in the current version of U.S. Green Building Council LEED Credits EQ E4.1 and EQ E4.2.
   6. Provide materials which are the standard products of manufacturers regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least two (2) years prior to bid opening. Provide insulation systems in accordance with the approved MICA or NAIMA Insulation Standards.
   7. Insulation shall be clearly marked with manufacturer's name, identification of installed thermal resistance (R) value, out-of-package R value, flame spread and smoke developed indexes in accordance with Energy Code requirements.

2.2 ACCEPTABLE MANUFACTURERS

A. Fiberglass: Knauf, Johns Manville, Owen-Corning, Certainteed

B. Polyisocyanurate: Dow Trymer 2000XP, HyTherm.

C. Calcium Silicate: Industrial Insulation Group (ILG).

D. Ceramic Fiber: Unifrax Durablanket S.

E. Flexible Elastomeric: Armacell, K-Flex.

F. Adhesives: Childers Products, Foster.

G. Heat Tracing: Raychem, Thermon.

2.3 PIPE INSULATION (RIGID FIBERGLASS TYPE)

A. Product meeting ASTM C547, ASTM C585, and ASTM C795; rigid, molded, noncombustible.

B. 'K' Value: ASTM C 335, 0.23 at 75°F mean temperature. Maximum Service Temperature: 1000°F.

C. Vapor Retarder Jacket: ASJ/SSL conforming to ASTM C1136 Type I, secured with self-sealing longitudinal laps and butt strips.

D. Field-Applied PVC Fitting Covers with Flexible Fiberglass Insulation: Proto Corporation 25/50 or Indoor/Outdoor, UV-resistant fittings, jacketing and accessories, white or colored. Fitting cover system shall consist of pre-molded, high-impact PVC materials with blanket type fiberglass wrap inserts. Blanket fiberglass wrap inserts shall have a thermal conductivity ('K') of 0.26 at 75°F mean temperature. Closures shall be stainless steel tacks, matching PVC tape, or PVC adhesive per manufacturer's recommendations.

E. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C450 for dimensions used in pre-forming insulation to cover valves, elbows, tees, and flanges.

2.4 PIPE INSULATION (RIGID POLYISOCYANURATE TYPE)

A. Preformed Rigid Polyisocyanurate Insulation: Cellular foam complying with ASTM C591, rigid molded, non-combustible. 2-lb./ft3 nominal density. Maximum thermal conductivity (k) shall be 0.19 -in/ft2 hr. °F at 75°F mean temperature.

2.5 PIPE INSULATION (FLEXIBLE TYPE)

A. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials. Adhesive: As recommended by insulation material manufacturer.

B. Insulation 1 inch. thickness and smaller) shall have a flame-spread index of less than 25 and a smoke-developed index of less than 50 as tested by ASTM E84 and CAN/ULC S-102, "Method of Test for Surface Burning Characteristics of Building Materials".

2.6 MATERIALS AND SCHEDULES

A. See Exhibits at the end of this section.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. All materials shall be installed by skilled labor regularly engaged in this type of work. All materials shall be installed in strict accordance with manufacturer's recommendations, building codes, and industry standards.

B. Locate insulation and cover seams in the least visible location. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation. No glass fibers shall be exposed to the air.

C. All pipe insulation shall be continuous through hangers, sleeves, walls, ceiling, floor, or roof openings, unless not allowed by fire stop system. Refer to Sections 220500, "Basic Plumbing Requirements" and 221010, "Piping Systems and Accessories" for firestop systems.

D. Provide thermal insulation on clean, dry surfaces and after piping and equipment (as applicable) have been tested. Do not cover pipe joints with insulation until required tests are completed.

E. All cold surfaces that may "sweat" must be insulated. Vapor barrier must be maintained; insulation shall be applied with a continuous, unbroken moisture and vapor seal. All hangers, supports, anchors, or other projections that are secured to cold surfaces shall be insulated and vapor sealed to prevent condensation. Cover valves, fittings and similar items in each piping system with insulation as applied to adjoining pipe run. Extra care must be taken on piping appurtenances to ensure a tight fit to the piping system. For piping systems with fluid temperatures below ambient, all vapor retarder jacket (ASJ) seams must be coated with vapor barrier coating. All associated elbows, fittings, valves, etc. must be coated with vapor barrier coating and reinforcing mesh to prevent moisture ingress. Valve extension stems require Elastomeric insulation that is tight fitting to the adjoining fiberglass system insulation. Pumps, strainers, drain valves, etc. must be totally encapsulated with Elastomeric insulation.

F. Items such as manholes, handholds, clean-outs, plugged connections, pet cocks, air vents, ASME stamp, and manufacturers' nameplates, may be left un-insulated unless omitting insulation would cause a condensation problem. When such is the case, appropriate tagging shall be provided to identify the presence of these items. Provide neatly beveled edges at interruptions of insulation.

G. Provide protective insulation as required to prevent personal injury.

H. All pipes shall be individually insulated.

I. If any insulation material becomes wet because of transit or job site exposure to moisture or water, the contractor shall not install such material, and shall remove it from the job site.

J. All exposed surfaces shall be white, unless noted otherwise.

3.2 PIPE INSULATION

A. Insulate piping systems including fittings, valves, flanges, unions, strainers, and other attachments installed in piping system, whether exposed or concealed including all piping, valves, etc. within meter/backflow preventer enclosure.

B. Insulation installed on piping operating below ambient temperatures must have a continuous vapor retarder. All joints, seams and fittings must be sealed. Insulation shall be continuous through hangers on all water piping and storm water piping.

C. Hanger Shields: Refer to Section 221010 "Piping Systems and Accessories".

D. Hanger shields shall be installed between hangers or supports and the piping insulation. Rigid insulation inserts shall be installed as required between the pipe and the insulation shields. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required.
1. Pre-Insulated Type: Butt insulation to hanger shields and apply a wet coat of vapor barrier cement to the joints and seal with 3 inch. wide vapor barrier tape.
2. Field Insulated Type: Provide Hamfab Co. "H" blocks per manufacturers recommended spacing between pipe and shield.
3. Tape shields to insulation.

E. Joints in section pipe covering made as follows:
1. All ends must be firmly butted and secured with appropriate butt-strip material. On high-temperature piping, double layering with staggered joints may be appropriate. When double layering, the inner layer should not be jacketed.
2. Standard: Longitudinal laps and butt joint sealing strips cemented with white vapor barrier coating, or factory supplied pressure sensitive adhesive lap seal.
3. Vapor Barrier: For cold services, Longitudinal laps and 4 inch. vapor barrier strip at butt joints shall be sealed with white vapor barrier coating. Seal ends of pipe insulation at valves, flanges, and fittings with white vapor barrier coating.

F. Fittings, Valves and Flanges:
1. Domestic Hot and Cold Water: Premolded fitting insulation of the same material and thickness as the adjacent pipe insulation.
2. White PVC jacketing, with continuous solvent weld of all seams. Tape all fittings.

G. Flexible Pipe Insulation:
1. Split longitudinal joint and seal with adhesive.

2. Fittings made from miter-cut pieces properly sealed with adhesive, or elbows may be continuous.
3. Where exposed outdoors, provide with Alumaguard jacketing.

H. For piping exposed to the elements, jacketing shall be aluminum with a factory applied moisture barrier. Fitting covers shall be of similar materials. The insulation and jacketing shall be held firmly in place with a friction type Z lock or a minimum 2 inch. overlap joint. All joints shall be sealed completely along the longitudinal seam and installed so as to shed water. All circumferential joints shall be sealed by use of preformed butt strips; minimum 2 in. wide or a minimum 2 in. overlap. Butt strips shall overlap the adjacent jacketing a minimum 1/2 in. and be completely weather sealed. Jacket at elbows and tees shall be mitered, or pre-manufactured fitting jackets shall be provided, with additional aluminum holding bands, as required. All joints shall be sealed watertight using specified metal jacketing sealant as recommended by the manufacturer.

I. Apply PVC jacket where indicated, with 1 inch. overlap at longitudinal seams and end joints. Seal with manufacturers recommended adhesive.

J. Apply either aluminum or PVC jacketing to exposed insulated pipe, valves, fittings, and specialties, at an elevation of 8 feet or less above finished floor in mechanical/electrical rooms, penthouses, and services aisles/pipe chases. Fittings of aluminum-jacketed piping may be either aluminum or standard PVC fitting covers.

K. Piping in exterior walls, spaces, overhangs, attics, or where subject to freezing: Insulate pipe with double the thickness called for. Piping in wall chases: In addition to the above, pack chase with loose glass fiber insulation.

L. Provide insulation on exposed hot and cold plumbing piping to within 18 inch. of fixture or equipment connection.

M. Insulate exposed domestic water and waste piping for plumbing fixtures designated for use by the handicapped.

3.3 EXISTING INSULATION

A. Patch existing insulation damaged during the course of the work.

B. Insulate existing piping and equipment as called for.

C. Jacketing for piping in existing areas shall match existing jacketing.

EXHIBIT "I" - PIPE INSULATION MATERIALS

(NOTES AT END OF EXHIBIT "I")

SERVICE	INSULATION MATERIAL	THICKNESS	REMARKS
Domestic cold water	Glass fiber	1-1/2 inch. and larger: 1 inch. 1-1/4 inch. and smaller: 1/2 inch.	SEE NOTES 1, 2
Domestic cold water (buried)	Flexible	1-1/2 inch. and larger: 1 in. 1-1/4 inch. and smaller: 1/2 inch.	
Non potable cold water	Glass fiber	1-1/2 inch. and larger: 1 in. 1-1/4 inch. and smaller: 1/2 in.	SEE NOTE 2
Domestic hot, tempered and circulation water (105°F - 140°F)	Glass fiber	1-1/2 inch. and larger: 1-1/2 inch. 1-1/4 inch. and smaller: 1 in.	SEE NOTES 1, 2
Domestic hot, tempered and circulation water (105°F - 140°F) (buried)	Flexible	1-1/2 inch. and larger: 1-1/2 inch. 1-1/4 inch. and smaller: 1 in.	
Domestic hot, tempered and circulation water (141°F - 200°F)	Glass fiber	1-1/2 inch. and larger: 2 in. 1-1/4 inch. and	SEE NOTES 1

SERVICE	INSULATION MATERIAL	THICKNESS	REMARKS
		smaller: 1-1/2 inch.	
AC unit drains, overflows and indirect waste piping associated with any HVAC equipment	Glass fiber Flexible	All sizes: 1/2 in.	Not required for exposed PVC drains SEE NOTE 2
Storm and secondary storm water	Glass fiber	All sizes: 1 in.	Insulate body of drain and storm water piping, horizontal and vertical, down to connection below ground floor slab or in crawl space SEE NOTE 4
Sanitary and waste	Glass fiber	All sizes: 1/2 in.	SEE NOTE 3, 4

NOTES FOR EXHIBIT I:

NOTE 2: Flexible allowed in 1/2 inch. thickness only.

NOTE 3: Insulation on sanitary and waste piping located within plumbing chases and crawl spaces are not required.

NOTE 4: When PVC piping is installed for storm, sanitary and vent piping within return air plenums, the piping shall be insulated and enclosed in materials listed and labeled for installation within a plenum.

EXHIBIT "II" - EQUIPMENT INSULATION MATERIALS

(NOTES AT END OF EXHIBIT "II")

SERVICE	INSULATION MATERIAL	THICKNESS	REMARKS
Domestic hot water tanks	Calcium silicate	1-1/2 inch. segmented blocks	Secure blocks with galvanized steel bands, 12 inch. O.C., then point with insulating cement. Provide

SERVICE	INSULATION MATERIAL	THICKNESS	REMARKS
			RECOVERING per specification.
	6 lb. fiberglass suitable for 450°F service	3 inch. rigid preformed	Secure fiberglass with pins, studs or clips. Provide RECOVERING per specification. SEE NOTE 1
Emergency generator exhaust piping and mufflers up to 1000□F	Calcium silicate	3 in.	Provide aluminum jacketing
Emergency generator exhaust piping and mufflers up to 2150□F	Ceramic fiber	1-1/2 inch.	Provide vermiculite jacketing
Storm water reclaim tank	Glass fiber	1 inch.	Secure fiberglass with pins, studs or clips. Provide RECOVERING per specification. SEE NOTE 1

NOTES FOR EXHIBIT II:

NOTE 1: Where required, provide welded studs, clips or angles as anchors for bands, wires and mesh.

END OF SECTION 220700

SECTION 221010 - PIPING SYSTEMS AND ACCESSORIES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 SUBMITTALS

A. Provide a schedule of pipe materials, fittings and connections.

B. Provide a detailed matrix listing the specific UL approved firestop system assembly to be used for each type of piping provided and each type of construction to be penetrated along with all associated UL assembly details.

PART 2 - PRODUCTS

2.1 GENERAL

A. Pipe and fittings shall be new, marked with manufacturer's name and comply with applicable ASTM and ANSI Standards.

B. All items here-in used to convey water for potable use shall be lead free in accordance with NSF, Standard 61, Section 9 - Standard for Drinking Water and Lavatory Faucets and NSF Standard 372 - Maximum Lead Requirements. Compliance shall be via third party testing and certification.

2.2 STEEL PIPING AND FITTINGS

A. Pipe: ASTM A53, or ASTM A106 seamless, Schedule 40 or Schedule 80 weight; black or galvanized finish as called for; ends chamfered for welding or grooved for grooved mechanical connections.

B. Fittings: Same material and pressure class as adjoining pipe.
   1. Welded fittings: Factory forged, seamless construction, butt weld type chamfered ends. Where branch connections are two or more sizes smaller than main size, use of "Weldolets", "Thredolets" or "Sockolets" acceptable. Mitered elbows, "shaped" nipples, and job fabricated reductions not acceptable unless specifically called for. Socket weld type, 2000 psi wp, where called for.

2. Threaded fittings: Cast or malleable iron, black or galvanized, as called for; drainage type where called for; UL listed and FM approved for fire protection systems. Street type 45° and 90° elbows are not acceptable.

C. Flanges, Unions, and Couplings:
1. Threaded Connections:
a. Flanges: Cast iron companion type; for sizes 2-1/2 inch. and larger.
b. Unions: Malleable iron, bronze to iron seat, 300 lb. wwp; for sizes 2 inch. and smaller.
c. Couplings: Malleable iron. Steel thread protectors are not acceptable as couplings.
2. Welded Connections:
a. Flanges: Welding neck type. Slip-on type not allowed unless noted and shall not be installed in conjunction with butterfly valves.

2.3 STEEL PIPING AND FITTINGS - PRESS CONNECT FITTINGS

A. Piping Standard: Black steel piping shall conform to ASTM A53 or ASTM A106 seamless, Schedule 40 weight pipe.

B. Fittings: Listed in accordance with ANSI LC 4/CSA 6.32.
1. For natural gas service, -40 deg. F to 180 degrees Fahrenheit at 125 PSI.
2. Sizes 1/2 inch through 4-inch, Schedule 40.
3. Schedule 40 steel fittings with zinc/nickel coating for use with IPS schedule 40 carbon steel, pipe conforming to ASTM A53 or ASTM A106. Fittings shall have an HNBR sealing element, 420 stainless steel grip ring, separator ring and "Smart Connect" (SC) feature.

C. Design Make: Viega Mega Press G System.

D. Acceptable Manufacturer: Viega.

2.4 COPPER TUBE AND FITTINGS

A. Pipe: ASTM B88; Type K or L, hard temper. Soft temper only as called for. Plans show copper tube sizes.

B. Fittings: Wrought copper and copper alloy, ASME B16.22 or cast copper alloy, ASME B16.18; solder end connections.

C. Joints: Comply with the requirements of ASTM B828.

D. Unions and Flanges: 2 inch. and smaller use unions, solder type, cast bronze, ground joint, 150 lb. swp: 2-1/2 inch. and over use flanges, cast bronze, companion type, ASME drilled, solder connection, 150 lb. swp.

E. Flux Materials: Flux shall comply with ASTM B813 and the provisions of the New York State Plumbing Code.

F. Solder Materials: No-lead solder, using alloys made from tin, copper, silver and nickel. Harris, Inc., "Stay-Safe 50" and "Bright", Engelhard "Silvabright 100", Canfield "Watersafe" or approved equal.

G. Brazing Materials: Class BcuP-5 for brazing copper to brass, bronze to copper. Harris, Inc. "Stay-Silv 15" or approved equal.

2.5 COPPER TUBE AND FITTINGS - PRESS FITTINGS

A. Tubing Standard: Copper tubing shall conform to ASTM B75 or ASTM B88.

B. Fitting Standard: Copper fittings shall conform to ASME B16.18, ASME B16.22, or ASME B16.26.

C. Press Fittings: Copper press fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. O-rings for copper press fittings shall be EPDM.

D. Acceptable Manufacturers: Apollo, Mueller, Nibco, Viega.

2.6 COPPER DRAINAGE TUBE AND FITTINGS

A. Pipe: ASTM B306, Type DWV, hard temper.
1. Copper not allowed for urinal waste.

B. Fittings: Wrought copper, ANSI B16.29 or cast bronze, ANSI B16.23; solder end connections.

C. Flux Materials: Flux shall comply with ASTM B813 and the provisions of the New York State Plumbing Code.

D. Solder Materials: No lead solder, using alloys made from tin, copper, silver and nickel.

E. Acceptable Manufacturers: Harris, Inc., "Stay-Safe 50" and "Bright", Engelhard "Silvabright 100", Canfield "Watersafe", or approved equal.

2.7 BRASS PIPE AND FITTINGS

A. Piping: ASTM B43, semi-annealed, red brass containing not less than 85% copper; chrome plated where called for.

B. Fittings: Cast brass, sps, malleable iron pattern, reinforced corresponding to weight of pipe; chrome plated with high polished finish where called for.

2.8 HUB AND SPIGOT CAST IRON SOIL PIPE AND FITTINGS

A. Pipe: ASTM A74 service weight cast iron, bitumen coated.

B. Fittings: Cast iron, service weight, hub and spigot, drainage pattern, bitumen coated.

C. Connections: ASTM C564 neoprene gaskets and lubricant.

D. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.

2.9 NO-HUB CAST IRON SOIL PIPE AND FITTINGS

A. Pipe: ASTM A888, CISPI Standard 301, no-hub cast iron, bitumen coated.
   1. For above grade only.

B. Fittings: Cast iron, no-hub drainage pattern, bitumen coated.

C. Couplings:
   1. 1-1/2 inch. to 2 inch.: CISPI standard 310 with 300 series stainless steel corrugated shield and clamp assembly with ASTM C564 neoprene sealing sleeve (or) same as specified for 3 inch. and larger.
   2. 3 inch. and Larger: 24 gauge, Type 304 stainless steel housing clamp assembly with ASTM C564 neoprene sealing sleeve, 60 inch. lbs. minimum torque rating, shall meet requirements of pipe manufacturer and shall be compatible with specified pipe. Acceptable Manufacturers: Clamp-All Coupling System, Tyler "Wide Body", Husky "Series 2000", Mission "Heavy Weight", Ideal Tridon or approved equal.

D. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.

2.10 PVC SOLID WALL PIPE AND FITTINGS - DWV SYSTEM

A. Pipe: PVC Schedule 40 solid wall pipe, iron pipe size conforming to ASTM D1785 and ASTM D2665. Pipe shall be manufactured from PVC compounds as identified in ASTM D1784. Both pipe and fittings shall conform to National Sanitation Foundation Standard 14.

B. Fittings: Type DWV, socket type conforming to ASTM D2665. Fittings shall be manufactured from PVC compounds as identified in ASTM D1784. Solvent cement joints shall be made utilizing a two-step process with primer manufactured for thermoplastic piping and solvent cement conforming to ASTM D2564.

2.11 HANGERS, INSERTS AND SUPPORTS

A. Hangers, Inserts, Clamps: B-Line, Grinnell, Michigan Hanger, PHD Manufacturing.

B. Hangers:

1. Adjustable, wrought malleable iron or steel with electroplated zinc or cadmium finish. PVC coated where in contact with copper piping.
2. Adjustable ring type where piping is installed directly on hanger for piping 3 inch. and smaller.
3. Adjustable steel clevis type for piping 4 inch. and larger.
4. Nuts, washers and rods with electroplated zinc or cadmium finish.
5. Provide hot dipped galvanized finish for hangers and accessories installed in exterior locations and interior areas with moist environment conditions such as pools, pool filter rooms, areaways, garages and similar areas.

C. Spacing Schedule:

Pipe Size	Steel	Copper	Plastic	Cast Iron	Rod Size
3/4 inch. to 1 inch.	8 feet	6 feet	3 feet	Each	3/8 inch.
1-1/4 inch. to 2 inch.	10 feet	6 ft.	3 ft.	Horizontal	3/8 inch.
2-1/2 inch. to 4 inch.	12 feet	10 ft.	4 feet	Joint 5 feet	1/2 in.
5 inch. and over	12 ft.	10 ft.	4 ft.	Maximum	5/8 inch.
8 in.	12 ft.	10 ft.	4 ft.	O.C.	3/4 in.
Over 8 in.	To suit loading conditions.				

D. Cast Iron No-Hub Supports:
1. In accordance with manufacturer's recommendations.
2. Vertical piping supported at each stack base, at each floor and 15 feet on center, maximum. Freestanding vertical pipe should be adequately staked or braced during construction to maintain alignment. Bases of stacks shall be supported on concrete, brick laid in cement mortar, metal brackets attached to the building construction or by other methods approved by the Owner's Representative.
3. Horizontal piping supported within 24 inch. each side of the coupling joint at 10 feet intervals for 10 ft. pipe lengths and at 5 feet intervals for 5 ft. pipe lengths. Supports or hangers placed to maintain alignment and grade with provision made to prevent shear. Greater than 3 inch. diameter pipe braced at changes of direction to prevent horizontal movement.

E. Beam Attachments:
1. C-Clamp style, locknut, restraining strap, electroplated finish, UL listed, FM approved for pipe sizes 2 inch. and smaller.
2. Center loaded style with clamp attachments that engage both edges of beam, electroplated finish, UL listed, FM approved, for pipe sizes larger than 2 inch., refer to "Supports" for additional requirements.

F. Inserts: Carbon steel body and square insert nut, galvanized finish, maximum loading 1300 lbs., for 3/8 inch. to 3/4 inch. rod sizes, reinforcing rods on both sides, MSS-SP-69 Type 19 or approved equal.

G. Supports:
1. Provide intermediate structural steel members where required for hanger attachment. Members shall span across the bar joists at panel points of joists. Secure member to structure. Select size of members based on a minimum factor of safety of four.
2. For Weights Under 1000 lbs.: "Drill-In" inserts, "U" shaped Channel, beam clamps or other structurally reviewed support. The factor of safety shall be at least four. Follow manufacturer's recommendations.
3. For Weights Above 1000 lbs.: Drill through floor slabs and provide flat flush plate welded to top of rod or provide additional "Drill-In" inserts and hangers to reduce load per hanger below 1000 lbs.
4. For Metal Decks: Drill hole through for hanger rods and imbed a welded plate in concrete or use devices designed for this application, with a safety factor of four.
5. For Wood Construction: Provide hangers and supports designed for attachment to wood construction.
6. Acceptable Manufacturers: Hilti, ITW Ramset, Phillips "Red Head" or approved equal.

H. Roof Pipe Supports - Deck Mounted Rail:
1. Raised cant for insulated roof, heavy-gauge galvanized steel with integral base, 2 x 4 pressure treated wood nailer, removable galvanized steel counter flashing.
2. Steel channel track, roller assembly and accessories, adjustable, locking devices in roller assembly, all parts galvanized except painted cast iron roller.
3. Length as required for quantity of pipes to be supported. Anchor to roof deck per manufacturer.
4. Acceptable Manufacturers: Pate #PRS-5A or approved equal.

I. Roof Pipe Supports - Fixed and Adjustable Pillow Block Style:
1. Pipe support for placement on roof surface with base perforated for drainage. Provide pipe anchor strap option and manufacturer's support pad or roofing manufacturer's recommended slip sheet below support. Support models shall be selected based on total pipe O.D. and pipe weight operating full. All polycarbonate materials shall be UV stabilized.
2. Fixed Height Pipe Stand: For bare piping up to 5 inch. nominal or insulated piping up to 6 inch. outside diameter. Polycarbonate resin base plate with fixed height self-lubricating polycarbonate roller supported by glass-filled nylon or stainless steel rod. Miro Industries Model R Series.

3. Adjustable Height Pipe Stand with Polycarbonate Base: For bare piping up to 5 inch. nominal or insulated piping up to 6 inch. outside diameter. Polycarbonate base plate with adjustable stainless steel all thread rod vertical supports, polycarbonate roller on stainless steel rod. Miro Industries Model RAH Series.
4. Adjustable Height Pipe Stand with Metal Base: For bare piping 4 inch. to 6 inch. nominal or insulated piping up to 7 inch. outside diameter. 12 inch. by 16 in. wide stainless steel base plate with adjustable stainless steel all thread rod vertical supports, polycarbonate roller on stainless steel rod. Miro Industries Model RAH (SS) Series.
5. Pipe Hanger Stand with Polycarbonate Base: For bare piping up to 2-1/2 inch. nominal or insulated piping up to 3-1/2 inch. outside diameter. 9 inch. by 15 inch. wide polycarbonate resin base plate with adjustable stainless steel all thread rod vertical supports, galvanized top strut with clevis hanger suspended on stainless steel all thread rod. Miro Industries Model 2.5-SB-H Series.
6. Adjustable Height Pipe Stand with Metal Base: For bare piping up to 6 inch. nominal or insulated piping up to 7-1/2 inch. outside diameter. Two (2) 8 inch. by 14 inch. wide stainless ssteel base plates, with adjustable height galvanized braced strut assembly with clevis hanger suspended on a stainless steel all thread rod. Miro Industries Model 6-H Series.

J. Hanger Insulation Shields:
1. Hanger insulation shields shall be provided for all water and storm water piping. Hangers shall attach directly to pipe for all remaining services.
2. Piping 2 inch. and Smaller: Pipe insulated with glass fiber insulation shall be protected at point of support by a sheet metal shield. Shield shall be #18 gauge, galvanized steel, minimum 120 degree arc, formed to fit insulation thickness and 12 in. long. Tape shields to pipe insulation.
3. Piping 3 inch. and Larger: Pipe insulated with glass fiber insulation shall be protected at point of support by a sheet metal shield and pipe support insulation insert(s) between pipe and hanger. Shield shall be #18 gauge, galvanized steel, minimum 120 degree arc, formed to fit insulation thickness and 12 inch. long. Tape shields to pipe insulation. Provide temporary blocking to maintain proper spacing for insulation.

K. Provide continuous support for unpigmented polypropylene piping.

L. Piping systems with material not listed above shall be supported and protected in accordance with manufacturer's recommendations.

2.12 PIPING ACCESSORIES

A. Escutcheon Plates: Steel or cast brass, split hinge type with setscrew, high plates where required for extended sleeves. Chrome plated in finished areas and at plumbing fixtures.

B. All cleanout plugs, bushings and nipples, required for instruments and gauges shall be brass.

C. Hubless cast iron fitting restraints shall be Holdrite Series #117 or approved equal.

2.13 SLEEVES

A. Standard Type:
1. Schedule 40 black steel pipe sleeves for structural surfaces, two pipe sizes larger than the pipe, and as recommended by the sealing element manufacturer. Provide full circle water stop collar for sleeves located within below grade walls, wet wells and waterproofed surfaces. The collar shall be fabricated from steel plate and welded to the sleeve around its entire circumference.
2. Schedule 40 PVC sleeves or sheet metal sleeves for nonstructural surfaces and existing construction. Sheet metal sleeves shall be 18 gauge minimum and braced to prevent collapsing.

2.14 SEALING ELEMENTS

A. Expanding neoprene link type, watertight seal consisting of interlocking links with zinc plated bolts.
1. Acceptable Manufacturers: Thunderline "Link-Seal" Series 200, 300 or 400, Pyropac, Calipco.

2.15 FIRESTOP SYSTEM FOR OPENINGS THROUGH FIRE RATED WALL AND FLOOR ASSEMBLIES

A. Materials for firestopping seals shall be listed by an approved independent testing laboratory for "Through-Penetration Firestop Systems". The system shall meet the standard fire test for Through-Penetration Firestop Systems designated ASTM E814. Firestop system seals shall be provided at locations where piping pass through fire rated wall, floor/ceiling, or ceiling/roof assembly. Minimum required fire resistant ratings of the assembly shall be maintained by the Firestop System. Installation shall conform with the manufacturer's recommendations and other requirements necessary to meet the testing laboratory's listing for the specific installation.

2.16 STACK SLEEVE

A. Cast iron body with caulking recess, flashing clamp and under deck clamp.

B. Acceptable Manufacturers: Jay R. Smith Series 1720, Zurn, Wade.

2.17 PIPING MATERIALS AND SCHEDULE

A. See Exhibit "A", "Schedule of Piping Materials" at end of this Section for (Plumbing) piping.

B. See Exhibit "B", "Testing" at end of this Section.

PART 3 - EXECUTION

3.1 EQUIPMENT AND SYSTEMS

A. Install equipment and systems in accordance with provisions of each applicable Section of these Specifications, and Local/State Codes/Regulations having jurisdiction. Accurately establish grade and elevation of piping before setting sleeves. Install piping without springing or forcing, except where specifically called for, making proper allowance for expansion and anchoring. Changes in sizes shall be made with reducing fittings. Reducing couplings are not acceptable. Arrange piping at equipment with necessary offsets, unions, flanges, and valves, to allow for easy part removal and maintenance. Offset piping and change elevation as required to coordinate with other work. Avoid contact with other mechanical or electrical systems. Provide adequate means of draining and venting units, risers, circuits and systems. Conceal piping unless otherwise called for. Copper tubing shall be cut with a wheeled tubing cutter or other approved copper tubing cutter tool. The tubing must be cut square to permit proper joining with the fittings. Ream pipes after cutting and clean before installing. Cap or plug equipment and pipe openings during construction. Install piping parallel with lines of building, properly spaced to provide clearance for insulation. Make changes in direction and branch connections with fittings. Do not install valves, unions and flanges in inaccessible locations. Materials within a system and between systems shall be consistent. If this is not possible, install dielectric fittings.

3.2 PIPING OVER ELECTRICAL EQUIPMENT

A. Contractor shall route piping to avoid installation directly over electric equipment, including, but not limited to panels, transformers, disconnects, starters, motor control center, adjustable speed drives and fused switches.

B. Piping shall not be installed in the dedicated electric and working space as defined by NEC 110. Dedicated electrical space is generally equal to the depth and width of electrical equipment, and extends 6 feet above the electrical equipment, or to a structural ceiling. Dedicated working space is a minimum of 30 inch. wide or the width of equipment (whichever is larger) a minimum of 6 ft.-6 inch. tall, with a depth of 3ft. to 9 feet depending on the voltage.

3.3 HANGERS, INSERTS AND SUPPORTS

A. Piping shall not be supported by wires, band iron, chains, from other piping, or by vertical expansion bolts. Support piping with individual hangers from concrete inserts, wood construction, welded supports, or beams clamps of proper configuration and loading design requirements for each location; replace if not suitable. Follow manufacturer's safe loading recommendations. Suspend with rods of sufficient length for swing and of size called for, using four (4) nuts per rod. Provide additional structural steel members, having one coat rustproof paint, where required for proper support. Provide oversized hangers where insulation/supports must pass between pipe and hanger. Provide continuous support or extra supports for plastic piping per manufacturer's requirements. Hangers, when attached to joists, shall only be placed at the top or bottom chord panel point. Only concentric type hangers are permissible on piping larger that 2-1/2 inch.; "C" types are permitted for piping 2 inch. and smaller on joists. Provide riser clamps for each riser at each floor. Use trapeze hangers where a group of piping can be installed.

B. Provide a pipe hanger within 12 inches of pipe unions and piping connections to equipment, in order to facilitate disconnections of piping without pipe sagging.

3.4 HANGERS ATTACHED TO JOISTS

A. Individual hangers may be suspended directly from the bottom chord panel point provided that the sum of the concentrated loads within the chord panel does not exceed 100 pounds and the attachments are concentric to the chord. (Eccentrically loaded joists using beam clamps or other attachment methods are not acceptable.)

B. For nominal concentrated loads between panel chords, which have been accounted for in the specified uniform design load for the joists, this Contractor is to provide struts to transfer the load to a panel point on the opposite chord as reviewed and acceptable by the Structural Engineer of Record.

3.5 PIPE CONNECTIONS

A. No-Lead Solder Connections: Nonacid flux and clean off excess flux and solder.

B. Copper Press Connections: Copper press fittings shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.

C. Steel Press Connections:

1. Natural Gas Systems: Sealing elements shall be verified for the intended use. Pipe ends shall be cut on a right angle (square) to the pipe. Pipe ends shall be reamed and all paint, lacquer, grease, oil, and dirt shall be removed from the pipe end with an abrasive cloth, or with a Ridgid MegaPress pipe end prep tool. Visually examine each fitting sealing element to ensure there is no damage. Insert the pipe fully into the fitting and mark the pipe wall at the face of the fitting. Always examine the pipe to ensure it is fully inserted into the fitting prior to pressing the joint. Steel Press fittings shall be installed using Ridgid, MegaPress Tools. Steel Press fittings shall be installed according to the most current edition of the manufacturer's installation guidelines. Installers shall be trained by a manufacturer representative on proper installation procedures.
2. Testing: After Steel Press fittings have been installed a “two step test” shall be followed. Utilizing air or, dry nitrogen, pressurize the system between 5 psi and 45 psi. Check the pressure gauge for pressure loss. If the system does not hold pressure, inspect entire system and check for un-pressed fittings. Should un-pressed fittings be identified, ensure the pipe is fully inserted into the fitting and properly marked prior to pressing the joint. After appropriate repairs have been made, test the system per local code, or specification requirements, not to exceed 200 psig.

D. Brazed Connections: Make joints with silver brazing alloy in accordance with manufacturer's instructions. Remove working parts of valves before applying heat.

E. Threaded Connections: Clean out tapering threads, made up with pipe dope; screwed until tight connection. Pipe dope must be specifically selected for each application.

F. Flanged Joints: Select appropriate gasket material, size, type and thickness for service applications. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

G. Dielectric Pipe Fittings: Provide dielectric unions at ALL equipment connections where dissimilar metals meet. In addition, provide dielectric unions in all open type piping systems (condensing water, domestic water, etc.) where dissimilar metals are to be joined.

H. FRP Pipe Joints: Bonded with resin catalyst adhesive.

I. Grooved Mechanical Joints: Pipe to be prepared in accordance with the latest manufacturer's grooving specification. Use manufacturer's recommended grooving tools. Pipe shall be checked to be sure it is free of indentations, projections; weld seams or roll marks on the exterior of the pipe over the entire gasket seating area. Pipe ends are to be square cut. Lubricant shall be applied to gasket and/or pipe ends and housing interiors to eliminate pinching the gasket.

J. Solvent-Cement Plastic Piping Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join according to ASTM D 2846.
3. PVC Piping: Join according to ASTM D2855.

3.6 WELDING

A. Welding shall be performed in compliance with the welding procedure specifications prepared by the National Certified Pipe Welding Bureau. Welded pipe fabricated by certified welder. Contractor shall submit proof of current certification of each welder if requested by Owner. Use full-length pipe where possible; minimum distance between welds, 18 inch. on straight runs. Welds must be at least full thickness of pipe inside smooth and remove cutting beads, slag and excess material at joints; chamfer ends. Minimum gap 1/8 inch., maximum 1/4 inch., for butt welds. Overlaps on position and bench welds to be not less than 3/4 inch. One internal pass and one external pass minimum required on slip-on flanges. Do not apply heat to rectify distorted pipe due to concentrated welding; replace distorted pipe.

B. When welding galvanized pipe, apply cold galvanizing on joint following welding.

3.7 SLEEVES

A. Provide for pipes passing through floors, walls or ceilings. Not required for floors that are core-drilled, except where floor is waterproofed.

B. Extend 1/8 inch. above finished floor in finished areas. In above grade Mechanical Rooms and other areas with floor drains, use steel pipe sleeves 2 inch. above floor.

C. Use steel pipe sleeves in bearing wall, structural slabs, beams and other structural surfaces, and where called for.

D. Sleeves shall be as small as practical, consistent with insulation, so as to preserve fire rating.

E. Fill abandoned sleeves with concrete.

F. Provide rubber grommet seals for pipes passing through ducts or air chambers or built-up housings.

3.8 SLEEVE PACKING

A. Seal void space at sleeves as follows:
1. Interior Locations: Firmly pack with fiberglass and caulk.
2. Exterior Walls and Below Grade Cored Holes: Use sealing element.
3. Cored Holes: Use sealing element.

4. Fire Rated, Partitions and Floor Slabs: Use fire rated sealing elements, materials and methods. Provide per manufacturer's instructions to maintain firestop.
5. Waterproofed Walls/Floors: Use waterproof sealing element, device or compound.

3.9 ESCUTCHEON PLATES

A. Provide polished chrome setscrew type escutcheon plates for all exposed piping passing through floors, walls or ceilings, in all rooms except in Boiler, Fan and Mechanical Rooms.

3.10 TESTS

A. Refer to Exhibit "B" at the end of this section for testing of Plumbing Systems.

B. Provide all necessary items to complete proper testing of work. Perform all testing in accordance with governing Codes, local utilities and other agencies having jurisdiction and as specified. Pay all costs to perform tests. Perform all testing in a safe manner. Isolate existing systems.

C. Domestic Water:
1. Do not cover joints with insulation until required tests are completed and the Owner's Representative accepts the system.
2. Make leaks tight; no caulking permitted. Replace defective fittings, pipe or connections. Piping shall be tight and show no loss of pressure.
3. Air test not acceptable as final test.
4. Confirm in writing that tests and flushing have been conducted and successfully completed. Submit copy of the test report to Owner's Representative.

D. Sanitary and Storm:
1. There shall be no loss of water when testing interior piping.
2. Air test not acceptable as final test.
3. Should any leaks, defective joints or defective construction be detected in sewers and/or floors or walls of appurtenant structures, they shall be permanently stopped. Should any defective pipes, fittings or accessories be discovered they shall be removed and replaced at the Contractor's expense.
4. Confirm in writing that tests have been conducted and successfully completed. Submit copy of the test report to Owner's Representative.

3.11 DOMESTIC WATER PIPING CLEANING AND DISINFECTION

A. Cleaning and disinfecting shall be in accordance with requirements of New York State Department of Health and authority having jurisdiction. Prior to disinfecting, flush piping to remove any sediment and debris.

B. Clean and disinfect water distribution piping systems and parts of existing potable water systems that have been altered, extended or repaired.

C. After disinfection procedures, submit water samples in sterile bottles to an approved Department of Health Laboratory. Samples shall be proven equal to the water quality served to the public from the existing water supply system and acceptable to the Department of Health. Flush and disinfect all sections of pipe that fail the laboratory tests. Submit test results indicating water is potable.

3.12 CONNECTIONS TO SPECIAL EQUIPMENT

A. Kitchen Equipment:
1. Kitchen Equipment shall be furnished by others and set in place by others.
2. Provide all piping, stops, valves, traps and fittings.
3. Where exposed, provide chrome plated brass piping, valves, hangers, brackets and accessories.
4. Pipe relief valves to floor. Size and arrangement of pipe, traps, valves and fittings, as recommended by manufacturer of equipment.

3.13 PIPE LINE SIZING

A. Pipe sizes called for are to be maintained. Pipe size changes made only as reviewed by Owner's Representative. Where discrepancy in size occurs, the larger size shall be provided.

EXHIBIT "A" - PIPING MATERIALS (PLUMBING)

(NOTES AT END OF EXHIBIT "A")

SERVICE	PIPE MATERIALS	FITTINGS	CONNECTIONS
DOMESTIC WATER INTERIOR/HOT, COLD AND CIRCULATING 3 INCH. AND SMALLER	TYPE L COPPER	WROUGHT OR CAST COPPER	NO-LEAD SOLDER
	TYPE L COPPER	WROUGHT OR CAST COPPER	PRESS FIT
SANITARY, SANITARY VENT, GREASE WASTE AND STORM (BURIED)	SEE "UNDERGROUND PIPING AND ACCESSORIES" SECTION 221020		
SANITARY, SANITARY VENT AND GREASE WASTE	SERVICE WEIGHT CAST IRON SOIL PIPE	CAST IRON HUB AND SPIGOT	NEOPRENE COMPRESSION TYPE GASKET

SERVICE	PIPE MATERIALS	FITTINGS	CONNECTIONS
	SERVICE WEIGHT CAST IRON SOIL PIPE	NO HUB	NO HUB NEOPRENE GASKET AND STAINLESS STEEL CLAMP ASSEMBLY
	TYPE DWV COPPER	WROUGHT COPPER	NO-LEAD SOLDER (SEE NOTE 5)
	SCHEDULE 40 PVC, SOLID WALL	PVC, SOCKET TYPE	SOLVENT CEMENT (SEE NOTE 4)
NATURAL GAS (EXTERIOR ABOVE GRADE)	SCHEDULE 40, BLACK STEEL	BUTT WELDED STEEL	WELDED (SEE NOTE 2)
	SCHEDULE 40, BLACK STEEL	MALLEABLE IRON, 2 INCH. AND SMALLER	THREADED (SEE NOTE 2)
	SCHEDULE 40, BLACK STEEL	STEEL WITH ZINC/NICKEL COATING	PRESS FIT

NOTES FOR EXHIBIT A:

NOTE 1: Provide ductile iron, double thickness cement - lined pipe and fittings up to the water meter inlet valve in accordance with the New York State Plumbing Code and Water Bureau Requirements. Pipe and fittings shall be flanged.

NOTE 2: Provide one coat of alkyd primer and two coats of exterior acrylic latex gloss enamel on exposed exterior and interior piping. Color as selected.

NOTE 3: For gas piping systems having operating pressure other than the standard 50 to 55 psig, provide Type K copper for medical gas.

NOTE 4: PVC piping shall not be installed within return air plenums.

NOTE 5: Copper piping shall not be used for urinal waste piping.

NOTE 6: CPVC piping, copper tube size (SDR11) permitted for piping 2 inch. and smaller. CPVC piping, Schedule 80 permitted for piping 3 inch. and larger.

NOTE 7: Siphonic roof drain piping shall be restrained to prevent movement and assure the integrity and connectivity of pipe joints at no less than every change in direction.

NOTE 8: All uninsulated piping supported by trapeze hangers shall be securely fastened to each hanger using strut-mounted cushion clamps.

EXHIBIT "B" - TESTING

SERVICE	TEST REQUIREMENTS
DOMESTIC WATER	TEST HYDROSTATICALLY AT 150 PSI FOR TWO (2) HOURS OR AT 1.5 TIMES THE WORKING PRESSURE WHEN WORKING PRESSURE EXCEEDS 100 PSI
SANITARY, SANITARY VENT, STORM	MAINTAIN 10 FEET HEAD OF WATER FOR TWO (2) HOURS.
NATURAL GAS	REFER TO SECTION 227010 - "NATURAL GAS SYSTEMS".

END OF SECTION 221010

SECTION 221100 - WATER SUPPLY

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 QUALITY ASSURANCE

A. Follow all requirements, recommendations and appendices to comply with the following publications, codes, standards, and listings/approvals:
   1. ANSI/AWWA C600: AWWA Standard for Installation of Ductile Iron Water Mains and Their Appurtenances.
   2. NFPA 24: Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
   3. New York State Health Department.
   4. Local municipality and fire department requirements and standards.
   5. All items here-in used to convey water for potable use shall be lead free in accordance with NSF 61, Standard 61, Section 9 - Standard for Drinking Water and Lavatory Faucets and NSF Standard 372 - Maximum Lead Requirements. Compliance shall be via third party testing and certification.

1.3 SUBMITTALS

A. Provide submittals for all items specified under Part 2 of this Section.

PART 2 - PRODUCTS

2.1 WATER PIPING

A. Piping Materials: Refer to Specification Section 221010, "Piping Systems and Accessories" and Section 221020, "Underground Piping and Accessories".

2.2 WATER METER

A. Water Service: Badger E-Series Ultrasonic Flow Meter. Shall meet local Water Authority Standards.

2.3 BACKFLOW PREVENTERS AND ACCESSORIES

A. Reduced Pressure Type (Domestic Water - 2 inch. and Smaller):
   1. All bronze body construction, stainless steel bolts and internal parts, stainless steel check seats. All castings with less than .025% lead content.
   2. Four (4) test cocks, bronze strainer and full port ball valve shutoffs.
   3. Design Equipment: Watts Series LF009SQT.
   4. ASSE Standard 1013: AWWA Standard C511-92
   5. Acceptable Manufacturers: Zurn-Wilkins, Watts.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate work with all other trades and utility companies.

B. Inspect pipe, fittings and equipment prior to installation. Remove all defective materials from the site.

C. Install pipe and equipment in accordance with manufacturer's recommendations and in a workmanlike manner as determined by the Owner's Representative.

3.2 WATER METER

A. Provide pressure gauge on outlet side of meter. Provide line size strainer on inlet side of meter. Provide concrete base or pipe stands to support meter assembly.

B. The water meter assembly and piping arrangement shall be installed in accordance with the local Water Authority Standards.

3.3 BACKFLOW PREVENTERS

A. The backflow preventer installation shall be installed in accordance with the Health Department approved drawings.

B. Prior to installation of backflow preventers, obtain the approved drawings from the Engineer.

C. Provide hub style drain for emergency relief drain with a pipe separation of at least two (2) pipe diameters from backflow preventer relief outlet. Piped Air-Gap NOT PERMITTED

3.4 PIPING

A. Run slightly off level to low points; provide drain valves at low points. Provide shock absorbers where shown or specified. Branch headers serving flush valves shall be full size as shown. Exposed water piping in Kitchen shall be chrome plated brass (from insulation to fixture or equipment connection.). Provide dielectric pipe fittings when connecting to piping systems of dissimilar metals. All supply piping to fixtures, faucets, hydrants and flush valves shall be anchored to prevent movement.

3.5 ARRANGEMENTS

A. Provide for application to and obtain approval from the local Water Authority for connection to municipal systems.

B. Contact the Water Authority for the extent of their work, the costs, fees, required permits and their installation requirements. Make all arrangements, pay all costs, fees and obtain all permits. Include all costs within the base bid.

3.6 CLEANING AND DISINFECTING

A. Refer to Specification Section 221010, "Piping Systems and Accessories" for domestic water piping cleaning and disinfecting requirements.

3.7 TESTS

A. Provide all necessary items to complete proper testing of work. Perform all testing in accordance with governing codes, local utilities and other agencies having jurisdiction and as specified. Pay all costs to perform tests. Perform all testing in a safe manner.

B. Upon completion of construction, all backflow prevention devices provided under this contract shall be tested. Tests shall be performed by a certified backflow preventer tester registered by the New York State Department of Health. Provide three (3) copies of Form DOH-1013 for each device with Part A completed by the tester. Submit forms to Engineer. Pay all costs required for testing devices, including administrative costs associated with satisfying the requirements and regulations of Water Authority and Health Department. Repair or replace any device failing the test and repeat the test.

C. Refer to Specification Section 221010, "Piping Systems and Accessories" for pipe testing requirements.

END OF SECTION 221100

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SECTION 223011 - BACKFLOW PREVENTER ENCLOSURE

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 SUBMITTALS

A. Submit manufacturer's product data for backflow preventer cover. Product data shall include dimensioned drawings and manufacture's installation instructions. Submit in accordance with Division 01 requirements.

1.3 QUALITY ASSURANCE

A. Qualifications: The backflow preventer cover manufacturer shall be a company specializing in the manufacture of backflow preventer covers with at least two (2) years of successful experience.

B. Regulatory Requirements: The backflow preventer cover shall comply with all applicable state and local plumbing codes.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and protect products under provisions of Division 01.

B. Store products in shipping containers and maintain in place until installation.

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTER ENCLOSURE

A. Manufactured Unit: Provide factory fabricated assembly consisting of sheet metal housing, insulation, access panels and drain.

B. Housing: Fabricated from 18 gauge aluminum, paint grip sheet metal panels, and faced insulation. Housing shall be supported with 14 gauge galvanized steel angle braces and wood support members. Panels shall be assembled such that any panel can be removed for access.

C. Insulation: Minimum 1-1/2 inch. thick closed cell faced insulation with a minimum R value of 8.

D. Drain: The housing shall include an integral insulated hinged panel designed to open against hydrostatic pressure. The opening area of the hinged panel shall be sized to accommodate full flow discharge.

E. Electric heater equal to 90W – qty 2.

F. Mounting Hardware:
   1. Mounting hardware and threaded fasteners shall be 300 series stainless steel.
   2. Masonry fasteners shall be Hilti metal hit anchors.
   3. Screw fasteners No. 12 or larger shall be hex head.
   4. Enclosure shall be assembled and mounted to concrete pad in such a way that it will remain locked and secured to pad even if outside screws are removed.
   5. Handle shall be recessed lockable type.
   6. Provide padlock to suit Owner requirements.

G. Make: Watts DuraFold.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventer cover in accordance with manufacturer's installation instructions.

B. Coordinate work of this section with work of other trades.

C. Select backflow preventer cover to allow adequate clearance for access to backflow preventer.

D. Coordinate installation of backflow preventer cover with installation of electric heat/heat tracing.

E. Color as selected by Owner.

END OF SECTION 223011

SECTION 223400 - WATER HEATERS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Work of this section shall be performed in accordance with the requirements of the Contract Documents, including but not limited to Instructions to Bidders, Agreement and General Conditions, General Requirements and Basic Mechanical/Electrical Requirements.

B. Provide labor, materials, equipment and services to perform work and related work required by Contract Documents for a complete operating system.

1.2 SUBMITTALS

A. Submit manufacturer's data for approval in accordance with Basic Mechanical/Electrical Requirements. Obtain approval prior to ordering material.

B. Provide submittals for all products to be installed including, but not limited to:
   1. Water Heater.
   2. All Heater Accessories.
   3. All System Wiring Diagrams.

1.3 SPECIAL COORDINATION

A. Coordinate all work of other trades in Mechanical Room.

B. Furnish Division 26 "Electric" with dimensional drawings showing location of electrical connections, location of equipment mounted on walls, and of other equipment requiring electrical connections, removals or replacements.

PART 2 - PRODUCTS

2.1 WATER HEATERS

A. The contractor shall supply and install Qty.: 1 Laars Model No. MT2V 0400 pump-mounted water heater(s).

B. The heater shall be a Laars Mighty Therm2 Model MT2V 0400, rated at the input and output shown on the schedule. The unit(s) shall be design certified to comply with the current edition of the Harmonized ANSI Z21.10.3 / CSA 4.3 Standard for Gas Water Heaters and shall be design certified for both indoor and outdoor use. The unit(s) shall be designed and constructed in accordance with the ASME Boiler & Pressure Vessel Code, Section IV requirements for 160 psi working pressure, and shall bear the ASME "H" Stamp. The unit(s) shall be constructed to comply with the efficiency requirements of the latest edition of ASHRAE Standard 90.1.

C. The water tube heat exchanger shall be a straight tube design with ten 7/8" (22mm) inner diameter integral finned copper tubes. The tubes shall be rolled directly into glass-lined cast iron headers, rated for 160 psi working pressure. The heat exchanger shall be a low water volume design. All gaskets shall be non-metallic, outside the jacket, and separated from the combustion chamber by at least 3.5" (89mm) to eliminate deterioration from heat. Headers shall have covers permitting visual inspection and cleaning of all internal surfaces. The heat exchanger shall have a ten year warranty.

D. The piping side header shall have removable flanges, and the water heater design shall permit removal of the complete heat exchanger for service from either the front or top, to facilitate maintenance.

E. The heater shall come complete with a volute-mounted pump sized to provide the correct heater flow rate, for the heater and 30 feet of full-sized piping. Each unit shall have a pump time delay. The pump time delay shall be adjustable from 0.1 to 10 minutes for continued pump circulation after the call for heat has been satisfied, to remove residual heat from the unit's combustion chamber.

F. The units shall use a proved hot surface ignition with a 15 second pre-purge cycle to clean out the combustion chamber. Upon a call for heat, if a flame is not detected, the ignition module shall attempt two more times before locking out and requiring manual reset. If there is a loss of flame signal during a call for heat, the ignition control shall attempt three re-ignition cycles before locking out. (units with some options, such as ASME CSD-1, are built with single-try ignition controls.) The control circuit shall be 24V. Unit shall be 120V, single phase, less than 12 Amps. Mounted pump shall be 120V, single- phase (Amp draw depends on model size).

G. Burners shall be multi-port design and shall be constructed of high temperature stainless steel. The burners shall be designed to mix air and gas and burn cleanly with NOx emissions not exceeding 10ppm. Burners shall be in easily removable burner tray assemblies with no more than 4 burners per tray.

H. The combustion chamber shall be lined with lightweight, ceramic fiberboard insulation to retain heat, and shall be approved for service temperatures of not less than 2000°F (1093°C). The outer jacket shall be a unitized shell finished with acrylic thermo-set paint baked at not less than 325°F (163°C). The frame shall be constructed of galvanized steel for strength and protection. Chamber shall include a sight glass for viewing flame.

I. Heaters shall have a forced draft design and shall meet a minimum 85% steady state combustion efficiency. The unit shall be designed for vertical venting with standard B-vent as a fan-assisted Category I appliance, and for horizontal venting as a Category III appliance and shall not require an external draft hood. The unit shall accept ducted combustion air or shall be able to pull combustion air from the room.

J. The heater shall have two firing stages, and the heater shall have connections for an external staging control, and a selector switch to enable the user to choose between the water heater's staging control or a field-supplied staging control, without bypassing any of the heater's safety controls.

K. Unit(s) shall have multiple gas trains, such that each gas train shall have a maximum input of 399,000 /hr. Each gas train shall have a gas shutoff valve and main gas valve with built-in redundant valve seats and gas regulator. Flanges or unions shall be used before and after each main gas valve, to permit easy removal of each gas valve, gas train and burner tray assembly from the front of the unit.

L. The heater shall be provided with an integral, washable combustion air filter. The air filter shall provide 83% arrestence to protect the burners and blower(s) from debris. The air filter shall be constructed of open-cell polyurethane foam.

M. Heater shall include as standard equipment the following controls and trim:
- ASME 160 psi working pressure heat exchanger
- ASME "H" stamp
- Flanged water connections
- Glass-lined cast iron headers
- External header gaskets
- 125 psi ASME rated pressure relief valve
- Flow switch
- Multiple operating gas valve/pressure regulators
- Manual "A" gas valve
- Intake air filter
- Multiple, removable burner trays
- Stainless steel burners
- Built-in draft fan(s) for Category I or III venting
- Air pressure switch
- Burner site glass
- 115/24VAC transformer
- Pump, mounted and wired
- Manual reset high limit
- External controller connections with selector switch
- Hot surface ignition
- On/Off toggle switch
- Pump time delay

- Temperature and pressure gauge
- 24V control system

PART 3 - EXECUTION

3.1 WATER HEATERS

A. Install each heater on a 6 inch. high concrete pad.

B. Pipe pressure and temperature relief valve drain to discharge to nearest floor drain.

C. Provide all electric wiring and equipment in accordance with manufacturer's wiring diagrams and instructions. Make all final connections.

D. Provide all piping, valves and fittings in accordance with manufacturer's piping instructions. Make all final connections.

E. Provide equipment in accordance with contract drawings and all local codes.

F. Provide start-up services of a factory trained technician to inspect the installation based on factory recommendations. Items include but are not limited to:
1. Verification of proper piping arrangement.
2. Fuel supply piping and connection(s).
3. Combustion efficiency.
4. Verification of proper temperature rise across heater(s).
5. Verification of proper venting with draft reading.
6. Operating and safety controls.
7. Proper operation of equipment.
8. Verification of piping arrangement and aquastat location.
9. Verification of proper gas pressure to unit and to burners.
10. Relief valve settings and AGA BTU capacities.
11. All control settings.

G. Submit three (3) copies of startup reports in writing with all factory checkout data signed by the factory authorized service agent to the Owner's Representative.

H. Place equipment in operation.

I. The installation of water heaters shall be based on the details shown on the drawings and specified in this Section. Approved water heaters provided other than type shown or specified shall be installed in accordance with manufacturer's recommended installation instructions and piping diagrams.

END OF SECTION 223400

SECTION 224000 - PLUMBING FIXTURES AND TRIM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 SUBMITTALS

A. Submit manufacturer's data in accordance with Basic Mechanical/Electrical Requirements. Obtain approval prior to ordering material.

B. Provide submittals for all items specified under Part 2 - Products of this section.

1.3 DESCRIPTION OF FIXTURES

A. Fixtures and trim shall be of those manufacturers listed, unless otherwise indicated. Fixtures for this project shall be of same manufacturer.
   1. Fixtures: American Standard, Kohler, Mansfield, Sloan, Toto, Watts or Zurn.
   2. Faucets: Chicago Faucets, Delta, Moen, Symmons, T&S Brass or Zurn. All faucets shall be lead-free in accordance with NSF 61 and NSF 372.
   3. Flushometers: Sloan "Regal XL" or Zurn.
   4. Closet Seats: Bemis, Beneke, Church or Olsonite.
   5. Fixture Carriers: Jay R. Smith, Watts, Wade, Josam or Zurn.
   6. Sinks: Elkay, Just or Kohler.
   7. Water Coolers: Elkay, Haws, Murdock or Oasis.
   8. Supplies, Stops and Traps: Brasscraft, EBC, McGuire or Sanitary Dash.

B. Exposed parts of trim shall have polished chrome plated finish.

C. Tubular drainage products ("P" traps, nipples, etc.) shall be 17 gauge brass.

1.4 QUALITY ASSURANCE

A. Comply with requirements of the Plumbing Fixture Law of the New York State Department of Environmental Conservation.

B. Comply with the American Disabilities Act Guidelines and ANSI A117.1 "Accessible and Usable Buildings and Facilities".

C. All items here-in used to convey water for potable use shall be lead free in accordance with NSF Standard 61, Section 9 Standard for Drinking Water and Lavatory Faucets and NSF Standard 372 - Maximum Lead Requirements. Compliance shall be via third-party testing and certification.

D. All fixture trim used to convey water for potable use shall be lead free.

PART 2 - PRODUCTS

2.1 SINKS

A. SK-A (HDCP):
1. Elkay Lustertone LRAD2219, 22 inch. x 19 inch. x 6 inch. deep, nickel type 302 stainless steel single bowl sink, ADA compliant, three (3) faucet holes, 18 gauge, self rimming for countertop installation, fitted with the following:
   a. F-A faucet as specified herein.
   b. Elkay #LKAD18 stamped brass drain outlet with 3 inch. perforated grid strainer and LKADOS 1-1/2 inch. O.D. offset tailpiece.
   c. McGuire #8912 semi-cast brass adjustable "P" trap, 1-1/2 inch. x 1-1/2 inch., with cleanout plug and cast brass escutcheon with set screw.
   d. McGuire #LF2167LKF, lead-free, 1/2 inch. copper sweat supplies with 1/2 in. OD flexible risers, loose key stops and cast brass escutcheons with set screws.

2.2 FAUCETS

A. F-A: Chicago Faucets #895-317FCABCP, lead-free manual close faucet, quarter-turn cartridges, deck mounted, 4 inch. centers, 4 in. wrist blade handles with color coded indexes, rigid/swing plain end gooseneck spout with 1.5 GPM laminar flow control device in spout base, ADA compliant. For 0.5 GPM add #50-046KJKABNF 0.5 GPM FC device.
1. Powers #LFe480, lead-free, tempering valve, 3/8 inch. rough chrome finish.

PART 3 - EXECUTION

3.1 FIXTURES, EQUIPMENT AND SYSTEMS

A. Install fixtures, equipment and systems as shown on Drawings or specified herein in accordance with provisions of each applicable Specification Section and all local and state codes having jurisdiction.

3.2 INSTALLATION OF PLUMBING FIXTURES

A. Install plumbing fixtures level and plumb, in accordance with fixture manufacturers written installation instructions.

B. Carefully drill holes for through bolts to avoid chipping blocks or plaster.

C. Except where carriers are specified, attach hangers or brackets to walls as follows:
   1. Masonry Construction: Secure fixture hangers to partition by thru-bolts extending through a steel plate on opposite side of partition. Obtain Owner's Representative's approval prior to work.
   2. Metal Stud Construction: Anchor backing for fixtures or equipment to 1/8 inch. x 12 inch. steel plate bolted or riveted to at least three studs. Obtain Owner's Representative's approval prior to work.

D. Anchor carriers to concrete floor with 1/2 inch. x 3 inch. anchor or thru-bolts and washers. Provide for the drilling of floor and installation of expansion shields. Quantity of anchors:
   1. Water Closets - Four (4).
   2. Lavatories - Eight (8).
   3. Urinals - Eight (8).

E. Seal fixtures in contact with walls, floors and counters using a sanitary-type, one-part, mildew-resistant, silicone caulk. Match color to fixture color.

F. Set self-rimming lavatories and sinks in a bed of silicone caulk.

G. Install floor-mounted, floor-outlet water closets with closet flanges and gasket seals.

H. Install wall-hanging, back-outlet water closets with support manufacturer's tiling frame or setting gage.

I. Install wall-hanging, back-outlet urinals with gasket seals.

J. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified and to building wall construction where no support is indicated.

K. Fasten counter-mounting-type plumbing fixtures to casework.

L. Metering faucets shall be adjusted for minimum ten (10) second run time, but not more than 0.25 gallons per cycle.

M. Immediately after installation, provide protective covering over fixtures and trim.

3.3 MOUNTING HEIGHT AND LOCATION

A. Mount fixtures at height and location as indicated on Architectural plans and elevations.

B. Mount accessible fixtures in conformance with the requirements of ANSI A117.1.

3.4 CONNECTIONS

A. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other sections of Division 22.

3.5 ADJUSTING AND CLEANING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings and controls.

B. Adjust water pressure at electric water coolers, faucets and flush valves to provide proper flow and stream.

C. Replace washers of leaking and dripping faucets and stops.

D. Clean fixtures, fittings, spout and drain strainers with manufacturers' recommended cleaning methods and materials.

E. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning fixtures and components and retest. Repeat procedure until all units operate properly.

END OF SECTION 224000

APPENDIX A

TAG	MOUNT TYPE	FLUSH TYPE	ADA	HEALTH CARE	K-12	HIGHER ED	COMMERCIAL	RES.	LEED	REMARKS
WATER CLOSETS										
WC-A	WALL	FV 1.6		X	X	X	X			MANUAL/BATTERY/WIRED
WC-B	WALL	FV 1.6	X	X	X	X	X			MANUAL/BATTERY/WIRED
WC-C	FLOOR	FV 1.6		X	X	X	X			MANUAL
WC-D	FLOOR	FV 1.6	X	X	X	X	X			MANUAL
WC-E	FLOOR	TANK					X	X		
WC-F	FLOOR	TANK	X				X	X		
WC-G	FLOOR	FV 1.6			X					CHILD HEIGHT
WC-H	WALL	FV 3.5	X	X						BEDPAN WASHER
WC-I	FLOOR	FV 3.5	X	X						BEDPAN WASHER
WC-J	FLOOR	TANK				X	X			PRESSURE ASSIST
WC-K	FLOOR	TANK				X	X			PRESSURE ASSIST
WC-L	WALL	FV 1.6	X	X						BARIATRIC
WC-M	FLOOR	FV 1.6	X	X						BARIATRIC
WC-N	WALL	FV 1.28			X	X	X		X	HETS MANUAL
WC-O	WALL	FV 1.28	X		X	X	X		X	HETS MANUAL
WC-P	WALL	FV 1.28			X	X	X		X	HETS BATTERY

WC-Q	WALL	FV 1.28	X		X	X	X		X	HETS BATTERY
WC-R	FLOOR	FV 1.28			X	X	X		X	HETS MANUAL
WC-S	FLOOR	FV 1.28	X		X	X	X		X	HETS MANUAL

TAG	MOUNT TYPE	FLUSH TYPE	ADA	HEALTH CARE	K-12	HIGHER ED	COMMERCIAL	RES.	LEED	REMARKS
URINALS										
UR-A	WALL	FV 1.0		X	X	X	X			MANUAL/BATTERY/ WIRED
UR-B	WALL	FV 1.0	X	X	X	X	X			MANUAL/BATTERY/ WIRED
UR-C	WALL	WATERLESS							X	
UR-D	WALL	WATERLESS	X						X	
UR-E	FLOOR	FV 1.0	X							REPLACEMENT ONLY

FLUSH VALVES										
FV-A										
FV-B										
FV-C										
FV-D										
FV-E										
FV-F										
FV-G										
FV-H										

TAG	MOUNT TYPE	DRAIN STYLE	ADA	HEALTH CARE	K-12	HIGHER ED	COMMERCIAL	RES.	LEED	FAUCET STYLE & TYPE
LAVATORIES										
LAV-A	WALL	GRID		X	X	X	X			MANUAL/METERING/ BATTERY/HARDWIRED
LAV-B	WALL	GRID	X	X						GOOSENECK W/WRIST BLADES
LAV-C	WALL	POP-UP						X		SINGLE HANDLE LEVER
LAV-D	WALL	GRID	X					X		SINGLE HANDLE LEVER
LAV-E	SELF-RIMMING	GRID			X	X	X	X		MANUAL/METERING/ BATTERY/HARDWIRED
LAV-F	SELF-RIMMING	GRID	X	X						GOOSENECK W/WRIST BLADES
LAV-G	UNDER-MOUNT	GRID								MANUAL/METERING/ BATTERY/HARDWIRED
LAV-H	UNDER-MOUNT	GRID	X							MANUAL/METERING/ BATTERY/HARDWIRED

TAG	MANUF.	MODEL #	FLOW RATE (GPM)	TYPE	ADA	LEED	REMARKS
LAVATORY FAUCETS							
F-A	CHICAGO						
F-B	CHICAGO						

TAG	MANUF.	MODEL #	FLOW RATE (GPM)	TYPE	ADA	LEED	REMARKS
LAVATORY FAUCETS							
F-C	CHICAGO						
F-D	CHICAGO						
F-E	CHICAGO						
F-F	CHICAGO						
F-G	CHICAGO						
F-H	CHICAGO						
F-I	CHICAGO						
F-J	CHICAGO						
F-K	CHICAGO						
F-L	CHICAGO						
F-M	CHICAGO						
F-N	CHICAGO						
F-O	CHICAGO						

TAG	MOUNT TYPE	DRAIN STYLE	ADA	HEALTH CARE	K-12	HIGHER ED	COMMERCIAL	RES.	LEED	FAUCET STYLE & TYPE
SINKS										

SK-A	SELF-RIMMING SINGLE BOWL	GRID/BASKET		X	X	X	X	X		MANUAL, SINGLE & DUAL HANDLE
SK-B	SELF-RIMMING SINGLE BOWL	GRID/BASKET	X	X	X	X	X	X		MANUAL, SINGLE & DUAL HANDLE
SK-C	SELF-RIMMING DOUBLE BOWL	GRID/BASKET		X	X	X	X	X		MANUAL, SINGLE HANDLE
SK-D	SELF-RIMMING SINGLE BOWL	BASKET	X	X	X	X	X	X		MANUAL, SINGLE HANDLE

TAG	MOUNT TYPE	ADA	HEALTH CARE	K-12	HIGHER ED	COMMERCIAL	RES.	LEED	REMARKS
SERVICE SINKS									
SS-A	WALL/TRAP STANDARD	X	X	X	X	X			ENAMELED CAST IRON

TAG	MOUNT TYPE	ADA	HEALTH CARE	K-12	HIGHER ED	COMMERCIAL	RES.	LEED	REMARKS
MOP BASINS									
MB-A	FLOOR	X	X	X	X	X			TERAZZO
MB-B	FLOOR	X	X	X	X	X			MOLDED STONE

TAG	MOUNT TYPE	ADA	HEALTH CARE	K-12	HIGHER ED	COMMERCIAL	RES.	LEED	REMARKS
ELECTRIC WATER COOLERS									
EWC-A	WALL, SURFACE	X	X	X	X	X			SINGLE LEVEL
EWC-B	WALL, SURFACE	X	X	X	X	X			BI-LEVEL
EWC-C	WALL, RECESSED	X	X	X	X	X			BI-LEVEL
EWC-C	WALL, RECESSED	X	X	X	X	X			SINGLE LEVEL

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SECTION 227010 - NATURAL GAS SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment, and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 SUBMITTALS

A. Provide manufacturer's data sheets and installation instructions for all equipment and accessories in this section in accordance with Basic Mechanical/Electrical Requirements and Division 01.

1.3 QUALITY ASSURANCE

A. Follow all requirements, recommendations, and appendices to comply with the following publications, codes, standards, and listings:
   1. 2020 Fuel Gas Code of New York State.
   2. American Gas Association.
   3. Local Utility Company.

B. Provide equipment and accessories that are listed and labeled by a nationally recognized testing laboratory.

1.4 GAS SERVICE

A. The existing gas service will be reused.

PART 2 - PRODUCTS

2.1 GAS PIPING

A. Piping Materials: Refer to Specification Section 221010, "Piping Systems and Accessories".

B. All exposed exterior and interior piping shall be primed and painted with one coat of alkyd primer and two coats of exterior acrylic latex gloss enamel. Color shall be as selected.

2.2 VALVES

A. Refer to Specification Section 220523, "Valves".

PART 3 - EXECUTION

3.1 ARRANGEMENTS

A. Coordinate all service requirements with the utility company.

B. The contractor shall arrange for the plumbing inspector to inspect the gas piping and vent installations upon completion including underground and rough-ins, as well as installation of gas-fired appliances.

C. Provide distribution system from existing piping, including mains, risers, branches, drips, shut-offs and other required parts. Connect to appliances indicated or specified as requiring gas for their operation.

3.2 PIPING INSTALLATION

A. Install gas piping at a uniform slope of 1/4 inch. in 15 feet to prevent traps. Horizontal lines shall slope upward to risers to the equipment.

B. Drips and Sediment Traps: Install drips at points where condensate may collect. Locate where readily accessible to permit cleaning and emptying. Do not install where condensate would be subject to freezing. The sediment trap shall be installed in the gas supply line to gas fired equipment. The trap shall be a tee fitting having a threaded capped nipple installed vertically in the bottom most opening of the tee.

C. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down. Connect branch piping from top or side of horizontal piping.

D. Install unions in pipes 2 inch. and smaller, adjacent to each valve, regulator and at final connection to each piece of equipment. Unions are not required on flanged devices.

E. Provide pressure regulator in supply to each gas fired appliance as required.

F. Install valve and strainer on the supply side of each gas pressure regulator.

G. Install vent piping for gas pressure regulators and gas trains, extend outside building and vent to atmosphere. Terminate vents with turned-down reducing elbow fittings with corrosion-resistant insect screens in large end.

H. Install containment conduits for buried gas piping within building in gas-tight conduits extending 12 inch. minimum outside building and vented to atmosphere. Terminate vents with turned-down, reducing elbow fittings with corrosion-resistant insect screens in large end. Prepare and paint outside of conduits with coal tar epoxy.

I. Install pressure-relief or pressure-limiting devices so they can be readily operated to determine if valve is free; test to determine pressure at which they will operate; and examine for leakage when in closed position.

J. Install gas piping across exit corridors within an airtight conduit constructed of Schedule 40 seamless black steel pipe with welded joints. Vent conduit to outside of exit corridor.

3.3 WELDING

A. Welding shall be performed in compliance with the welding procedure specifications prepared by the National Certified Pipe Welding Bureau. Welded pipe fabricated by certified welder. Contractor shall submit proof of current certification of each welder if requested by the Owner. Use full-length pipe where possible; minimum distance between welds, 18 inch. on straight runs. Welds must be at least full thickness of pipe with inside smooth; remove cutting beads, slag and excess material at joints; chamfer ends. Minimum gap 1/8 inch., maximum 1/4 inch. for butt welds. Overlaps on position and bench welds to be not less than 3/4 inch. One internal pass and one external pass minimum required on slip-on flanges. Do not apply heat to rectify distorted pipe due to concentrated welding; replace distorted pipe. Exercise caution to prevent heat related damage to plastic parts within the gas meter or regulators.

B. Welder qualifications: Welded piping fabricated by certified welder. Welder shall be certified under ASME or API Code III.

3.4 CONNECTIONS

A. Install gas piping next to gas-utilizing equipment and appliances for servicing and maintenance. Connect gas piping to gas-utilizing equipment and appliances with shutoff valves and unions. Make connections to equipment downstream of valves and unions with flexible connectors. Valves, unions and flexible connectors shall be same size as the gas supply piping to the equipment.

B. Install a gas valve upstream within 6 feet of each gas-utilizing appliance. Install a union connection downstream from the valve to permit removal of controls.

C. Sediment Traps: Install full size threaded tee fittings forming drips, as close as practical to gas appliance inlets. Cap or plug bottom outlet.

3.5 UNDERGROUND PIPING INSTALLATION

A. All underground piping shall be installed by a utility approved contractor in accordance with the gas company's requirements.

B. Qualification by the utility company is required for the individual making heat-fusion joints.

C. The service main shall be installed with a minimum 36 inch. cover and shall in all cases conform to be requirements of the pipe manufacturer instructions.

D. Install piping a minimum 5 feet - 0 inch. from buildings.

3.6 LOCATOR TAPE

A. Install the locator tape with the gas main, which can be used to help determine the location of the gas piping at a future time. Locate directly over the buried gas line at a depth of 6 inch. below finished grade.

B. Terminate tracer wire in cast iron boxes. Maximum spacing between boxes shall be 500 feet

3.7 GAS PIPING TESTS

A. Test natural gas systems according to 2020 Fuel Gas Code of New York State and the local utility requirements unless otherwise noted:
   1. Test pressure shall be 15 psi for one (1) hour for steel piping.
   2. Pressure testing of plastic piping shall be per utility's requirements.

B. Tests shall be witnessed by utility company. Make arrangements, provide all necessary items to complete testing and pay all costs.

C. All tests shall be performed prior to the connection of equipment. Regulator shall be isolated from test pressures. Soap test shall be conducted on all joints. Repair leaks and defects with new materials. Retest system until satisfactory results are obtained.

D. Verify correct pressure settings for pressure regulators.

E. Provide written certification that tests have been conducted and satisfactorily completed. Submit to Owner's Representative.

3.8 GAS LINE PURGING

A. At completion of pressure test, purge all natural gas systems according to 2020 Fuel Gas Code of New York State and the utility company requirements.

B. Provide three (3) days notice to utility company to have the meter unlocked for service and equipment start up. Make all arrangements and pay all fees as required by the Utility Company.

END OF SECTION 227010

SECTION 230500 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

B. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.2 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. All materials and equipment shall be installed in accordance with the manufacturer's recommendations.

1.3 LICENSING

A. The Contractor shall hold a license to perform the work as issued by the authority having jurisdiction.

B. Plumbing contract work shall be performed by, or under, the direct supervision of a licensed master plumber.

C. Electrical contract work shall be performed by, or under, the direct supervision of a licensed electrician.

1.4 PERMITS

A. Apply for and obtain all required permits and inspections, pay all fees and charges including all service charges. Provide certificate of approval from the Authorities Having Jurisdiction prior to request for final payment.

B. Provide electrical inspection certificate of approval from Middle Department Inspection Agency, Commonwealth Inspection Agency, or an Engineer approved Inspection Agency prior to request for final payment.

1.5 CODE COMPLIANCE

A. Provide work in compliance with the following Codes and Standards based on the current edition in effect at project location:
   1. Building, Code of New York State.
   2. Existing Building Code of New York State.
   3. Fire Code of New York State.
   4. Plumbing Code of New York State.
   5. Mechanical Code of New York State.
   6. Fuel Gas Code of New York State.
   7. Property Maintenance Code of New York State.
   8. Energy Conservation Code of New York State
   9. Accessible and Usable Buildings and Facilities, ICC A117.1.
   10. New York State Department of Labor Rules and Regulations.
   11. New York State Department of Health.
   12. National Electrical Code (NEC).
   13. Occupational Safety and Health Administration (OSHA).
   14. Local Codes and Ordinances.
   15. Life Safety Code, NFPA 101.
   16. Local Plumbing Department.
   17. New York State Education Department Manual of Planning Standards.

1.6 GLOSSARY

ACI	American Concrete Institute
AGA	American Gas Association
AGCA	Associated General Contractors of America, Inc.
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AFBMA	Anti-Friction Bearing Manufacturer's Association
AMCA	Air Moving and Conditioning Association, Inc.
ANSI	American National Standards Institute
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing Materials
AWSC	American Welding Society Code
AWWA	American Water Works Association
FM	Factory Mutual Insurance Company
IBR	Institute of Boiler & Radiation Manufacturers

IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Insurers
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NYS/DEC	New York State Department of Environmental Conservation
SBI	Steel Boiler Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
UFPO	Underground Facilities Protective Organization
UL	Underwriter's Laboratories, Inc.
OSHA	Occupational Safety and Health Administration
XL - GAP	XL Global Asset Protection Services

1.7 DEFINITIONS

Acceptance	Owner acceptance of the project from Contractor upon certification by Owner's Representative.
As Specified	Materials, equipment including the execution specified/shown in the contract documents.
Basis of Design	Equipment, materials, installation, etc. on which the design is based. (Refer to the article, Equipment Arrangements, and the article, Substitutions.)
Code Requirements	Minimum requirements.
Concealed	Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
Coordination Drawings	Show the relationship and integration of different construction elements and trades that require careful coordination during fabrication or installation, to fit in the space provided or to function as intended.
Delegated-Design Services	Performance and Design criteria for Contractor provided professional services. Where professional design services or certifications by a design professional are specifically required of a Contractor, by the Contract Documents. Provide products and systems with the specific design criteria indicated. If criteria indicated is insufficient to perform services or certification required, submit a written request for

	additional information to the Engineer. Submit wet signed and sealed certification by the licensed design professional for each product and system specifically assigned to the Contractor to be designed or certified by a design professional. Examples: structural maintenance ladders, stairs and platforms, pipe anchors, seismic compliant system, wind, structural supports for material equipment, sprinkler hydraulic calculations.
Equal, Equivalent, Equal To, Equivalent To, As Directed and As Required	Shall all be interpreted and should be taken to mean "to the satisfaction of the Engineer".
Exposed	Work not identified as concealed.
Extract	Carefully dismantle and store where directed by Owner's Representative and/or reinstall as indicated on drawings or as described in specifications.
Furnish	Purchase and deliver to job site, location as directed by the Owner's Representative.
Inspection	Visual observations by Owner's site Representative.
Install	Store at job site if required, proper placement within building construction including miscellaneous items needed to affect placement as required and protect during construction. Take responsibility to mount, connect, start-up and make fully functional.
Labeled	Refers to classification by a standards agency.
Manufacturers	Refer to the article, Equipment Arrangements, and the article, Substitutions.
Prime Professional	Architect or Engineer having a contract directly with the Owner for professional services.
Product Data	Illustrations, standard schedules, performance charts, instructions, brochures, wiring diagrams, finishes, or other information furnished by the Contractor to illustrate materials or equipment for some portion of the work.
Provide (Furnish and Install)	Contractor shall furnish all labor, materials, equipment and supplies necessary to install and place in operating condition, unless otherwise specifically stated.

Relocate	Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
Remove	Dismantle and take away from premises without added cost to Owner, and dispose of in a legal manner.
Review and Reviewed	Should be taken to mean to be followed by "for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents".
Roughing	Pipe, duct, conduit, equipment layout and installation.
Samples	Physical full scale examples which illustrate materials, finishes, coatings, equipment or workmanship, and establishes standards by which work will be judged.
Satisfactory	As specified in contract documents.
Shop Drawings	Fabrication drawings, diagrams, schedules and other instruments, specifically prepared for the work by the Contractor or a Sub-contractor, manufacturer, supplier or distributor to illustrate some portion of the work.
Site Representative	Owner's Inspector or "Clerk of Works" at the work site.
Submittals Defined (Technical)	Any item required to be delivered to the Engineer for review as requirement of the Contract Documents. The purpose of technical submittals is to demonstrate for those portions of the work for which a submittal is required, the manner in which the Contractor proposes to conform to the information given and design concepts expressed and required by the Contract Documents.

1.8 EXISTING CONDITIONS

A. Contractor shall review all available record documents of existing construction or other existing conditions and hazardous material information. Owner does not guarantee that existing conditions are the same as those indicated in these documents. Contractor shall record existing conditions via measured drawings and preconstruction photographs or video. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage, removal or construction operations.

B. Owner will occupy portions of the building immediately adjacent to the area(s) of removals. Conduct removals so Owner's operations are not disrupted. Contractor shall locate, identify, disconnect and seal or cap mechanical, plumbing, fire protection and/or electrical systems serving areas of removals, unless noted otherwise in the contract documents. Contractor shall arrange shut-down of systems with the Owner/Construction Manager. Piping and ductwork indicated to be removed shall be removed and capped or plugged with compatible materials. If services/systems are required to be removed, relocated or abandoned, provide temporary services/systems the bypass area(s) of removals to maintain continuity of services/systems to other parts of the building, as required.

1.9 SHOP DRAWINGS/PRODUCT DATA/SAMPLES

A. Provide submittals on all items of equipment and materials to be furnished and installed. Submittals shall be accompanied by a transmittal letter, stating name of project and contractor, name of vendor supplying equipment, number of drawings, titles, specification sections (name and number) and other pertinent data called for in individual sections. Submittals shall have individual cover sheets that 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 under one cover sheet per specification section (e.g. lighting fixtures, valves, plumbing fixtures, etc.). Submittals shall include all required documentation for each product listed in the specification section at the same time as a complete package. Number each submittal by trade. Indicate deviations from contract requirements on Letter of Transmittal. Submittals will be given a general review only. Corrections or comments made on the Submittals 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. If submitting hard copies, submit four (4) copies for review.

B. The Engineer will review up to two (2) submissions of any single submittal. The Contractor will be invoiced on an hourly rate basis for the time spent reviewing the same shop drawing in excess of twice.

C. If submittals are to be submitted electronically, all requirements in Item A apply. Submittals shall be emailed in PDF format to specific email address provided by the Construction Manager, General Contractor, Architect or Project Manager. Name of project shall be in subject line of email. Send emails to mealbasubmittalclerk@meengineering.com

D. Refer to Division 01 for additional requirements.

1.10 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.

1.11 EQUIPMENT ARRANGEMENTS

A. The contract documents are prepared using one manufacturer as the Basis of Design, even though other manufacturers' names are listed. If Contractor elects to use one of the listed manufacturers other than Basis of Design or if the physical size, performance or electrical characteristics for the Basis of Design equipment differs from what is indicated in the contract documents, submit detailed drawings, indicating proposed installation of equipment. Show maintenance clearances, service removal space required, and other pertinent revisions to the design 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 doorframes, access doors, walls, ceilings, or floors required to install. If revised arrangement submittal is rejected, revise and resubmit specified Basis of Design item which conforms to Contract Documents.

1.12 SUBSTITUTIONS

A. If Contractor desires to bid on any other kind, type, brand, or manufacture of material or equipment than those named in specifications, secure prior approval. To request such approval, Contractor shall submit complete information comparing (item-for-item) material or equipment offered with design material or equipment. Include sufficient information to permit quick and thorough comparison, and include performance curves on same basis, capacities, power requirements, controls, materials, metal gauges, finishes, dimensions, weights, etc., of major parts. If accepted, an addendum will be issued to this effect ahead of bid date. Unless such addendum is issued, substitution offered may not be used.

1.13 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 electrical connections and relocations as required to accomplish the above. Obtain approval in writing as to date, time, and location for shutdown of existing mechanical/electrical facilities or services.

1.14 ROUGHING

A. The Contract Drawings have been prepared in order to convey design intent and are diagrammatic only. Drawings shall not be interpreted to be fully coordinated for construction.

B. 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 avoid 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.

C. 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. Provide new materials, including new piping and insulation for relocated work.

D. Coordinate work with other trades and determine exact route or location of each duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Obtain from Owner's Representative exact location of all equipment in finished areas, such as thermostat, fixture, and switch mounting heights, and equipment mounting heights. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers, and other items. Do not rough-in contract work without reflected ceiling location plans.

E. Before roughing for equipment furnished by Owner or in other Divisions, obtain from Owner and other Divisions, 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.

1.15 COORDINATION DRAWINGS

A. Before construction work commences, Divisions for all trades shall submit coordination drawings in the form of CAD drawing files, drawn at not less than 1/4 inch. scale. Such drawings will be required throughout all areas, for all Contracts. 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. Division 23 shall prepare the base plan CAD coordination drawings showing all ductwork, all pertinent heating piping, and equipment. These drawings may be CAD files of the required Ductwork Shop Drawings. The drawings shall be coordinated with lighting fixtures, sprinklers, 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 redrawn.
   2. Division 23 shall provide CAD files and submit the base plan CAD Coordination Drawings to all Divisions.
   3. Divisions 21 and 22 shall draw the location of piping and equipment on the base plan CAD Coordination Drawings, indicating areas of conflict and suggested resolutions.
   4. Divisions 26, 27 and 28 shall draw the location of lighting fixtures, cable trays, and feeders over 1-1/2 inch. on the base plan CAD Coordination Drawings, indicating areas of conflict and suggested resolution.
   5. The General Construction Trade shall indicate areas of architectural/structural conflicts or obstacles on the CAD Coordination Drawings, and coordinate to suit the overall construction schedule.

6. The Construction Manager shall expedite all Coordination Drawing work and coordinate to suit the overall construction schedule. In the case of unresolved interferences, he shall notify the Owner's Representative. The Owner's Representative will then direct the various trades as to how to revise their drawings as required to eliminate installation interferences.
7. If a given trade proceeds prior 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 Divisions.

B. The purpose of the coordination drawing process is to identify and resolve potential conflicts between trades, and between trades and existing or new building construction, before they occur in construction. Coordination drawings are intended for the respective trade's use during construction and shall not replace any Shop Drawings, or record drawings required elsewhere in these contract documents.

1.16 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, lead paint, mercury and PCB's shall be in accordance with Federal, State and Local law requirements. Where equipment is called for to be relocated, contractor shall carefully remove, clean and recondition, then reinstall. Remove all abandoned piping, wiring, equipment, lighting, ductwork, tubing, 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.

B. For materials indicated to contain lead, that are being affected by demolition or construction, the contractor shall comply with all Federal, State and Local law requirements regarding worker exposure to lead disturbance and abatement procedures.

C. Refer to the Owner's Lead Paint Survey. The Survey identifies the surfaces within the buildings that were tested for lead by collecting paint samples and performing laboratory analysis. If any unidentified surfaces are to be impacted the lead content shall be tested by analytical determinations conducted by a qualified laboratory approved by the Owner. The contractor shall review the current owner's lead paint reports on file before starting any work which may disturb existing surfaces.

D. Refer to Division 02 for additional information regarding hazardous materials.

1.17 REFRIGERANT RECOVERY

A. Existing equipment to be removed, as shown on the plans may contain refrigerant and refrigerant oils. This refrigerant and refrigerant oil must be handled in accordance with Federal, State and Local law requirements.

B. Removal and recovery of refrigerant shall be in accordance with the current edition of Section 608 of the Clean Air Act of 1990, including all final regulations.

C. Refrigerant recovery must be performed by a technician, certified by an EPA-approved certification program, using refrigerant recovery and recycling equipment certified by an EPA-approved testing organization.

D. Owner "reserves the right of first refusal" on ownership of recovered refrigerant. Should Owner choose to maintain ownership of refrigerant, refrigerant shall be reclaimed, cleaned by this Contractor to ARI 700-1993 Standard of Purity, by an EPA certified refrigerant reclaimer. Refrigerant shall be turned over to the Owner in suitable marked containers to be stored on site, at a place of the Owner's choosing.

1.18 EQUIPMENT AND MATERIAL REQUIREMENTS

A. 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. 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. All electrical equipment and systems, as a whole, shall be tested and listed by an OSHA approved Nationally Recognized Testing Laboratory (NRTL) for the intended use in accordance with the applicable standards and have a physical label indicating such.
   6. Fire protection equipment shall be UL listed and FM approved.

B. Exterior and wet locations shall utilize materials, equipment supports, mounting, etc. suitable for the intended locations. Metals shall be stainless steel, galvanized or with baked enamel finish as a minimum. Finishes and coatings shall be continuous and any surface damaged or cut ends shall be field corrected in accordance with the manufacturer's recommendations. Hardware (screws, bolts, nuts, washers, supports, fasteners, etc.) shall be:
   1. Stainless steel where the associated system or equipment material is stainless steel or aluminum.
   2. Hot dipped galvanized or stainless steel where the associated system or equipment is steel, galvanized steel or other.

1.19 CUTTING AND PATCHING

A. Each trade shall include their required cutting and patching work unless shown as part of the General Construction Contract. 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 cut or abandoned holes left by removals of equipment or fixtures. 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.

1.20 PAINTING

A. Paint all insulated and bare piping, pipe hangers and supports exposed to view in mechanical equipment rooms, penthouse, boiler rooms and similar spaces. Paint all bare piping, ductwork and supports exposed to the out-of-doors with rust inhibiting coatings. Paint all equipment that is not factory finish painted (i.e. expansion tanks, etc.).

B. All painting shall consist of one (1) prime coat and two (2) finish coats of non-lead oil base paint, unless otherwise indicated herein. Provide galvanized iron primer for all galvanized surfaces. All surfaces must be thoroughly cleaned before painting. Review system color coding prior to painting with the Owner's Representative or Architect.

C. All items installed after finished painting is completed and any damaged factory finish paint on equipment furnished under this contract must be touched up by the Contractor responsible for same.

D. 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 Specifications.

E. All primers and paint used in the interior of the building shall comply with the maximum Volatile Organic Compound (VOC) limits called for in the current version of U.S. Green Building Council LEED Credits EQ 4.1 and EQ 4.2.

F. Refer to Division 9 - Finishes, for additional information.

1.21 EXISTING CEILING REMOVAL AND RE-INSTALLATION

A. In a renovation project, any existing ceiling removal and re-installation work required for the completion of a Contractors or Subcontractors work, shall be removed and re-installed by that Contractor or Subcontractor. This applies in any areas not called for to have a new ceiling installed.

B. The ceiling removal and re-installation shall include lay-in ceiling tile and grid, to the extent necessary to accomplish the work. Removed ceiling tile and grid shall be safely stored during the course of the work, and it shall be re-installed to the original existing condition.

C. The ceiling removal and re-installation shall include gypsum board or plaster ceilings and the associated suspension systems. Removed ceiling areas shall be patched with materials to match the existing ceiling, and painted to match. If paint cannot be matched exactly, paint the entire ceiling a similar color.

1.22 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 their review.
In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

1.23 CHASES

A. New Construction:
1. Certain chases, recesses, openings, shafts, and wall pockets will be provided as part of General Construction Trade. Mechanical and Electrical trades 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 Construction trade.

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 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 inch. 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.

1.24 PENETRATION FIRESTOPPING

A. Refer to Division 07 for project-wide fire stopping information.

1.25 NON-RATED WALL PENETRATIONS

A. Each trade shall be responsible for sealing wall penetrations related to their installed work, including but not limited to ductwork, piping, conduits, etc. See individual specification sections for requirements.

1.26 SUPPORTS

A. Provide required supports, beams, angles, hangers, rods, bases, braces, and other items to properly support contract work. 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.

B. For precast panels/planks and metal decks, support mechanical/electrical work as determined by manufacturer and the Engineer. Provide heavy gauge steel mounting plates for mounting contract work. Mounting plates shall span two or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

C. For finished areas without a finished ceiling system such as classrooms, offices, conference rooms, etc., where decking and structure is exposed, and ductwork/piping/conduit is exposed: All mounting brackets, channel support systems and mounting hardware for ductwork, piping, lighting, etc. shall be concealed and approved by the Architect/Engineer prior to the installation. AirCraft cable style hanging for ductwork is required. It is recommended that room mockups be done and receive Architect/Engineer approval prior to proceeding with installation.

D. Equipment, piping, conduit, raceway, etc. supports shall be installed to minimize the generation and transmission of vibration.

E. Materials and equipment shall be solely supported by the building structure and connected framing. Gypboard, ceilings, other finishes, etc. shall not be used for support of materials and equipment.

1.27 APPLIED FIREPROOFING

A. Scope: Provide encapsulation of surfaces where applied fireproofing materials have been disturbed, removed, or left missing by the removal of hangers or upper attachments, or when new hangers or upper attachment are installed.

B. Fire Resistance Rating: Fireproofing shall meet the original hourly rating when applied to the construction assembly where materials have been removed or disturbed, or is missing.

C. Fire Hazard Classification: Fireproofing shall be listed in the Underwriters Laboratories Building Materials Directory with the following performance properties:
1. Flame Spread: 10 or less.
2. Smoke Developed: 5 or less.

D. Product Data: Provide manufacturer's product descriptions for each required fireproofing material. Include application instructions, including primer/adhesive requirements and recommended minimum thickness and density for each required hourly rating.

E. Fire Proofing Manufacturer:
1. Retro-Guard cementitious replacement fireproofing by Grace Construction Products, or equivalent Cafco Blaze Shield, and Cafco 300 by Isolatek.
2. Physical Properties:
a. Dry Field Density (ASTM E 605): 15 lb/cu ft minimum average.
b. Cohesion/Adhesion (Bond Strength) (ASTM E 736): 200 lb/sq ft minimum average.
c. Compressive Strength (ASTM E 761): 500 lb/sq ft minimum.
d. Impact (Bond Impact) Resistance (ASTM E 760): Shall not crack or delaminate.
e. Effect of Deflection (ASTM E 759): Shall not crack or delaminate.

f. Corrosion Resistance (ASTM E 937): No evidence of corrosion.
g. Air Erosion (ASTM E 859): Maximum 0.025 g/sq ft weight loss.
h. Provide primer or adhesive recommended by the fireproofing manufacturer to obtain required bond strength for the specific fireproofing and substrate.

F. Apply fireproofing prior to installation of ductwork, piping, conduits, and other suspended items. Hangers, clips and other supports for these items shall be installed before application of fireproofing.

G. Examine the substrate and conditions under which fireproofing is to be applied. Do not proceed with the fireproofing work until unsatisfactory conditions have been corrected. Verify that hangers, clips, sleeves, and other items that will penetrate the fireproofing are in place. Check paint on substrate for compatibility with primer/fireproofing and adequacy of bond strength in accordance with fireproofing manufacturer's instructions.

H. Surface Preparation: Remove dirt, dust, oil, grease, loose paint and rust, mill scale, and other foreign matter that may impair the bonding of the fireproofing to the substrate. Clean substrate free of contamination from chemicals and solvents. Apply primer/adhesive where necessary to obtain bond strength of fireproofing to steel shop paint and where recommended by the fireproofing manufacturer.

I. Apply the fireproofing in accordance with UL fire test report and the manufacturer's application instructions. Thickness and density of fireproofing shall be in accordance with the approved product data and as required to produce the hourly fire resistance rating required.

1.28 ACCESS PANELS

A. Provide access panels for required access to respective trade's work. Location and size shall be the responsibility of each trade. Access panels provided for equipment shall provide an opening not smaller than 22 inch. by 22 in. Panels shall be capable of opening a minimum of 90 degrees. 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 cam locks. 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 Construction trade with a set of architectural plans with size and locations of access panels.

1.29 CONCRETE BASES

A. Provide concrete bases for all floor mounted equipment. Provide 3,000 lb. concrete, chamfer edges, trowel finish, and securely bond to floor by roughening slab and coating with cement grout. Bases 4 inch. high (unless otherwise indicated); shape and size to accommodate equipment. Provide anchor bolts in equipment bases for all equipment provided for the project, whether mounted on new concrete bases or existing concrete bases.

1.30 HVAC 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 final hot water, drain, vent, and gas connections to all equipment as required by the equipment. Provide final connections, including domestic water piping, wiring, controls, and devices from equipment to outlets left by other trades. Provide equipment waste, drip, overflow and drain 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.

1.31 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, gas connections to all equipment. Provide loose key stops, sanitary "P" traps, tailpiece, adapters, gas or air cocks, and all necessary piping and fittings from roughing point to equipment. Provide installation of sinks, faucets, traps, tailpiece furnished by others. Provide cold water line with gate valve and backflow prevention device at locations called for. Provide continuation of piping and connection to equipment that is furnished by others. Provide relief valve discharge piping from equipment relief valves.

C. Provide 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 and 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, as required.

1.32 ELECTRICAL EQUIPMENT CONNECTIONS

A. Provide complete power connections to all electrical equipment. Provide control connections to equipment. Heavy duty NEC rated disconnect ahead of each piece of equipment. Ground all equipment in accordance with NEC.

B. Provide for Owner furnished and Contractor furnished equipment all power wiring, electric equipment, control wiring, switches, lights, receptacles, and connections as required.

1.33 STORAGE AND PROTECTION OF MATERIALS AND EQUIPMENT

A. Store Materials on dry base, at least 6 inch. 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.

B. Refer to Division 01 for additional information.

1.34 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 change in contract, any such damage to equipment, systems, and building. Perform first seasons winterizing in presence of Owner's operating staff.

1.35 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. Divisions 22 and 26 shall add contract items to the chart provided by Division 23 or provide separate charts.

1.36 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.

1.37 OPERATION AND MAINTENANCE MANUALS

A. Submit by email (preferred) or digital media, thru the normal project submittal process. Include a copy of each final approved Shop Drawing, wiring diagrams, piping diagrams, spare parts lists, final testing and balancing report, 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 installing contractor and of supplier manufacturer Representative and service agency for all major equipment items. Provide a table of contents page and dividers based upon specification section numbers. Submit in a compiled and bookmarked PDF format as outlined below. Each item listed in the table of contents shall include a hyperlink to the associated section of the O&M Manual, in addition to the bookmarking.

B. Provide content for Operation and Maintenance Manuals as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
   1. Engineer will comment on whether content of operation and maintenance submittals is acceptable.
   2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

C. Submit Operation and Maintenance Manuals in the following format:
   1. Submit by uploading to web-based project software site, or by email to Architect, as a formal project submittal in conformance with the project specific submittal procedures. Enable reviewer comments on draft submittals.
   2. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.

3. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in the table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

D. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing Owner training. Engineer will comment on whether general scope and content of manual are acceptable.

E. Final Manual Submittal: Submit O&M manual in final form prior to requesting inspection for Substantial Completion and at least 2 weeks before commencing Owner training. Engineer will return copy with review comments.
1. Correct or revise O&M manual to comply with Engineer's comments. Submit copies of each corrected manual within 2 weeks of receipt of Engineer's comments.

F. Refer to Division 01 for additional requirements.

1.38 RECORD DRAWINGS

A. The Contractor shall obtain at his expense one (1) set of construction Contract Drawings, (including non-reproduction black and white prints or electronic files) for the purpose of recording as-built 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 contract documents in red 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, the complete set of red marked contract documents, plus all approved field sketches and diagrams shall be submitted to the engineer and used in preparation of the record drawings.

D. A complete set of red marked contract drawings shall be submitted, at one time, as the "Record" set. If there are no changes to a specific drawing, the contractor shall indicate "NO CHANGES" on that drawing. ALL drawings shall be included in the "Record" set.

E. The complete set of red marked Contract Documents or electronic files shall be certified by the Contractor as reflecting record conditions and submitted to the engineer for review.

F. The Contractor shall have the marked up set scanned, if they are not already electronic files, and then submit them to the Engineer as the "Record Set".

G. Refer to Division 01 for additional requirements.

1.39 FINAL INSPECTION

A. Upon completion of all Engineering Site Observation list items, the Contractor shall provide a copy of the Engineering Site Observation Report back to the Engineer with each items noted as completed or the current status of the item.

1.40 COMMISSIONING

A. Refer to General Commissioning Requirements in Division 01 for additional requirements.

1.41 TEMPORARY HEATING AND COOLING

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

B. Systems and equipment installed as part of this project shall not be used for temporary heating or cooling.

1.42 MAINTENANCE OF HVAC SYSTEMS DURING TEMPORARY USE PERIODS

A. Provide each air handling system with a set of prefilters in addition to the permanent filters. Furnish four 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 MERV-8 filters in all open ended ducts, return grilles and registers to keep dust out of ductwork. Change as often as necessary. Remove all such temporary filters upon completion. Use supply fans 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 and install new set. 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.

1.43 TEMPORARY FACILITIES

A. Refer to the Division 01 Sections, General Conditions and Supplemental General Conditions.

1.44 TEMPORARY LIGHT AND POWER

A. Refer to the Division 01 Sections, General Conditions and Supplemental General Conditions.

1.45 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:
   1. Thoroughly clean entire installation, both exposed surfaces and interiors.
   2. Remove all debris caused by work.
   3. Remove tools, surplus, materials, when work is finally accepted.

1.46 SYSTEM START-UP AND TESTING

A. All new heating and ventilating systems 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% outside air during the bake-off for an additional eight hours to purge the building. This work shall be completed prior to fall school occupancy or 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 one week prior to and one week after the commencement of school except upon written approval by the Owner.

C. Prior to commencement of work, the Division(s) effecting such system shall survey all building mechanical, plumbing, fire protection and electrical systems and components and make written notice to the Owner's Representative regarding any damage, missing items and/or incomplete systems. Prior to the conclusion of this project, the Contractor shall verify with the Owner's Representative that all building systems have been returned to their original conditions.

D. Start-up and testing of HVAC systems shall occur while the building is not occupied by students and only after notice to the Owner's Representative is made at least 24 hours in advance. Division 23 shall be responsible for providing temporary filter media over all supply air registers and diffusers during the HVAC system start-up procedure. Division 23 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 Owner's Representative.

1.47 TRANSFER OF ELECTRONIC FILES

A. Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering) will provide electronic files for the Contractor's use in the preparation of sheet metal shop drawings, coordination drawings, or record drawings related to the project, subject to the following terms and conditions:
   1. The Contractor shall submit a formal request for electronic drawing files on the Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering) website, by utilizing the following website link: http://www.meengineering.com/contact-pages/contractor-request
   2. Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering) makes no representation as to the compatibility of these files with the Contractor's hardware or the Contractor's software beyond the specific release of the referenced specifications.
   3. Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering) can only provide CAD files of M/E/P/FP drawing levels for which we are the Engineer of Record. CAD files of Architectural backgrounds, reflected ceiling plans, structural plans, etc. must be obtained separately from the Architect of Record.

4. Data contained on these electronic files is part of Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering) instruments of service shall not be used by the Contractor or anyone else receiving data through or from the Contractor for any purpose other than as convenience in the preparation of shop drawings for the referenced project. Any other use or reuse by the Contractor or by others will be at the Contractor's sole risk and without liability or legal exposure to Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering). The Contractor agrees to make no claim and hereby waive, to the fullest extent permitted by law, any claim or cause of action of any nature against Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering), its officers, directors, employees, agents or sub-consultants which may arise out of or in connection with the Contractor's use of the electronic files.
5. Furthermore, the Contractor shall, to the fullest extent permitted by law, indemnify and hold harmless, Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering) from all claims, damages, losses and expenses, including attorney's fees arising out of or resulting from the Contractor's use of these electronic files.
6. These electronic files are not contract documents. Significant difference may arise between these electronic files and corresponding hard copy contract documents due to addenda, change orders or other revisions. Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering) makes no representation regarding the accuracy or completeness of the electronic files the Contractor receives. In the event that a conflict arises between the signed contract documents prepared by Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering) and electronic files, the signed contract documents shall govern. The Contractor is responsible for determining if any conflicts exist. By the Contractor's use of these electronic files the Contractor is not relieved of the Contractor's duty to comply with the contract documents, including and without limitation, the need to check, confirm and coordinate all dimensions and details, take field measurements, field verify conditions and coordinate the Contractor's work with that of other contractors for the project.

1.48 VIDEO RECORDING OF TRAINING SESSIONS

A. The contractor shall video record all training sessions required by their discipline. Video shall be in Windows Media Player video format saved on flash drives. Two (2) copies on flash drives are to be provided as a formal submittal. . Flash drives are to be tagged with project name, training session name(s), installing Contractor and date of training. The flash drive shall include a scanned version of the training session sign in list(s), including the presenter and the owner's participants.

1.49 ENERGY INCENTIVES

A. The Contractor, his Subcontractors and Suppliers shall provide to the Owner all paperwork necessary to support the Owners pursuit of incentives related to energy conservation as offered by the utility company or state sponsored incentive programs. This shall include at a minimum, receipts, and quantities and data sheets for energy efficient equipment such as: lighting, motors, variable frequency drives, etc.

1.50 INFECTION CONTROL

A. Construction procedures, temporary partitions, negative air systems, cleaning procedures, HVAC system isolation, dust control, etc. shall be in accordance with the infection control standards set forth by the Facility. A copy of the facilities standards are available from the Owner upon request.

END OF SECTION 230500

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SECTION 230504 - ELECTRIC WIRING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services for the complete installation of motor control wiring and temperature control wiring as required in Contract Documents. Provide wiring and conduit, required to connect devices furnished as part of or adjunctive to the automatic temperature control system and for motor control regardless of the source of supply. Control wiring includes 120 volt and lower voltage wiring for control signals directing equipment operation. Control circuits shall be 120 volt maximum. Provide wiring in accordance with requirements specified in Division 26, "Electrical" and the National Electrical Code. Provide devices required for proper system operation, including special electrical switches, transformers, disconnect switches, relays, and circuit breaker protection.

B. Coordinate all work with Division 26, "Electrical".

1.2 WORK NOT INCLUDED

A. Power wiring for motors, motor starters and associated starting and control equipment, as well as the motor starters (except in the case of equipment specified to have packaged control/starters), are included in Division 26, "Electrical", unless otherwise called for.

1.3 QUALIFICATIONS

A. Wiring shall be installed in compliance with all requirements of Division 26, "Electrical".

1.4 SUBMITTALS

A. Provide complete wiring diagrams for equipment systems. Deliver wiring diagrams to proper trades in time for roughing of conduit, equipment connections, and avoid delay in construction schedule. Wiring diagrams and roughing information to be wired as part of the Work of Division 26, "Electrical", shall be clearly indicated.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Refer to Division 26 specifications for required wiring materials.

PART 3 - EXECUTION

3.1 GENERAL

A. Check electrical wiring pertaining to equipment for completeness and correctness of connections. Correct any misapplied motor and/or motor starter, improper thermal overload device, or device which fails to function and resultant damage, whether due to incorrect connections or improper information on wiring diagrams.

3.2 WIRING FOR CONTROL SYSTEMS

A. Provide motor control and temperature control wiring for equipment. All wiring shall be in conduit, unless otherwise noted below, supported on 5ft. centers. Refer to Section 260501 for the type of conduit to be used in specific applications.
   1. Provide 18 inch. length flexible conduit at motors and devices subject to vibration.
   2. Do not attach directly to hot surfaces, piping, or ductwork.
   3. Control wiring shall be in separate conduit from all other wiring.
   4. Where allowable by Code and contract documents, temperature control wiring may be installed without conduit. Installation and wire insulation types shall be as described by NEC, Article 725. All low voltage wiring circuits 50 volt and under shall:
      a. Have the proper insulation and meet the requirements of NEC Article 300-22 when installed in plenums or other spaces used for environmental air.
      b. Be adequately supported using bridle rings spaced a maximum of 3 feet on centers or other approved method when installed horizontally above accessible ceilings or run exposed in unfinished areas.
      c. Be run in wall cavity or surface metal raceway where no access is available to wall cavity, in finished areas.
      d. Be installed in conduit when installed vertically in Mechanical/Utility Rooms from panels and devices up to above ceiling, or 10 feet above finished floor if no ceiling, then run exposed.
      e. Be installed in conduit in all cases not specifically covered by the above cases, or where subject to physical damage.

B. Provide pushbutton stations, pilot lights, selector switches, auxiliary starter contacts, and other devices required to provide specified functions.
   1. Provide green grounding wire circuited from starter, and run ground wire through conduit to each remote auxiliary relay, pushbutton station, remote panel heating device, thermostat, or device with potentials in excess of 50 volts. Size ground wire as required by NEC.

3.3 EQUIPMENT WIRING

A. Provide power and control wiring between sections of electrical radiation units, between shipping splits, and between remote panels, thermostats, disconnect switches, and their respective units. Provide control wiring from the package control system, to each respective electric heat coil, reheat coil or motor. Properly mount control package. Power wiring to and including disconnect switch shall be by Division 26 "Electrical".

3.4 FIELD WIRING IN STARTERS, CONTROLLERS AND PANELS

A. Wiring within starters, controllers, and temperature control panels, shall be routed neatly in gutter space, away from moving and/or heat producing parts. Provide suitably rated terminal blocks. Do not place more than two wire connections on pilot device or relay terminal. Where more than two circuit connections are required, use terminal blocks. Provide nylon insulated, ring spade terminal for all control wires. Cables and wires shall be neatly bundled and lashed with nylon cable straps.

END OF SECTION 230504

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SECTION 230513 - MOTORS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 SUBMITTALS

A. Submit manufacturer's product data on all motors.

B. Product Data: For each motor, provide dimensions; mounting arrangements; frame type, enclosure type, location for conduit entries; shipping and operating weights; and manufacturer's technical data on features, performance, electrical ratings, and characteristics.

C. Motor Performance Data: For each motor, include the following manufacturers' data:
   1. Motor Performance: Percent Efficiency, Power Factor, Torque, RPM, Duty Rating and Design Category.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Motor manufacturer shall be based and headquartered in the United States of America and shall design and manufacture motors in the United States.
   2. Motor manufacturer shall have over fifteen (15) years-experience in the motor industry and shall maintain active company-wide quality assurance program.
   3. Motor manufacturer shall maintain an authorized service center within 60 miles of the project site, capable of providing training, parts and emergency maintenance and repairs.

B. Motor performance shall be warranted against material and workmanship defects by manufacturer's limited warranty and service policy for the period of at least 18 months from the day of shipment from the factory or the manufacturer's warehouse.
   1. Premium efficiency motors shall be warranted for 36 months.
   2. Severe duty motors (as applicable) shall be warranted for 60 months.
   3. Extended warranty shall be offered for certain products or as agreed by additional terms and specified elsewhere.

PART 2 - PRODUCTS

2.1 MOTORS

A. General Requirements:
1. Motors built for 60 Hz operation, three phase for 1/2 HP and larger; single phase for 1/3 HP and smaller.
a. In compliance with NEMA Standards, wound specifically for nameplate voltage, and selected for appropriate duty and environment.
b. 1.15 minimum service factor at rated voltage and frequency. 1.0 service factor for inverter duty motors.
c. Bearings: Bearings shall have a rated fatigue life of L-10 (B-10) of 150,000 hours for direct-coupled applications and 50,000 hours for belted applications minimum. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG 1-14.43. The calculation will be determined from the pulley centerline being at the end of the motor shaft.
d. V-belt connected motors with adjustable slide rail bases and pulleys.
e. Motors shall have Class F insulation system, with Class B temperature rise, insulation meeting NEMA MG 1 Part 31. Maximum allowable motor temperature rise for open drip-proof (ODP) or totally enclosed fan cooled (TEFC) type at 1.15 service factor shall be 105°C above 40°C ambient with a total temperature rating of 155°C.
f. NEMA locked rotor kVA code as required to match unit equipment torque characteristics.
g. Single-phase motors shall be capacitor start, induction run, or split phase type.
h. Polyphase motors shall be constant speed, squirrel cage, unless otherwise specified.
i. Nameplates shall have as a minimum, all information as described in NEMA Standard MG-1-20.60. Motor nameplate shall be mounted on enclosure with stainless steel fastening pins.
2. Motors for use with adjustable speed drive applications shall be premium efficiency inverter duty rated in accordance with NEMA and be capable of a 20:1 turndown.
a. These motors shall meet NEMA corona inception voltage requirements, withstanding peak voltages up to 1600 volts, and be manufactured in accordance with NEMA MG 1 Part 30 and 31.
b. All motors controlled by adjustable speed drives shall be equipped with circumferential micro-fiber shaft grounding rings to provide protection from electrical bearing damage, to meet NEMA MG 1, 31.4.4.3. Provide AEGIS Bearing Protection Ring Kit (or equal), installed in accordance with the manufacturer's recommendation. For motors controlled by adjustable speed drives and 50hp or greater the motor shall have a ceramic electrically insulating bearing assembly on the opposite end of the grounding brushes.
3. EC Motors:

a. The motor shall be DC rated with permanent magnet rotor and automatically resetting integral overload protection.
b. The unit shall meet the scheduled voltage, phase, control and other requirements indicated.
c. Input Control: The unit shall have the following control features as a minimum:
   1) Packaged Unit controls: DDC input to include start/stop/status/general trouble.
   2) External Control: Minimum of Modbus and/or BACnet digital start/stop, digital trouble, 0-10VDC and 4-20mA speed control input.
d. Unit insulation shall be Class H.
e. Electrical termination lugs shall be suitable for the intended feed circuit.
f. Ratings shall be 90% minimum power factor and 10% maximum total harmonic distortion.
g. Speed control suitable for 100% to 10% operational capability.
h. Fully programmable and reviewable settings and parameters.
i. Suitable for operation at ambient conditions of 32 to 104 degrees Fahrenheit.
j. The power circuiting shall be separated from the low voltage control circuiting.
k. Output parameters where indicated:
   1) Speed.
   2) Trouble indication.
   3) Overload indication.

4. Three phase motors rated 1 HP and greater shall be copper winding, re-lubable ball bearings, 1.15 service factor (1.0 service factor for inverter duty motors), premium efficiency, energy-saver type with a guaranteed NEMA nominal full-load efficiency, by IEEE Standard 112 Test Method "B". Efficiency rating shall appear on nameplate, and shall be not less than as follows; per NEMA MG 1 Part 12, Table 12-12, nominal minimum efficiencies:

MINIMUM NOMINAL FULL-LOAD MOTOR EFFICIENCY						
HP	ODP MOTORS (RPM)			TEFC MOTORS (RPM)		
	1200	1800	3600	1200	1800	3600
1.0	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2.0	87.5	86.5	85.5	88.5	86.5	85.5
3.0	88.5	89.5	85.5	89.5	89.5	86.5
5.0	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	91.7	93.0	90.2	91.7	92.4	91.0

MINIMUM NOMINAL FULL-LOAD MOTOR EFFICIENCY						
HP	ODP MOTORS (RPM)			TEFC MOTORS (RPM)		
	1200	1800	3600	1200	1800	3600
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93.0	94.1	94.5	93.0
60	94.5	95.0	93.6	94.5	95.0	93.6
75	94.5	95.0	93.6	94.5	95.4	93.6
100	95.0	95.4	93.6	95.0	95.4	94.1
125	95.0	95.4	94.1	95.0	95.4	95.0
150	95.4	95.8	94.1	95.8	95.8	95.0
200	95.4	95.8	95.0	95.8	96.2	95.4

5. Nominal Motor Voltage Table:

Nominal System Voltage	Motor Nameplate
480V - 3 phase	460 volt
240V - 1 phase and 3 phase	230 volt
208V - 1 phase and 3 phase	200 volt
120V - 1 phase	115 volt

6. Motor Application; Provide the following enclosure types unless noted otherwise:

Environment/Location	Motor Enclosure Type
General Purpose	Open drip-proof, TEFC with cast iron frame, or encapsulated
Outdoors, below grade or high humidity	TEFC with cast iron frame
Hazardous	Explosion-proof
Packaged Refrigeration Compressors	Hermetic or semi-hermetic

7. Acceptable Manufacturers: Motors need not all be of the same manufacturer. Subject to the requirements of this section provide products by the following:
   a. General Electric Energy & Saver NEMA Premium Efficiency/(ODP); General Electric X$D Ultra NEMA Premium Efficiency (TEFC).
   b. Century/A.O. Smith Speed Plus
   c. Baldor-Reliance Super E.
   d. Lincoln Ultimate E CTAC.
   e. Marathon XRI.

f. Siemens GO100A.
g. Nidec Motor Co. (U.S. Motors) Premium Efficient.

PART 3 - EXECUTION

3.1 MOTORS

A. Furnished by equipment manufacturer and especially manufactured and/or selected, mounted, and installed for intended use. Install motors accessible for maintenance and belt adjustment.

END OF SECTION 230513

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SECTION 230514 - MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. NFPA 70B - Recommended Practice for Electrical Equipment Maintenance; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.2 DESCRIPTION

A. Provide labor, materials, equipment, and services as required for the complete installation and full operation of separately enclosed, preassembled, motor controls, rated 600V and less.

1.3 DEFINITIONS

A. ASD: Adjustable speed drive motor controller.

B. CPT: Control power transformer.

C. DDC: Direct digital control. Building management/control system.

D. EMI: Electromagnetic interference.

E. PWM: Pulse width modulated.

F. RFI: Radio-frequency interference.

1.4 SUBMITTALS

A. Submit manufacturer's product data for each type and rating of motor controller indicated.

1. Include dimensions, weights, enclosure types, rating capacities, operating characteristics, electrical characteristics, furnished specialties and accessories, mounting and attachment details, method of field assembly, components, and location / size of each field connection.
2. Include diagrams for power, signal, and control wiring.
3. Control functions and programmable features.

B. As part of Operation and Maintenance Data, provide manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules, setting field-adjustable timers, controls, and status and alarm points, and setting field-adjustable overload relays.

1.5 QUALITY ASSURANCE

A. All methods of construction, details of workmanship, that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the specifications. The equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions, etc., correspond to the nomenclature dictated by those manufacturers. Where "or equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

B. Installation shall be in accordance with the manufacturer's recommendations, NFPA 70 (National Electrical Code), National Electrical Safety Code (NESC), state codes, local codes, and requirements of authority having jurisdiction.

C. Equipment shall be designed, manufactured, assembled, and tested in accordance with the latest revisions of applicable published ANSI, NEMA, UL and IEEE Standards.

D. Equipment and systems shall be NRTL tested and labeled.

1.6 WARRANTY

A. Provide full system warranty (labor, travel, equipment, etc.) in accordance with Division 1 with a minimum of one (1) year from acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers include:

B. Manual and Magnetic Motor Controllers:

1. Square-D
2. Cutler Hammer
3. General Electric
4. Allen-Bradley
5. Siemens

2.2 MOTOR STARTERS

A. Provide motor starters as listed on the Electric Equipment and Control Schedule on the drawings.

B. Starters, contactors and controllers shall comply with NEMA standards having general purpose NEMA 1 or 1B enclosure unless otherwise called for. Provide explosion proof, weather resistant or watertight construction as required. Starters shall be minimum NEMA size 0 with solid state overloads in each phase sized per NEC, motor full load amperage, service factor, and motor operating conditions.

C. Pad lock arrangements shall be provided to lock the disconnect device in the "off" position. Magnetic starters shall be provided with a control power transformer with 120V secondary and primary and secondary fusing and be sized to accept the loads imposed there on. Starters shall have LED type pilot lights. Each starter subject to electrical interlock and/or automatic control shall have necessary auxiliary contacts.

D. Auxiliary Devices: Provide pushbutton stations, pilot lights, devices, relays, transformers, selector switches, electric thermostats, auxiliary starter contacts as required for functions called for. Provide separate relay for each speed to operate electric dampers or other devices as required for multispeed motor circuit.

E. Manual Motor Starter - Speed Controller: Shall be similar to "Manual Motor Starter," above, except two-gang with motor speed control sized to handle motor indicated, with positive full on and full off bypass of speed control unit.

F. Manual Starter with Relay: Shall be similar to "Manual Motor Starter," above, except to include a two-gang box with relay sized for load indicated, and hand-off-automatic switch. Connect relay for 120V operation on load side of starter in "automatic" mode. Coordinate connection of Form C maintained contact for control with Mechanical Contractor.

G. Packaged Control Unit: Shall be furnished and mounted by others, and installed and connected by Electrical Contractor. This can consist of one or more starters, overloads and additional control devices prewired.

2.3 ENCLOSURES

A. Enclosures: To comply with NEMA 250, to meet the environmental conditions at installed location. Provide Type 1 for dry and clean indoor locations, Type 3R for outdoor locations, Type 4X stainless steel for kitchen and wash-down areas, and Type 12 for areas subject to dust, falling dirt, and dripping non corrosive liquids.

PART 3 - EXECUTION

3.1 3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive motor controllers, with installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine motor controllers before installation. Reject motor controllers that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before motor controller installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Wall-Mounted ASDs: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks.

B. Wall-Mounted Manual and Magnetic Controllers: Install on walls with tops at uniform height, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks.

C. Floor-Mounting Controllers: Install ASDs on 4-inch nominal thickness concrete base.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Roof-Mounting Controllers: Install ASD on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

F. Install fuses, heaters in thermal-overload relays (based on actual nameplate full-load amperes) after motors are installed, and install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

G. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

H. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

I. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

J. Comply with NECA 1.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between ASDs and remote devices and facility's central-control system.

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control devices where applicable.

D. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.

E. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.4 IDENTIFICATION

A. Identify motor controllers, components, and control wiring. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs. Label each ASD with engraved nameplate. Label each enclosure-mounted control and pilot device. Identify all items as described in Section 260501

3.5 FIELD QUALITY CONTROL

A. Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections for ASDs:
   1. Inspect ASDs, wiring, components, connections, and equipment installation.
   2. Test insulation resistance for each ASD element, component, connecting motor supply, feeder, and control circuits.
   3. Test continuity of each circuit.
   4. Verify that voltages at ASD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
   5. Test each motor for proper phase rotation.
   6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Tests and Inspections for Manual and Magnetic Motor Controllers:
   1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
   2. Visual and Mechanical Inspection:
      a. Compare equipment nameplate data with drawings and specifications.
      b. Inspect physical and mechanical condition, anchorage, alignment, and grounding, and that the controller is clean.
      c. Inspect contactors: Verify mechanical operation and contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
      d. Motor-Running Protection: Verify overload element rating is correct for its application and if protection is provided by fuses, verify correct fuse rating.
      e. Inspect bolted electrical connections for high resistance using one of the two following methods:
         1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
         2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

f. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

D. Motor controllers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the ASD and describes results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust carrier frequency for optimal operation with load and conditions.

D. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain motor controllers.

END OF SECTION 230514

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SECTION 230523 - VALVES

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).

1.2 WORK INCLUDED

A. Provide labor, materials, equipment, and services as required for the complete installation and related Work designed in Contract Documents.

1.3 SUBMITTAL

A. Submit product data for valves and accessories.

PART 2 - PRODUCTS

2.1 VALVES

A. General: Valves shall have following requirements:
   1. Working pressure stamped or cast on bodies.
   2. Stem packing serviceable without removing valve from line.
   3. Valves on insulated services shall have handle extensions so that the handle is fully beyond the insulation jacketing.
   4. Where possible, all valves of like type shall be of a single manufacturer.

B. Acceptable Manufacturers:
   1. Gate, Globe, and Check Valves: Apollo, Hammond, Milwaukee, Nibco, Watts, Victaulic.
   2. Ball Valves: Apollo, Hammond, Jamesbury, Milwaukee, Watts, Nibco, Victaulic.
   3. Butterfly Valves: Apollo, DeZurik, Jamesbury, Keystone, Milwaukee, Watts, Nibco, Victaulic.
   4. High Performance Butterfly Valves: Keystone, Bray, Velan, Milwaukee.
   5. To establish a standard of quality and to identify features, certain manufacturer's numbers are given in the following paragraphs.

C. Gate Valves:
   1. 2-1/2 inch. and Larger: Iron body, bronze solid wedge disc. OS&Y, flanged ends, rising stem, bolted bonnet, 125 lb. SWP, Milwaukee F-2885A.

2. 2 inch. and Smaller: Bronze body, bronze solid wedge disc, rising stem, threaded or union bonnet, threaded ends, 125 SWP, Milwaukee 1152.

D. Globe Valves:
1. 2-1/2 inch. and Larger: Iron body, bronze solid wedge disc, 125 SWP, flanged ends, bolted bonnet, Milwaukee F-2981-A
2. 2 inch. and Smaller: Bronze body, renewable composition or bronze disc, union bonnet, rising stem, threaded or soldered ends, 150 SWP, Milwaukee 590.

E. Check Valves:
1. 2-1/2 inch. and Larger: Iron body, cast iron disc with bronze disc face rings and bronze seat ring, bolted flange cap, flanged ends, 125 SWP, Milwaukee F-2974-A.
2. 2 inch. and Smaller: Bronze, swing check, threaded or soldered ends, 125 SWP, Milwaukee 1509.
3. Silent Check Valves, 2 inch. and Smaller: Renewable seat, bronze body with bronze trim and stainless steel spring, 125 lb. SWP. Apollo 61-500 Series.
4. Silent Check Valves, 2 inch. and Larger: Cast iron body, 304 stainless steel seat, disc, spring, bushing and screw, 125 lb. SWP. Milwaukee 1400.
5. Grooved End Spring-Loaded Check Valves:
   a. 2 inch. through 3 inch.: Ductile iron body, stainless steel disc and spring, brass shaft, nickel-plated seat, 365 psi CWP. Victaulic Series 716H.
   b. 4 inch. through 12 inch.: Ductile iron body, EPDM coated ductile iron disc, stainless steel spring and shaft, welded-in nickel seat, 300 psi CWP, Victaulic Series 716 or 779 with venture taps.
   c. 14 inch. through 24 inch.: Ductile iron body, dual disc design, stainless steel disc, spring and shaft, EPDM seat bonded to the valve body, 230 psi CWP. Victaulic Series W715.

F. Ball Valves for Water Service:
1. For chilled and hot water systems 3 inch. and under: Bronze body with hardened chrome-plated brass ballPTFE seats, full porting, 600 lb., W.O.G., adjustable packing gland, insulated handle, screwed or soldered ends, blowout proof stem. Provide handle extension on insulated services.
2. Grooved end valves for chilled, hot and condenser water systems 1-1/2 inch. through 6 inch. ductile iron body, chrome plated carbon steel ball and stem, standard port, blowout proof, 800 psi CWP, lever handle or gear operator with hand wheel. Victaulic Series 726.
3. Provide extended operations handle on non-thermal conductive material and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

G. Valves for Gauges and Instruments:
1. 1/4 inch., bronze body, hardened chrome plated brass ball, glass reinforced carbon impregnated seats, standard porting, 400 lb. W.O.G., adjustable packing gland, screwed ends, tee handle, Watts B6000TH.

H. Grooved Butterfly Valves for Water Service:
1. Bi-directional bubble tight shutoff against working pressure of 300 psi.
2. Body: Grooved type, coated ductile iron.
3. Disc: Nickel coated ductile iron.
4. Seat: EPDM; pressure responsive in sizes through 12 inch.
5. Stem: Stainless steel with EPDM seals. Stem shall be offset from the disc centerline to provide complete 360 degree circumferential seating.
6. Operators: Valves up to 6 inch. with lever operators; valves 8 inch. and larger with heavy duty manual gear actuators.
7. Victaulic VIC-300 Master Seal 2 inch. to 12 in.).
8. Victaulic VIC-AGS 14 inch. to 24 inch.).

I. Lug Type Butterfly Valves for Water Service:
1. Rated for working pressure 200 psi, bi-directional dead end service, bubble-tight.
2. Body: Lug type, cast iron ASTM A126, or ductile iron.
3. Disc: Aluminized bronze.
4. Seat: EPDM, resilient seat. Rated to 250oF.
5. Stem: 316 or 416 stainless steel. Single offset.
6. Operator: Lockable Lever for sizes through 6 inch. Manual hand wheel gear actuator for sizes 8 inch. and larger.
7. Milwaukee CL223E 2 inch. - 6 inch.), CL323E (8 inch. and larger), or Watts BF-03.

J. Hose Thread Drain Valves:
1. Ball valve, bronze body, hardened chrome ball with hose thread end, cap and chain.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Provide valves of type called for and where required to service equipment.
2. Provide at major building and systems sections.
3. Provide chain wheels, guides, and chain loops for valves, where called for or in Mechanical Rooms where valves are mounted higher than 8'-0" AFF.
4. Isolating valves for individual fan convectors, room units, terminal units, or other similar apparatus may be inside cabinet or at connection to branch mains where accessible.
5. Locate valves with handles at horizontal position when 5 feet or more above the floor, for greater visibility and easier use. Otherwise, locate valves with handles at or above horizontal position. Swing check valves in upright position only.
6. Butterfly valves may be used for water service over 2 inch. unless otherwise noted.

7. Ball valves may be used for water service through 3 inch., unless otherwise noted.
8. Provide hose threaded valves at low points, strainers, equipment, and as called for.

END OF SECTION 230523

SECTION 230525 - HYDRONIC COIL PIPING PACKAGE

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023c.

B. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.2 DESCRIPTION

A. Provide Hydronic Coil Piping Packages as shown on drawings and as specified herein.

B. Type, size, and rating compatible with intended service.

C. Suitable for use in Chilled Water and Hot Water Systems.

1.3 SUBMITTALS

A. Submittals shall include the following:
   1. Drawing of coil package showing product arrangement with end connection type and size listed. Components shall be clearly labeled.
   2. Written description of all components provided in the package.
   3. Manufacturer's system component specifications.
   4. Computer generated, job specific package schedule indicating package part number, end connection size and types, control valve Cv, flow cartridge spring range, design flow rate, and location tag for each coil package.

1.4 DELIVERY, STORAGE, AND HANDLING

A. All equipment provided under this specification shall be shipped to the job site clearly labeled for intended use and in shrink-wrapped plastic per coil assembly. Manufacturer shall factory mount actuators (supplied by others) to actuated ball valve prior to shrink-wrap and shipment.

B. Manufacturer's representative shall coordinate with valve actuator supplier to develop common schedule of actuator type, size, and location. This schedule will be used by coil piping package factory to mount actuators prior to shrink-wrap and shipping.

1.5 WARRANTY

A. Manufacturer shall warrant all components for eighteen (18) months from date of final acceptance. The flow limiting cartridge shall be warranted by manufacturer for no less than five (5) years from date of final acceptance.

B. Manufacturer shall provide replacement flow limiting cartridges (installation by others) at no charge for up to 10% of total quantity of purchased packages in the event that flow conditions (gpm) are modified by Engineer after packages have shipped to the jobsite.

1.6 ACCEPTABLE MANUFACTURER

A. Griswold Coil Piping Packages/Hose Kits (Basis of Design).

B. Victaulic Koil-Kit Coil Pack.

PART 2 - PRODUCTS

2.1 RETURN SIDE COIL PIPING PACKAGE

A. Stainless Steel Braided Hose (See section 2.3).

B. Combination valve shall include a flow limiting cartridge, integral P & T ports, and manual isolation ball valve in a single valve housing to prevent opportunity for leakage with union end connection. Separate assembled components shall not be acceptable.
1. Valve housing shall consist of forged brass, rated at no less than 360 psi at 250°F.
2. Valve shall have a union end connection that includes a factory installed manual air vent to allow for venting of the coil.

C. Automatic Flow Limiting Cartridge (FLC):
1. FLC shall automatically control flow rates with □5% accuracy over an operating pressure differential range of at least 14 times the minimum required for control. Three (3) operating pressure ranges shall be available with the minimum range requiring no more than 2 PSID to actuate the mechanism.
2. Valve internal control mechanism shall consist of a stainless-steel one-piece cartridge with segmented port design and full travel linear coil spring. Plated steel cartridges shall not be acceptable.
3. Dual pressure/temperature test valves for verifying the pressure differential across the cartridge and system shall be standard.
4. Manufacturer shall be able to provide certified independent laboratory tests verifying accuracy of performance.

D. Control Valves: All control valves for individual coil control shall be provided by the Controls Contractor and field installed in the coil kit. Mechanical Contractor is to coordinate the control valve connection type with the coil kit.

E. Isolation Ball Valve:

1. Valve shall include a 600 WOG manual isolation ball valve.

2.2 SUPPLY SIDE COIL PIPING PACKAGE

A. Stainless Steel Braided Hose (See section 2.3).

B. Combination valve shall include a manual isolation ball and integrated strainer, including drain valve with 3/4 inch. hose connection with cap, in a single valve housing to prevent opportunity for leakage. Separate assembled components shall not be acceptable. Dual pressure/temperature test valve shall be standard.

C. Valve housing shall consist of forged brass rated at no less than 360 psi at 250°F.

D. Valve shall have one (1) fixed end and one (1) union end connection.

E. Integrated Strainer:
1. Shall be 20 mesh stainless steel and can be removed from housing without disturbing pipe connections for inspection or replacement.
2. Drain valve shall consist of nickel-plated ball in a brass housing rated for 275 psi at 250°F.

F. Isolation Ball Valve:
1. Valve shall include a 600 WOG manual isolation ball valve.

2.3 SUPPLY/RETURN HOSES

A. All hoses shall be equipped with swivel end connections at terminal unit. All end connections shall be crimped to meet standard pressure ratings. Serrated/slip fit connections shall not be acceptable.

B. Flame Retardant Hoses:
1. Hose material shall be stainless steel braided over a synthetic polymer liner.
2. Hoses shall meet or exceed the ASTM D380-00 standard.
3. Hoses shall meet or exceed flame retardant testing per standards per ANSI/UL 723, NFPA 255, UBC 42-1, and ASTM E84-00.

C. Insulated Hoses:
1. Hose materials shall be high quality polyethylene pipe insulation over a stainless steel braided inner core.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install per manufacturer's recommendations and instructions.

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SECTION 230530 - ROOF CURBS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment, and services as required for the complete installation of roof curbs as shown in Contract Documents.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 230550 - Wind Restraint for HVAC Systems.

1.3 SUBMITTALS

A. Typical detail and schedule for equipment. Details shall include cross-sectional view illustrating clearly the type of curb being submitted, i.e. double wall insulated, with or without cant.

PART 2 - PRODUCTS

2.1 ROOF CURBS AND PIPE/DUCT/EQUIPMENT SUPPORTS

A. Basis of Design: Subject to compliance with requirements of this section, provide Roof Products and Systems Corp. (RPS) or comparable product by one of the following:
   1. RPI (Roof Products Inc.)
   2. ThyCurb
   3. Greenheck

B. Configuration: Coordinate curb type with roof deck construction and insulation thickness.
   1. Self-flashing without cant strip, with mounting flange (RPS Series 2A).
   2. Built-in cant and mounting flange (RPS Series 3A).
   3. Built-in raised cant and mounting flange (RPS Series 4A).

C. Provide wind restraint in accordance with specified requirements.

2.2 FAN CURBS/DUCT CURBS

A. Standard Curb:

1. Double wall, 1-1/2 inch. minimum thickness, fully insulated in the interior cavity with rigid insulation. Curb constructed of galvanized steel, 1-1/2 inch. 3# density insulation with continuous welded corner seams and painted at all welds. 20 gauge up to 36 inch., 18 gauge 38 to 72 inch., 16 gauge over 72 in. in any dimension.
2. Curb height shall be 24 inch. high or as otherwise noted on the drawings.
3. Provide curb with adhesive backed closed cell foam gasket on the top edge to make airtight seal between curb and ventilator, fan, or air handling unit.
4. Options:
    a. Pitch Mounting: Manufacture curb for roof slope(s).
    b. Vibration isolation.

B. Kitchen Exhaust Fan Curb:
1. Double wall, 1-1/2 inch. minimum thickness, fully insulated in the interior cavity with rigid insulation. Curb constructed of galvanized steel, 1-1/2 inch. 3# density insulation with continuous welded corner seams and painted at all welds. 20 gauge up to 36 inch., 18 gauge 38 to 72 inch., 16 gauge over 72 in. in any dimension.
2. Kitchen exhaust fan curbs shall be 24 inch. high (min.) with hinges and service hold-open chain or cable. Increase height if required to ensure that fan outlet is at least 40" above the adjacent roof level.
3. Provide curb with airtight seal between curb and fan. Gasketing for kitchen exhaust fan curbs shall be woven ceramic gasket tape rated for the operating temperature.
4. Options:
    a. Pitch Mounting: Manufacture curb for roof slope(s).
    b. Metal Liner: Galvanized steel.
    c. Vented Curb: Unlined with louvered vents in vertical sides.

C. Basis of Design: RPS - RC Roof Curbs.

2.3 CURB ADAPTER - TRANSITION/EXTENSION

A. Curb adapter/extension for equipment requiring a curb connection equal, larger or smaller than an existing curb.
1. Double wall, 1-1/2 inch. minimum thickness, fully insulated in the interior cavity with rigid insulation. Curb constructed of 18 gauge galvanized steel, 1-1/2 inch. 3# density insulation with continuous welded corner seams and painted at all welds.
2. Neoprene gasket between existing curb and adapter.

B. Basis of Design: RPS - CE-1 (equal) or CA-1 (larger) or CA-2 (smaller).

2.4 EQUIPMENT SUPPORTS

A. Double wall, minimum 24 inch. high. Constructed of 18 gauge galvanized steel with continuous welded corner seams and painted at all welds. Constructed of heavier gauge steel where standard rail cannot support unit weight. Provide with top cap counter flashing. Width to be 5-1/2 inches.

B. Basis of Design: RPS - Equipment Rail ER2.

2.5 DUCT SUPPORTS

A. Double wall, minimum 24 inch. high. Constructed of 18 gauge galvanized steel with continuous welded corner seams and painted at all welds. Constructed of heavier gauge steel where standard curb cannot support unit weight. Provide with top cap counter flashing. Width to be 5-1/2 inches.

B. Duct mounting pedestal shall consist of a support rail 12 inch. longer than the duct width for single duct support, with a single galvanized steel slide channel equal in length to the equipment rail attached to galvanized steel "U" shaped mounting brackets secured to the side of the equipment rail with lag bolts. The duct mounting slide assembly shall be sized to suit the duct supported and fabricated of galvanized steel and shall have galvanized 18 inch. long continuous threaded rods to allow 12 in. vertical adjustment, and lateral adjust spacer bracket for 12 in. horizontal adjustment.

C. Basis of Design: RPS - Duct Mounting Pedestal.

2.6 PIPE SUPPORTS

A. Same construction as "Equipment Supports". Provide with full length galvanized steel bracket, U bolts and accessories as required to secure piping to the pipe support as detailed on Contract Drawings. All fasteners shall be stainless steel.

B. Basis of Design: RPS - Pipe Mounting Pedestal Model ER.

2.7 PIPE CURB ASSEMBLY - PIPE PORTAL

A. Fully insulated with rigid 1-1/2 inch. 3# density insulation. Minimum 18 inch. high. Constructed of 18 gauge galvanized steel with continuous welded corner seams and painted at all welds.

B. Acrylic coated ABS rib reinforced curb cover and integral counter flashing, size and number of pipe and conduit openings as required to suit job conditions.

C. EPDM protective rubber pipe boots and stainless steel clamps secured around each pipe individually. Curb provided with raised cant, flanged or recessed. Curb flange shall suit roof construction and type of insulation being applied.

D. Basis of Design: RPS - Pipe Portal Flashing System.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation shall be in accordance with manufacturer's written instructions and in accordance with wind restraint requirements.

B. Height as recommended by equipment manufacturer, not less than described in this specification. This Contractor shall be responsible for exact size, length, and location and shall set and secure each curb or support to the roof. Shim and level curb or support as required. Provide curb and supports for all roof-mounted equipment. All roof penetrations shall be made through an appropriate curb. All roof mounted equipment including fans, air handling units, etc, shall be set on an equipment curb or support unless otherwise noted.

END OF SECTION 230530

SECTION 230548 - VIBRATION ISOLATION OF MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the Drawings and as specified herein to provide complete vibration isolation systems in proper working order.

1.2 RELATED SECTIONS

A. See Specification Section 230550 - Wind Restraint for Mechanical Systems.

1.3 MATERIAL AND EQUIPMENT

A. All vibration isolation mounts shall be supplied by one of the following approved manufacturers:
   1. Mason Industries Inc. (Hauppauge, NY) M.I.
   2. Kinetics Noise Control Inc. (Dublin, OH) K.N.C.
   3. Vibration Mountings & Controls Group. (Butler, NJ) VMC Group
   4. Vibration Eliminator Co. (Long Island City, NY) V.E.C.

1.4 QUALITY ASSURANCE

A. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.

B. Provide vibration isolators of the appropriate sizes, with the proper loading to meet the specified deflection requirements.

C. Supply and install any incidental materials such as mounting brackets, attachments and other accessories as may be needed to meet the requirements stated herein even if not expressly specified or shown on the Drawings, without claim for additional payment.

D. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specification.

E. Should any rotating equipment cause excessive noise or vibration when properly installed on the specified isolators, the Contractor shall be responsible for re-balancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

F. Upon completion of work, the Architect or the Architect's Representative shall inspect the installation and shall inform the installing contractor of any further work that must be completed. Make all adjustments as directed by the Architect that result from the final inspection. This work shall be done before vibration isolation systems are accepted.

1.5 SUBMITTALS

A. Refer to related sections elsewhere for procedural instruction for submittals.

B. Before ordering any products, submit shop drawings of the items listed below. The shop drawings must be completed when submitted and must be presented in a clear, easily understood form. Incomplete or unclear presentation of shop drawings may be reason for rejection of the submittal.

C. A complete description of products to be supplied, including product data, dimensions, specifications, and installation instructions.

D. Detailed selection data for each vibration isolator supporting equipment, including:
1. The equipment identification mark.
2. The isolator type.
3. The actual load.
4. The static deflection expected under the actual load.
5. The specified minimum static deflection.
6. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.
7. Special details necessary to convey complete understanding of the work to be performed.

E. Submission of samples may be requested for each type of vibration isolation device. After approval, samples will be returned for installation at the job if requested. All costs associated with submission of samples shall be borne by the Contractor.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATOR TYPES

A. General:
1. All springs installed out-of-doors shall be zinc electroplated or powder-coated after fabrication. Hardware and other metal parts shall be cadmium-plated or galvanized. Galvanizing shall meet ASTM Salt Spray Test Standards and Federal Test Standard No. 14.
2. All isolators installed out-of-doors shall have base plates with bolt holes for fastening the isolators to the support members.

3. Isolator types are scheduled to establish minimum standards. At the Contractor's option, labor-saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories and seismic restraint features must not degrade the isolation performance of the isolators.
4. Static deflection of isolators shall be as provided in the EXECUTION section and as shown on the Drawings. All static deflections stated are the minimum acceptable deflection for the mounts under actual load. Isolators selected solely on the basis of rated deflections are not acceptable and will be disapproved.

B. Type FSN (Floor Spring and Neoprene):
1. Spring isolators shall be freestanding and laterally stable without any housing. Spring diameter shall be not less than 0.8 of the compressed height of the spring at the rated load. Springs shall have a minimum additional travel-to-solid equal to 50% of the rated deflection. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately 1 (one). All mounts shall have leveling bolts. The spring element in the isolator shall be set in a neoprene cup and have a steel washer or a flat surface in contact with the neoprene to distribute the load evenly over the bearing surface of the neoprene. Alternatively, each isolator shall be mounted on a Type NP isolator. If the NP isolator is used, a rectangular bearing plate of appropriate size shall be provided to load the pad uniformly within the manufacturer's recommended range. If the isolator is to be fastened to the building and the NP isolator is used, grommets shall be provided for each bolt hole in the base plate. If the basic spring isolator has a neoprene friction pad on its base and a NP isolator is to be added to the base, a galvanized steel, stainless steel or aluminum bearing plate shall be used between the friction pad and the NP isolator. If the isolator is outdoors, bearing plates shall not be made of galvanized steel. The NP isolator, bearing plate and friction pad shall be permanently adhered to one another and to the bottom of the isolator base plate.
2. Type FSN isolators shall be one of the following products with the appropriate neoprene pad (if used) selected from Type NP or approved equal:
    a. Type SLF M.I.
    b. Type FDS K.N.C.
    c. Series A VMC Group

C. Type FSNTL (Floor Spring and Neoprene Travel Limited):

1. Spring isolators shall be freestanding and laterally stable. Spring diameter shall not be less than 0.8 of the compression height of the spring at the rated load. Spring shall have a minimum additional travel-to-solid equal to 50% of the rated deflection. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately one (1). All mounts shall have leveling bolts. All mounts shall have vertical travel limit stops to control extension when weight is removed. The travel limit stops shall be capable of serving as blocking during erection of the equipment. A minimum clearance of 1/4 inch. shall be maintained around restraining bolts and between the limit stops and the spring to avoid interference with the spring action.
2. The spring element in the isolator shall be set in a neoprene cup and have a steel washer or a flat surface in contact with the neoprene to distribute the load evenly over the bearing surface of the neoprene. Alternatively, each isolator shall be mounted on a Type NP isolator. If the NP isolator is used, a rectangular bearing plate of appropriate size shall be provided to load the pad uniformly within the manufacturer's recommended range. If the isolator is to be fastened to the building and the NP isolator is use, grommets shall be provided for each bolt hole in the base plate.
3. If the basic spring isolator has a neoprene friction pad on its base and a NP isolator is to be added to the base, a galvanized steel, stainless steel or aluminum bearing plate shall be used between the friction pad and the NP isolator. If the isolator is outdoors, bearing plates shall not be made of galvanized steel. The NP isolator, bearing plate and friction pad shall be permanently adhered to one another and to the bottom of the isolator base plate.
4. Type FSNTL isolators shall be one of the following products, with the appropriate neoprene pad (if used) selected from Type NP or approved equal:
    a. Type SLR M.I.
    b. Type FLS K.N.C.
    c. Series AWR VMC Group

D. Type FN (Floor Neoprene):
1. Neoprene isolators shall be neoprene-in-shear type with steel reinforced top and base. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed. Bolt holes shall be provided in the base and the top shall have a threaded fastener. The mounts shall include leveling bolts that may be rigidly connected to the equipment.
2. Type FN isolators shall be one of the following products or approved equal:
    a. Type ND M.I.
    b. Type RD K.N.C.
    c. Series RD VMC Group

E. Type NP (Neoprene Pad):

1. Neoprene pad isolators shall be one layer of 1/4 inch. to 3/8 inch. thick ribbed or waffled neoprene. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.
2. Type NP isolators shall be one of the following products or approved equal:
   a. Type W M.I.
   b. Type NPS K.N.C.
   c. Series Shear Flex VMC Group

F. Type DNP (Double Neoprene Pad):
1. Neoprene pad isolators shall be formed by two layers of 1/4 inch. to 3/8 inch. thick ribbed or waffled neoprene, separated by a galvanized steel, stainless steel or aluminum plate. If the isolator is outdoors, the plate shall not be made of galvanized steel. These layers shall be permanently adhered together. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.
2. Type DNP isolators shall be formed from one of the following products or approved equal:
   a. Type WSW M.I.
   b. Type NPS K.N.C.
   c. Series Shear Flex VMC Group

G. Type HSN (Hanger Spring and Neoprene):
1. Vibration isolator hangers shall consist of a free standing and laterally stable steel spring and a neoprene element in series, contained within a steel housing. Spring diameters and hanger housing lower hole size shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the housing. Alternatively, other provisions shall be made to allow for a 30° arc of movement of the bottom hanger rod without contacting the isolator housing. Spring diameter shall not be less than 0.8 of the compressed height of the spring at the rated load. Spring elements shall have a minimum additional travel-to-solid equal to 50% of the rated deflection. The neoprene element shall be designed to have a 0.3 inch. minimum static deflection. The deflection of both the spring element and the neoprene element shall be included in determining the overall deflection of Type HSN isolators.
2. Type HSN isolators shall be one of the following products or approved equal:
   a. Type 30N M.I.
   b. Type SRH or SFH K.N.C.
   c. Type RSH or RFH VMC Group

H. Type HN (Hanger Neoprene):

1. Vibration isolator hangers shall consist of a neoprene-in-shear element contained within a steel housing. A neoprene neck brushing shall be provided where the hanger rod passes through the hanger housing to prevent the rod from contacting the hanger housing. The diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30° arc before contacting the hanger housing.
2. Type HN isolators shall be one of the following products or approved equal:
   a. Type HD M.I.
   b. Type RH or FH K.N.C.
   c. Type RHD or RFD VMC Group

2.2 EQUIPMENT BASES

A. Type BSF (Base-Steel Frame):
   1. Steel base frames shall consist of structural steel section sized, spaced, and connected to form a rigid base which will not twist, rack, deform, or deflect in any manner which will negatively affect the operation of the supported equipment or the vibration isolation mounts. Frames shall be adequately sized to support basic equipment units and motors plus any associated pipe elbow supports, duct elbow supports, electrical control elements, or other components closely related and requiring resilient support in order to prevent vibration transfer to the building structure. The depth of steel frame shall be at least 1/10 the longest dimension of the base and not less than 6 inch. The base footprint shall be large enough to provide stability for supported equipment.
   2. Frame bases shall include side mounting brackets for attachment to vibration isolators. Mounting brackets shall be located on the sides of the base that are parallel to the axis of rotation of the supported equipment.
   3. Type BSF bases shall be supplied by the isolator manufacturer and shall be one of the following products or approved equal:
      a. Type WFSL M.I.
      b. Type SFB or SRB K.N.C.
      c. Series WFB VMC Group

B. Type BIB (Base-Inertia Base):

1. Concrete inertia bases shall be formed of stone-aggregate concrete (150 lb./cu. ft.) and appropriate steel reinforcing cast between welded or bolted perimeter structural steel channels. Inertia bases shall be built to form a rigid base that will not twist, rack, deform, deflect, or crack in any manner that would negatively affect the operation of the supported equipment or the vibration isolation mounts. Inertia bases shall be adequately sized to support basic equipment units and motors plus any associated pipe elbow supports, duct elbow supports, electrical control elements, or other components closely related and requiring resilient support in order to prevent vibration transfer to the building structure. Inertia base depth shall be at least 1/12 the longest dimension of the inertia base and not less than 6 inch. The base footprint shall be large enough to provide stability for supported equipment. Inertia bases shall include side mounting brackets for attachment to vibration isolators. Mounting brackets shall be located on the sides of the base that are parallel to the axis of rotation of the supported equipment.
2. The steel frame and reinforcement shall be supplied by the vibration isolator manufacturer.
3. Frame and reinforcement for Type BIB bases shall be one of the following products or approved equal:
   a. Type KSL M.I.
   b. Type CIB-L or CIB-H K.N.C.
   c. Series WPF VMC Group

2.3 RESILIENT PENETRATION SLEEVE/SEAL

A. Resilient penetration sleeve/seals shall be field-fabricated from a pipe or sheet metal section that is 1/2 inch. to 3/4 inch. larger than the penetrating element in all directions around the element, and shall be used to provide a sleeve through the construction penetrated. The sleeve shall extend 1 inch. beyond the penetrated construction on each side. The space between the sleeve and the penetrating element shall be packed with glass fiber or mineral wool to within 1/4 inch. of the ends of the sleeve. The remaining 1/4 in. space on each end shall be filled with acoustical sealant to form an airtight seal. The penetrating element shall be able to pass through the sleeve without contacting the sleeve. Refer to details on Drawings.

2.4 RESILIENT LATERAL SUPPORTS

A. These units shall either be a standard product of the vibration isolation mounting manufacturer, or be custom fabricated from standard components. These units shall incorporate neoprene isolation elements similar to Type FN that are specifically designed to provide resilient lateral bracing of ducts or pipe.

B. Resilient lateral supports shall be one of the following products or approved equal:
   1. Type ADA M.I.

2. Type RGN K.N.C.
3. Type MDPA VMC Group

2.5 FLEXIBLE DUCT CONNECTIONS

A. Flexible duct connections shall be heavy glass fabric, double neoprene coated, approximately 30 oz. per sq. yd. The clear space between connected parts shall be a minimum of 3 inch. and the connection shall have a minimum of 1.5 inch. of slack material. Materials for flex connection shall be fire retardant, water and mildew resistant, and comply with UL standard 214.

B. Flexible duct connections shall be one of the following products or approved equal:
1. Ventfabrics, Inc. "Ventglass".

2.6 FLEXIBLE PIPE AND PUMP CONNECTIONS (BRAIDED STAINLESS STEEL)

A. Braided stainless steel pump and pipe connector(s) shall be constructed of annular corrugated stainless steel close-pitch hose with stainless steel overbraid. The corrugated metal hose, braid(s) and a stainless steel ring-ferrule/band (material gauge not less than .048 inch.) shall be integrally seal-welded using a 100% circumferential, full-penetration TIG weld. Fittings shall be attached using a 100% circumferential TIG weld.

B. Braided stainless steel pump and pipe connector(s) must be suitable for operating temperatures up to 850°F. The rated working pressure of the braided metal hose must have a minimum 4:1 safety factor.

C. Each braided stainless steel connector shall be individually leak tested by the manufacturer using air-under-water or hydrostatic pressure.

D. Braided stainless steel connectors shall carry a three (3) year warranty when installed in accordance with all specifications and installation instructions as described by the manufacturer.

E. End fittings shall be flat-faceplate steel flanges with 150# ANSI drilling, and outside diameter, carbon steel MPT ends, flanged by Schedule 40 grooved ends or increasing ends.

F. Acceptable Manufacturers: Flexhose Pumpsaver or equivalent Keflex, Metraflex, Mason-Mercer.

2.7 THRUST RESTRAINTS

A. Thrust restraints shall consist of a spring element in series with a neoprene pad. The unit shall be designed to have the same deflection due to thrust-generated loads as specified for the isolators supporting the equipment. The spring element shall be contained within a steel frame and be designed so it can be pre-compressed at the factory to allow for a maximum of 1/4 inch. movement during starting or stopping of the equipment. Allowable movement shall be field-adjustable. The assembly shall be furnished complete with rods and angle brackets for attachment to both equipment and the adjacent fixed structural anchor. The thrust restraints shall be installed on the discharge of the fan so that the restraint rods are in tension. Assemblies that place the rods in compression are not acceptable. The holes in the spring restraint brackets through which the restraint rods pass must be oversized to prevent contact between the brackets and rods.

B. Thrust restraints shall be one of the following products or an approved equal:
   1. Type WB M.I.
   2. Type HSR K.N.C.
   3. Type HTR VMC Group

2.8 GROMMETS

A. Grommets shall be specially formed to prevent bolts from directly contacting the isolator base plate, and shall be sized so that they will be loaded within the manufacturer's recommended load range.

B. Grommets shall either be custom made by combining a neoprene washer and sleeve, or be one of the following products or an approved equal:
   1. Type Isogrommets MBIS, Inc. (Bedford Heights, OH)
   2. Type WB Barry Controls (Brighton, MA)
   3. Type HG Mason Industries Inc., (Hauppauge, NY)

2.9 ACOUSTICAL SEALANT

A. Sealants for acoustical purposes as described in this specification shall be silicone or one of the non-setting sealants indicated below:
   1. Acoustical sealant D.A.P.
   2. BR-96 Pecora
   3. Acoustical sealant Tremco
   4. Acoustical sealant U.S.G.

PART 3 - EXECUTION

3.1 APPLICATION

A. General:

1. Refer to the PRODUCTS section of this specification for vibration isolation devices identified on the Drawings or specified herein.
2. The static deflection of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected solely on the basis of rated deflection are not acceptable and will be disapproved.

B. Major Equipment:
1. Unless otherwise shown or specified on Drawings, all floor-mounted major equipment shall be set on 6 inch. high concrete housekeeping pads.
2. Types and minimum static deflections of vibration isolation devices for major equipment items shall be as specified hereunder.
3. Flexible duct connections shall be installed at all fan unit intakes, fan unit discharges, and wherever else shown on the Drawings.
4. Flexible pipe connections shall be installed at all pipe connections to vibration-isolated equipment and as indicated on Drawings in the positions shown on the Drawings.
5. Electrical connections to vibration-isolated equipment shall be flexible, as called for in the electrical portion of the specification.
6. Thrust restraints shall be installed on all suspended fans and on all floor-mounted fans developing 4 inch. or more of static pressure, unless the horizontal component of the thrust force can be demonstrated to be less than 10% of the equipment weight.

C. Equipment Vibration Isolation Schedule:

TYPE	VIBRATION ISOLATOR TYPE	MINIMUM STATIC DEFLECTION (In.)	EQUIPMENT BASE
Inline Fans	HSN	1.5	----

NOTE 1: Equipment base and vibration isolators can be deleted where pumps are provided on slabs on grade and if pumps are placed on concrete inertia slab isolated from surrounding floor slab.

A. Miscellaneous Mechanical Equipment:
1. Miscellaneous pieces of mechanical equipment such as converters, pressure reducing stations, dryers, strainers, storage tanks, condensate receiver tanks and expansion tanks which are connected to isolated piping systems shall be vibration-isolated from the building structure by Type NP or Type HN isolators (selected for .01 inch. static deflection) unless their position in the piping system requires a higher degree of isolation as called for under "Pipe Isolation".

B. Pipes:
1. All chilled water, condenser water, hot water, steam main and engine exhaust piping shall be isolated from the building structure within the following limits:
a. Within mechanical rooms.

b. Within 50 feet total pipe length of connected vibration-isolated equipment (chillers, pumps, air handling units, pressure reducing stations, etc.).
c. Piping shall be isolated from the building structure by means of vibration isolators, resilient lateral supports, and resilient penetration sleeve/seals.
d. Isolators for the first three support points adjacent to connected equipment shall achieve one half the specified static deflection of the isolators supporting the connected equipment. When the required static deflection of these isolators is greater than 1/2 inch., Type FSN or Type HSN isolators shall be used. When the required static deflection is less than or equal to 1/2 in., Type FN or Type HN isolators shall be used. All other pipe support isolators within the specified limits shall be either Type FN or Type HN achieving at least 1/4 inch. static deflection.
e. Where lateral support of pipes is required within the specified limits, this shall be accomplished by use of resilient lateral supports.
f. Pipes penetrating the building construction shall be isolated from the building structure by use of resilient penetration sleeve/seals.
g. Provide flexible pipe connections as called for under "Major Equipment" above and wherever shown on the Drawings.

3.2 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT

A. General:
1. Locations of all vibration isolation devices shall be selected for ease of inspection and adjustment as well as for proper operation.
2. Installation of vibration isolation equipment shall be in accordance with the manufacturer's instructions.

B. Isolators:
1. All vibration isolators shall be aligned squarely above or below mounting points of the supported equipment.
2. Isolators for equipment with bases shall be located on the sides of the bases which are parallel to the equipment shaft unless this is not possible because of physical constraints.
3. Locate isolators to provide stable support for equipment, without excess rocking. Consideration shall be given to the location of the center of gravity of the system and the location and spacing of the isolators. If necessary, a base with suitable footprint shall be provided to maintain stability of supported equipment, whether or not such a base is specifically called for herein.
4. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plates shall rest entirely on the pad.
5. Hanger rods for vibration-isolated support shall be connected to structural beams or joists, not the floor slab between beams and joists. Provide suitable intermediate support members as necessary.

6. Vibration isolation hanger elements shall be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360□ about the rod axis without contacting any object.
7. Parallel running pipes may be hung together on a trapeze, when allowed by Section 232010 that is isolated from the building. Isolator deflections must be the greatest required by the provisions for pipe isolation for any single pipe on the trapeze. Do not mix isolated and un-isolated pipes on the same trapeze.
8. Pipes, ducts and equipment shall not be supported from other pipes, ducts and equipment.
9. Resiliently isolated pipes, ducts and equipment shall not come in rigid contact with the building construction or rigidly supported equipment.
10. The installed and operating heights of equipment vibration-isolated with Type FSNTL isolators shall be identical. Limit stops shall be out of contact during normal operation. Adjust isolators to provide 1/4 inch. clearance between the limit stop brackets and the isolator top plate, and between the travel limit nuts and travel limit brackets.
11. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting ducts or pipes.

C. Bases:
1. No equipment unit shall bear directly on vibration isolators unless its own frame is suitable rigid to span between isolators and such direct support is approved by the equipment manufacturer. This provision shall apply whether or not a base frame is called for on the schedule. In the case that a base frame is required for the unit because of the equipment manufacturer's requirements, and is not specifically called for on the equipment schedule, a base frame recommended by the equipment manufacturer shall be provided at no additional expense.
2. Unless otherwise indicated, there is to be a minimum operating clearance of 1 inch. between steel rails, steel frame base or inertia bases and the floor beneath the equipment. The isolator mounting brackets shall be positioned and the isolators adjusted so that the required clearance is maintained. The clearance space shall be checked by the Contractor to ensure that no construction debris has been left to short circuit or restrict the proper operation of the vibration isolation system.

D. Flexible Duct Connections:
1. Sheet metal ducts and plenum openings shall be squarely aligned with the fan discharge, fan intake, or adjacent duct section prior to installation of the flexible connection, so that the clear length is approximately equal all the way around the perimeter. Flexible duct connections shall not be installed until this provision is met. There shall be no metal-to-metal contact between connected sections, and the fabric shall not be stretched taut.

E. Flexible Pipe Connections:
   1. Install flexible pipe connections in strict accordance with the manufacturer's instructions.

F. Thrust Restraints:
   1. Thrust restraints shall be attached on each side of the fan at the vertical centerline of thrust. The two rods of the thrust restraints shall be parallel to the thrust force. This may require custom brackets or standoffs. The body of the thrust restraint shall not come in contact with the connected elements. Thrust restraints shall be adjusted to constrain equipment movement to the specified limit.

G. Grommets:
   1. Where grommets are required at hold down bolts of isolators, bolt holes shall be properly sized to allow for grommets. The hold down bolt assembly shall include washers to distribute load evenly over the grommets. Bolts and washers shall be galvanized.

H. Resilient Penetration Sleeve/Seals:
   1. Maintain an airtight seal around the penetrating element and prevent rigid contact between the penetrating element and the building structure. Fit the sleeve tightly to the building construction and seal airtight on both sides of the construction penetrated with acoustical sealant.

END OF SECTION 230548

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SECTION 230550 - WIND RESTRAINT FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

1.2 SECTION INCLUDES

A. Support and brace mechanical and electrical systems, as called for, to resist directional wind forces (lateral, longitudinal, and vertical).

1.3 APPLICABLE CODES AND STANDARDS

A. Provide work in compliance with the following Codes and Standards based on the current edition in effect at project location:
   1. Building Code of New York State (Section 1609 and 1613).
   2. Existing Building Code of New York State
   3. Mechanical Code of New York State (Section 301, Item 301.15).
   4. American Society of Civil Engineers (ASCE) Minimum Design Loads for Buildings and Other Structures with Supplement No. 1 - Standard ASCE/SEI 7-16.

1.4 QUALITY ASSURANCE

A. General:
   1. The contractor shall provide Professional Engineer stamped and signed engineering calculations and details of wind restraint systems to meet total design lateral force requirements for support and restraint of mechanical systems. Engineer shall be licensed to practice in the state in which the project is located.
   2. The wind restraint engineering calculations and details shall provide the quantity of attachments and size/type of attachments for the mounting of an equipment curb or support rail to the building structure, and for attachment of the equipment or system to the equipment curb or support rail. It is not the intent for manufactured equipment curbs or support rails to be certified by their respective manufacturers, nor is it the intent for them to be certified by the Professional Engineer who is providing the wind restraint calculations and connection methodology.
   3. Systems requiring wind restraint including, but not limited to:
      a. Make up Air Units.
      b. Exhaust fans.

c. Dryer fans.
d. Rooftop Units
e. Ductwork.
f. Roof curbs and pipe/duct/equipment supports associated with any of the equipment listed above.

1.5 SUBMITTALS

A. Submit wind force level (Fp) calculations from applicable building code. Submit pre-approved restraint selections, installation details, and plans indicating locations of restraints.

B. Calculations, plans, restraint selection, and installation details shall be stamped and signed by a professionally licensed engineer experienced in wind restraint design.

C. Submit manufacturer's product data.

D. For each piece of equipment that requires wind restraint as outlined in this section, include the following:
1. Dimensioned Outline Drawings of Equipment Unit: Identify the center of gravity and locate and describe mounting and anchoring provisions.
2. Anchorage: Provide detailed description of equipment anchorage devices on which the calculations are based and their installation requirements. Identify anchor bolts, studs and other mounting devices. Provide information on the size, type and spacing of mounting brackets, holes and other provisions.

E. The Contractor shall provide photographs of the installed roof mounted equipment, showing the fully installed wind restraint anchoring, prior to the roofing material installation, as a formal submittal for verification that the work has been completed.

PART 2 - PRODUCTS

2.1 CODE INFORMATION

A. This project is subject to the wind bracing requirements of the codes listed above. The following criteria are applicable to this project:
1. Ultimate Design Wind Speed (V): 120 mph
2. Risk Category: III
3. Exposure Category: B
4. Ground Elevation Factor (Ke): 1.0
5. Topographic Factor (Kzt): 1.0
6. Wind Directionality Factor (Kd): 0.85
7. Combined Gust Factor for Rooftop Equipment (GCr): Per Section 29.4.1 of ASCE 7-2016, based on dimensions of individual rooftop equipment considered.
8. Height and Exposure Adjustment Coefficient (λ): 1.0

2.2 WIND BRACING AND SUPPORT OF SYSTEMS AND COMPONENTS

A. General:
   1. Design analysis shall include calculated dead loads, wind loads, and capacity of materials utilized for the connection of the equipment or system to the structure.
   2. Analysis shall detail anchoring methods, fastener sizes and spacing, etc.
   3. All wind restraint devices shall be designed to accept without failure the forces calculated per the applicable building code and as summarized in Section 2.1.

B. Friction from gravity loads shall not be considered resistance to wind forces.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wind Restraint of Piping:
   1. All restraint systems shall be installed in strict accordance with the wind restraint design submittal.
   2. Installation of restraints shall not cause any change in position of equipment or piping, resulting in stresses or misalignment.

B. Wind Restraint of Ductwork and Equipment:
   1. All restraint systems shall be installed in strict accordance with the wind restraint design submittal.
   2. The interaction between mechanical and electrical equipment and the supporting structures shall be designed into the restraint systems.
   3. Installation of restraints shall not cause any change in position of equipment or ductwork, resulting in stresses or misalignment.
   4. Exhaust fans with hinge kits shall have wind restraint fasteners installed on the hinged side, same as the three (3) non-hinged sides.
   5. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.
   6. Do not install any equipment or duct that makes rigid connections with the building unless isolation is not specified.
   7. Prior to installation, bring to the Architect's/Engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

3.2 INSPECTION

A. The engineer who performs the delegated design for wind restraint shall inspect photos provided by the installing contractor to verify that the installation is in accordance with their design and applicable codes. The delegated design engineer shall coordinate with the contractor(s) who have installed the work.

B. Upon final acceptance by the delegated design engineer of all work performed by the contractor(s), the delegated design engineer shall submit a letter to the Owner's Representative indicating that the installation of restraints complies with the requirements of their design and applicable codes.

END OF SECTION 230550

SECTION 230553 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 QUALIFICATION

A. All identification devices shall comply with ANSI/ASME A13.1 for lettering size, length of color field, colors, directional arrow, and viewing angles.

1.3 SUBMITTALS

A. Submit manufacturer's technical product data and installation instructions for each identification material and device.

B. Submit valve schedule for each piping system indicating valve number, location, and valve function.

C. Submit schedule of pipe, equipment and name identification for review before stenciling or labeling.

1.4 MAKES

A. Allen Systems, Inc.; Brady (W.H.) Co.; Signmark Div.; Industrial Safety Supply Co., Inc.; Seton Name Plate Corp.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide manufacturer's standard products of categories and types required for each application. In cases where this is more than one type specified for an application, selection is installer's option, but provide single selection for each product category.

B. All adhesives used for labels in the interior of the building shall comply with the maximum Volatile Organic Compound (VOC) limits as called for in the current version of U.S. Green Building Council LEED Credits EQ 4.1 and EQ 4.2.

C. For work within an existing building, the mechanical identification shall meet the intent of this section, but match the Owner's existing identification symbology.

2.2 PIPING IDENTIFICATION

A. Identification Types:
1. Pressure Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color coded, pressure sensitive vinyl pipe markers complying with ANSI/ASME A13.1.
a. Provide a 360° wrap of flow arrow tape at each end of pipe label.

B. Lettering:
1. Refer to HVAC symbols list and coordinate with existing facility labelling procedure for associated pipe function and labeling identification.

2.3 VALVE IDENTIFICATION

A. Valve Tags:
1. Standard brass valve tags, 2 inch. diameter with 1/2 in. high numerals. Identify between heating and plumbing services with 1/4 inch. letters above the valve number. Lettering to be stamped and in-filled black. Seton, or equal.
a. Valve-tag Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Chart:
1. Provide valve chart for all valves tagged as a part of this project. Frame and place under clear glass. Hang in Mechanical Room.
2. Valve chart to include as a minimum, valve #, valve size, valve type, valve service description, valve location.

2.4 EQUIPMENT LABELS

A. Metal Labels for Equipment (Outdoors):
1. Material and Thickness: Brass, 0.032 inch. minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 inch. by 3/4 inch.
3. Minimum Letter Size: 1/4 inch. for name of units if viewing distance is less than 24 inch., 1/2 inch. for viewing distances up to 72 inch. and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment (Indoors):
1. Material and Thickness: Multilayer, multicolor, phenolic (micarta) labels for mechanical engraving, 1/16 inch. thick, and having predrilled holes for attachment hardware.

2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 inch. by 3/4 inch.
6. Minimum Letter Size: 1/4 inch. for name of units if viewing distance is less than 24 inch., 1/2 inch. for viewing distances up to 72 inch., and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2 inch. x 11 inch. bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

E. Provide for the following equipment:
1. Air handling units
2. Fans
3. Make Up Air Units
4. Hot Water Coils

2.5 ABOVE CEILING EQUIPMENT LOCATOR

A. 3/4 inch. diameter adhesive stickers placed on ceiling grid. Color coded. Provide for the following:
1. Fire dampers/smoke dampers - RED
2. Plumbing valves - BLUE
3. HVAC valves - ORANGE
4. VAV boxes or reheat coils - GREEN
5. Fans - YELLOW
6. Pumps - BLACK

PART 3 - EXECUTION

3.1 GENERAL

A. Provide piping identification with directional flow arrows for all piping on project, at maximum intervals of 20 feet

1. For piping installed through floors or walls, provide at least one pipe label on each side of penetration, for each pipe function.
2. For piping adjacent to 3-way diverting/mixing valves and tee/wye branches, provide at least one pipe label on each side of valve/tee.
3. Label all abandoned piping if abandoned piping is allowed by Owner/Engineer. Document locations of all abandoned piping on as-builts.

B. Provide valve tags for all valves provided on project, except for service valves at terminal equipment.

C. Provide equipment tags for all equipment listed above.

D. Provide above ceiling equipment locator stickers on ceiling grid for all equipment listed above.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2023.

1.2 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for complete adjusting and balancing Work as required in Contract Documents.

B. This Section specifies the requirements and procedures of mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.

C. Test, adjust, and balance the following mechanical systems:
   1. Airside:
      a. Supply air systems, all pressure ranges; including constant volume and variable volume systems.
      b. Return air systems.
      c. Exhaust air systems; including kitchen exhaust systems.
   2. Hydronics:
      a. Constant flow systems.
      b. Variable flow systems.

D. This Section does not include:
   1. Testing boilers and pressure vessels for compliance with safety codes;
   2. Specifications for materials for patching mechanical systems;
   3. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.
   4. Requirements and procedures for piping and ductwork systems leakage tests.

1.3 SUBMITTALS

A. Provide information in report form listing items required by specifications. Results shall be guaranteed. Contractor shall be subject to recall to site to verify report information before acceptance of the report by the Owner's Representative.

B. Strategies and Procedures Plan: Within thirty (30) days of Contractor's Notice to Proceed, submit testing and balancing strategies and step-by-step procedures as specified in Section 3.1.B, "Preparation", and consistent with those listed in Part 3 of this specification.

C. System Readiness Checklists: Within thirty (30) days of Contractor's Notice to Proceed, AABC agency shall provide system readiness checklists as specified in Section 3.1.C, "Preparation", to be used and filled out by the installing contractors verifying that systems are ready for Testing and Balancing.

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

E. Certified report format shall consist of the following:
   1. Title sheet with job name, contractor, engineer, date, balance contractor's name, address, telephone number and contact person's name and the balancing technician's name.
   2. Individual test sheets for air handlers, terminal units, air distribution, exhaust fans, duct traverses, pumps, air handling coils, reheat coils, radiation, convectors, cabinet unit heaters, and unit ventilators.
   3. Manufacturer's pump and fan curves for equipment installed with design and actual operating conditions indicated.
   4. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or TABB's "Testing, Adjusting and Balancing Bureau".

1.4 DEFINITIONS

A. System testing, adjusting and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes:
   1. The balance of air and water distribution;
   2. Adjustment of total system to provide design quantities;
   3. Electrical measurement;
   4. Verification of performance of all equipment and automatic controls.

B. Test: To determine quantitative performance of equipment.

C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).

D. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.

E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.

F. Report Forms: Test data sheets arranged for collecting test data in logical order for submission and review. This data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.

G. Terminal: The point where the controlled fluid enters or leaves the distribution system. There are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return supply or outside air inlets or outlets on terminals such as registers, grilles, diffusers, and louvers.

H. Main: Duct or pipe containing the system's major or entire fluid flow.

I. Submain: Duct or pipe containing part of the systems' capacity and serving two or more branch mains.

J. Branch Main: Duct or pipe serving two or more terminals.

K. Branch: Duct or pipe serving a single terminal.

1.5 QUALIFICATIONS

A. Follow procedures and methods published by one or more of the following:
1. Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB) or Testing, Adjusting and Balancing Bureau (TABB).
2. Individual manufacturer requirements and recommendations.

B. Maintain qualified personnel at project for system operation and trouble shooting. TAB contractor shall change sheaves and perform mechanical adjustments in conjunction with balancing procedure.

C. Balancing contractor shall be current member of AABC, NEBB, or TABB.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in the AABC National Standards for Total System Balance and SMACNA (TAB) Procedural Guide.

1.6 GENERAL REQUIREMENTS

A. Before concealment of systems visit the job site to verify and advise on type and location of balancing devices and test points. Make changes as required to balance facilities.

B. Place systems in satisfactory operating condition.
1. Adjusting and balancing shall be accomplished as soon as the systems are complete and before Owner takes possession.

2. Initial adjustment and balancing to quantities as called for or as directed by the engineer, to satisfy job conditions.
3. All outdoor conditions (Db, Wb, and a description of the weather conditions) at the time of testing shall be documented in the report.
4. Airside:
    a. Prior to balancing, adjust balancing devices for full flow and replace temporary filters.
    b. Provide sheaves and belts as required to meet system performance requirements for all belt-driven fan motors 10 HP and greater. Adjust and align sheaves to obtain proper settings and operation. Verify motors are not overloading.
    c. Installing contractor shall replace dampers in new systems and identify dampers in existing systems that cannot be manipulated to satisfy balancing requirements.
    d. Traverse main ducts to determine total system air quantities after all outlets have been set prior to final adjustment if the system does not meet design requirements. A sum of room CFM's is not acceptable.
    e. If duct construction and/or installation prohibits proper traverse readings, provide coil measurements at main coils and/or fresh air intake traverse with units operating in 100% outside air mode (where applicable).
5. Hydronics:
    a. Prior to balancing, adjust balancing devices for full flow; fill, vent and clean hydronic systems, replace temporary strainers.
    b. Installing contractor shall replace balancing cocks and flow balancers in new systems and identify flow balancers and balancing cocks in existing systems that cannot be manipulated to satisfy balancing requirements.

1.7 CONTRACTOR RESPONSIBILITIES

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

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

C. Coordinate meetings and assistance from suppliers and contractors as required by Testing and Balancing agency.

D. Installing contractor shall replace or repair insulation as required by Testing and Balancing agency.

E. Have the HVAC systems at complete operational readiness for Testing and Balancing to begin. As a minimum verify the following:

1. Airside:
    a. Provide additional dampers, sheaves and belts as required by Testing and Balancing agency.
    b. Flag all manual volume dampers with fluorescent or other high-visibility tape.
    c. Provide access to all dampers, test ports, nameplates and other appurtenances as required by Testing and Balancing agency.
    d. All ductwork is complete with all terminals installed.
    e. All volume, smoke and fire dampers are open and functional.
    f. Clean filters are installed.
    g. All fans are operating, free of vibration, and rotating in correct direction.
    h. ASD start-up is complete and all safeties are verified.
    i. System readiness checklists are completed and returned to Testing and Balancing agency.
2. Hydronics:
    a. Provide additional valves as required by Testing and Balancing agency.
    b. Provide access to all valves, test ports, nameplates and other appurtenances as required by Testing and Balancing agency.
    c. Piping is complete with all terminals installed.
    d. Water treatment is complete.
    e. Systems are flushed, filled and air purged.
    f. Strainers are pulled and cleaned.
    g. Control valves are functioning per the sequence of operation.
    h. All shutoff and balance valves have been verified to be 100% open.
    i. Pumps are started, and proper rotation is verified.
    j. Pump gauge connections are installed directly at the pump inlet and outlet flange or in discharge and suction pipe prior to any valves or strainers.
    k. ASD start-up is complete and all safeties have been verified.
    l. System readiness checklists are completed and returned to Testing and Balancing agency.

F. Promptly correct deficiencies identified during Testing and Balancing.

G. Maintain a construction schedule that allows the Testing and Balancing agency to complete work prior to occupancy.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide tools, ladders, recording meters, gauges, thermometers, velometers, anemometers, Pitot tubes, inclined gauge manometers, magnehelic gauges, amprobes, voltmeters, psychrometers and tachometers required.

B. Instrumentation Calibration: Calibrate instruments at least every six (6) months or more frequently if required by instrument manufacturer.
   1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine Bid Documents and submittals and notify Owner's Representative and Engineer of any questions regarding balancing.
   1. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper Testing and Balancing of systems and equipment.
   2. Examine the approved submittals for HVAC systems and equipment.
   3. Examine equipment performance data including fan and pump curves.

B. Prepare a Testing and Balancing Strategies and Procedures Plan that includes:
   1. Equipment and systems to be tested.
   2. Strategies and step-by-step procedures for balancing the systems.
   3. Instrumentation to be used.
   4. Sample forms with specific identification for all equipment.

C. Prepare system-readiness checklists, as described in the AABC National Standards for Total System Balance and SMACNA (TAB) Procedural Guide, for use by contractors in verifying system readiness for Testing and Balancing. These shall include, at a minimum:
   1. Airside:
      a. All ductwork is complete with all terminals installed.
      b. All volume, smoke and fire dampers are open and functional.
      c. Clean filters are installed.
      d. All fans are operating, free of vibration, and rotating in correct direction.
      e. Permanent electrical power wiring and ASD start-up is complete and all safeties are verified.
      f. Automatic temperature-control systems are operational.
      g. Ceilings are installed.
      h. Windows and doors are installed.
      i. Suitable access to balancing devices and equipment is provided.
      j. Equipment and duct access doors are securely closed.
   2. Hydronics:
      a. Piping is complete with all terminals installed.
      b. Water treatment is complete.
      c. Systems are flushed, filled and air purged.

d. Strainers are pulled and cleaned.
e. Control valves are functioning per the sequence of operation.
f. All shutoff and balance valves have been verified to be 100% open.
g. Pumps are started and proper rotation is verified.
h. Pump gauge connections are installed directly at the pump inlet and outlet flange or in discharge and suction pipe prior to any valves or strainers.
i. Permanent electrical power wiring and ASD start-up is complete and all safeties are verified.
j. Suitable access to balancing devices and equipment is provided.

D. Examine construction and notify Owner's Representative and Engineer of outstanding issues related to balancing, as part of "Examination Report" submittal.
1. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, clean permanent filters are installed, and controls are ready for operation.
2. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected, configured by the controls contractor and functioning.
3. Airside:
a. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas.
b. Examine systems for installed balancing devices, such as test ports, gage cocks, flow-control devices, and manual volume dampers prior to pressure testing. Note the locations of devices that are not accessible for testing and balancing.
4. Hydronics:
a. Examine strainers to verify that Mechanical Contractor has replaced startup screens with permanent screens and that all strainers have been cleaned.
b. Examine two-way valves for proper installation and function.
c. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
d. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
e. Examine air vents to verify that mechanical contractor has removed all air from all hydronic systems.
f. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings and weld-o-lets prior to pressure testing. Note the locations of devices that are not accessible for testing and balancing.

3.2 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or TABB's "SMACNA (TAB) Procedural Guide" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

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

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

3.3 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

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

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

E. Check airflow patterns from the outside-air louvers and dampers and the return and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

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

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

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and function.

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

L. Check for proper sealing of air duct system.

3.4 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure fan static pressures to determine actual static pressure as follows:
      a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
      b. Measure static pressure directly at the fan outlet or through the flexible connection.
      c. Measure inlet static pressure of single-inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
      d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
   2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and treating equipment.
      a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
   3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
   4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
   5. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to sheaves sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
   6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
   1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
      a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
   2. Re-measure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
   1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
   2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.5 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
   1. Set outside-air dampers at minimum, and return-and exhaust-air dampers at a position that simulates full-cooling load.
   2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
   3. Measure total system airflow. Adjust to within indicated airflow.
   4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
   5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
      a. If air outlets are out of balance at minimum airflow, report the conditions but leave outlets balanced for maximum airflow.
   6. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that the adequate static pressure is maintained at the most critical unit.
8. Record the final fan performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
3. Set terminal units at full-airflow condition.
4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Adjust terminal units for minimum airflow.
6. Measure static pressure at the sensor.
7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

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

B. Verify that hydronic systems are ready for testing and balancing:
1. Check liquid level in expansion tank and verify that tank is set to specified pressure for system fill and expansion.
2. Check that makeup water has adequate pressure to highest vent.
3. Check that control valves are in their proper positions.
4. Check that air has been purged from the system.
5. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
6. Verify that motor starters are equipped with properly sized thermal protection.

3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design gpm.
1. Measure total water flow.
a. Position valves for full flow through coils.

b. Measure flow by main flow meter, if installed.
c. If main flow meter is not installed, determine flow by pump total dynamic head (TDH) or exchanger pressure drop.

2. Measure pump TDH as follows:
   a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves or fittings.
   b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
   c. Convert pressure to head and correct for differences in gauge heights.
   d. On single stage centrifugal pumps, verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
   e. With all valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

B. Adjust flow measuring devices installed in mains and branches to design water flows.
1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

C. Adjust flow measuring devices installed at terminals for each space to design water flows.
1. Measure flow at all terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after all have been adjusted.
4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after all flows have been balanced.

D. For systems with pressure-independent valves at the terminals:
1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after all flows have been verified.

E. For systems without pressure-independent valves or flow measuring devices at the terminals:
1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after all flows have been verified.

F. Verify final system conditions as follows:
1. Re-measure and confirm that total water flow is within design.

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

G. Verify that all memory stops have been set.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Adjust the variable-flow hydronic system as follows:
1. Verify that the differential pressure (DP) sensor is located per the Contract Documents.
2. Determine if there is diversity in the system.

B. For systems with no diversity:
1. Follow procedures outlined for constant-flow hydronic systems.
2. Prior to verifying final system conditions, determine the system DP setpoint.
3. If the pump discharge valve was used to set total system flow with ASD at 60 Hz, at completion open discharge valve 100% and allow ASD to control system DP setpoint. Record pump data under both conditions.
4. Mark all final settings and verify that all memory stops have been set.

C. For systems with diversity:
1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by the design Engineer.
3. Follow procedures outlined for constant flow hydronic systems.
4. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance the terminals that were just opened.
5. Prior to verifying final system conditions, determine the system DP setpoint.
6. If the pump discharge valve was used to set total system flow with ASD at 60 Hz, at completion open discharge valve 100% and allow ASD to control system DP setpoint. Record pump data under both conditions.
7. Mark all final settings and verify that all memory stops have been set.

D. For systems with pressure-independent valves at the terminals:
1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after all flows have been verified.

3.9 PROCEDURES FOR STEAM SYSTEMS

A. Measure and record upstream and downstream pressure of each piece of equipment using installed gauges.

B. Measure and record upstream and downstream steam pressure of pressure-reducing valves using installed gauges.

C. Check the setting and operation of automatic temperature -control valves, self-contained control valves, and pressure-reducing valves. Record the final setting.

D. Check the settings and operation of each safety valve. Record settings.

E. Verify the operation of each steam trap.

3.10 PROCEDURES FOR COMMERCIAL KITCHEN HOODS

A. Measure, adjust and record the airflow of each kitchen hood. For kitchen hoods designed with integral make-up air, measure and adjust the exhaust and make-up airflow. Measure airflow by duct Pitot-tube traverse. If a duct Pitot-tube traverse is not possible, provide an explanation in the report of the reason(s) why and also the reason why the method used was chosen.
   1. Install welded test ports in the sides of the exhaust duct for the duct Pitot-tube traverse. Install each test port with a threaded cap that is liquid tight.
   2. Recommend means to adjust airflow to achieve design values where exhaust fans serve multiple hoods.
   3. Installing contractor shall provide recommendations as required by Engineer.

B. Visually inspect the hood exhaust duct throughout its entire length in compliance with authorities having jurisdiction. Begin at the hood connection and end at the point it discharges outdoors. Report findings.
   1. Check duct slopes as required.
   2. Verify that duct access is installed as required.
   3. Perform a light test or an approved equivalent test method to determine that all welded and brazed joints are liquid tight. Test shall be performed by passing a lamp having a power rating of not less than 100 watts through the entire section of ductwork to be tested. The lamp shall be open as to emit light equally in all directions perpendicular to duct walls. Test every joint in the entire duct system, including the hood-to-duct connection. Ductwork may be tested in sections provided that every joint is tested.
   4. Verify that point of termination is as required.
   5. Verify that duct air velocity is within the range required.
   6. Prior to concealment of any portion of the grease-duct system, perform a duct leakage test in the presence of the code official.
   7. Verify that duct is within a fire-rated enclosure.

C. After balancing is complete, do the following:
   1. Measure and record the static pressure at the hood exhaust-duct connection.

2. Measure and record the hood face velocity. Make measurements at multiple points across the face of the hood. Perform measurements at a maximum of 12 inch. between points and between any point and the perimeter. Calculate the average of the measurements recorded. Verify that the hood average face velocity complies with the Contract Documents and governing codes.
3. Field test the hood for capture and containment of smoke using a smoke emitting device. Observe the smoke pattern. Make adjustments to room airflow patterns to achieve optimum results. The field test shall be conducted with all appliances under the hood at operating temperatures, with all sources of outdoor air providing make-up air for the hood operating, and with all sources of recirculated air providing conditioning for the space in which the hood is located operating.

D. Report deficiencies.

3.11 TOLERANCES

A. Set HVAC system's flow rates within the following tolerances:
1. Airside:
a. Supply, Return, and Exhaust Fans: Zero to plus 10 percent.
b. Air Outlets and Inlets: Plus or minus 10 percent.
c. Minimum Outside Air: Zero to plus 10 percent.
d. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.
2. Hydronics:
a. Heating-Water Flow Rate: Plus or minus 10 percent.

3.12 FINAL TEST AND BALANCE REPORT

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

B. The report must be organized by systems and shall include the following information as a minimum:
1. Title Page:
a. AABC or NEBB Certified Company Name.
b. Company Address.
c. Company Telephone Number.
d. Project Identification Number.
e. Location.

f. Project Architect.
g. Project Engineer.
h. Project Contractor.
i. Project Number.
j. Date of Report.
k. Certification Statement.
l. Name, Signature, and Certification Number.

2. Table of Contents.
3. National Performance Guaranty.
4. Report Summary:
   a. The summary shall include a list of items that do not meet design tolerances, with information that may be considered in resolving deficiencies.
5. Instrument List:
   a. Type
   b. Manufacturer
   c. Model
   d. Serial Number
   e. Calibration Date

C. Required Airside data - Test, adjust and record the following:
1. Motors:
   a. RPM
   b. BHP
   c. Full load amps
   d. Sheave sizes, number and size of belts
   e. Shaft diameter
   f. Complete nameplate data
2. Fans:
   a. Cfm
   b. RPM
   c. Suction static pressure
   d. Discharge static pressure
   e. Sheave sizes, number and size of belts, key sizes, shaft, diameter
   f. Complete nameplate data
   g. Sketch of system's inlet and outlet connections
   h. Location of test port
3. Duct: Traverse Zones:
   a. Cfm
   b. Static Pressure
4. AHU/RTU/MAU - (In both minimum O.A. and economizer modes):
   a. Minimum outdoor air Cfm

b. Total discharge and return Cfm
c. Static profile thru unit
d. Complete nameplate data

5. Coil:
   a. Entering air temperature (DB/WB)
   b. Leaving air temperature (DB/WB)
   c. Static differential
   d. Face velocity and area
   e. Cfm
   f. Complete nameplate data
6. Registers/Grilles/Diffusers:
   a. Cfm
   b. Set, adjust and record air flow pattern

D. Required Fluid Data: Test, adjust and record the following:
   1. Heat Transfer Devices: Including, but not limited to air handlers, convectors, fin tube radiation sections, unit ventilators, fan coils, cabinet heaters, unit heaters, heat pumps, heat exchangers.
      a. GPM (coil and bypass)
      b. Entering water temperature
      c. Leaving water temperature
      d. Water pressure drop
      e. Complete nameplate data

E. The final test and balance report shall be provided as a formal project submittal for review by the Engineer of Record.

END OF SECTION 230593

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SECTION 230710 - INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 SUBMITTAL

A. Submit product data, product description, manufacturer's installation instructions.

B. Submit schedule of types and thicknesses for each application, and location of materials.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 232010 - Piping Systems and Accessories.

B. Section 233100 - Sheet Metal and Ductwork Accessories Construction.

PART 2 - PRODUCTS

2.1 GENERAL

A. See Exhibits at the end of this section for where insulating materials shall be applied, thickness, jacketing and remarks.

B. Provide work in compliance with the following Codes and Standards based on the current edition in effect at project location:
   1. Energy Conservation Code of New York State.

C. Insulation, jackets, adhesive, and coatings shall comply with the following:
   1. Products shall not contain asbestos, lead, mercury, or mercury compounds.
   2. Insulation, including jackets, finishes and adhesives on the exterior surfaces of ducts, pipes, and equipment, shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less, when tested in accordance with ASTM E84 or UL 723.
      a. Plenums: Insulation materials shall be noncombustible or listed and labeled per ASTM E84 or UL 723.
      b. Treatment of jackets or facing for flame and smoke safety must be permanent. Water-soluble treatments are not permitted.

3. All adhesives, coatings, and sealants used for insulation in the interior of the building shall comply with the maximum Volatile Organic Compound (VOC) limits as called for in the current version of U.S. Green Building Council LEED Credits EQ 4.1 and EQ 4.2.
4. Provide materials which are the standard products of manufacturers regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least two (2) years prior to bid opening. Provide insulation systems in accordance with the approved MICA or NAIMA Insulation Standards.
5. Insulation shall be clearly marked with manufacturer's name, identification of installed thermal resistance (R) value, out-of-package R value, flame spread and smoke developed indexes in accordance with Energy Code requirements.
6. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C 871.
7. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

2.2 ACCEPTABLE MANUFACTURERS

A. Fiberglass: Johns Manville, Knauf/Manson, Owen-Corning, or approved equal.

B. Fire-Rated Insulation: Unifrax -FyreWrap, 3M Fire Wrap, or approved equal.

C. Polyisocyanurate: Johns Manville Trymer 25-50 PIR (Indoors), 2000XP (Outdoors), HiTherm, or approved equal.

D. Jacketing: Johns Manville (PVC, Aluminum), Polyguard Pro (Alumaguard), or approved equal.

E. Adhesives, Coatings, Mastics, Sealants: Childers, Foster, or approved equal.

2.3 FLEXIBLE FIBERGLASS

A. Glass fibers bonded with a resin.

B. Blanket:
1. Product meeting ASTM C553 Types I, II and III, and ASTM C1290; Greenguard compliant.
2. 'K' Value: 0.27 -in/ft2 hr. °F at 75°F mean temperature.
3. Maximum Service Temperature (Faced): 250°F.
4. Vapor Retarder Jacket: FSK conforming to ASTM C1136 Type II.
5. Density: As required to meet specified R-value in Exhibit, unless otherwise noted.

2.4 RIGID FIBERGLASS

A. Pre-formed glass fibers bonded with a thermosetting resin.

B. Pipe:
1. Product meeting ASTM C547, ASTM C585, and ASTM C795; rigid, molded, noncombustible.
2. 'K' Value: 0.23 -in/ft2 hr. °F at 75°F mean temperature.
3. Maximum Service Temperature: 1000°F.
4. Vapor Retarder Jacket: Factory applied ASJ/SSL conforming to ASTM C1136 Type I, secured with self-sealing longitudinal laps and butt strips.
5. Field applied PVC Fitting Covers with Flexible Fiberglass Insulation: Proto Corporation 25/50 or Indoor/Outdoor, UV resistant fittings, jacketing and accessories, white or colored. Fitting cover system consists of pre-molded, high-impact PVC materials with blanket type fiberglass wrap inserts. Blanket fiberglass wrap inserts shall have a thermal conductivity ('K') of 0.26 at 75°F mean temperature. Closures to be stainless steel tacks, matching PVC tape, or PVC adhesive per manufacturer's recommendations.

C. Board:
1. Product meeting ASTM C612 Type IA and IB. Maximum Service Temperature: 450º F.
2. 'K' Value: 0.24 -in/ft2 hr. °F at 75°F mean temperature.
3. Vapor Retarder Jacket:
   a. ASJ conforming to ASTM C1136 Type I
   b. FSK or PSK conforming to ASTM C1136 Type II.
4. Density: As required to meet specified R-value in Exhibit, unless otherwise noted.

2.5 FIRE-RATED INSULATION

A. Fire-resistant wrap consisting of an inorganic fiber blanket encapsulated with a scrim-reinforced foil.

B. Blanket:
1. Product meeting ASTM E2336, ASTM 814/UL 1479, ASTM E136, ASTM E119/UL 263, ASTM E84/UL 723.
2. "K" value: 0.60 -in/ft2 hr. °F at 500°F mean temperature.
3. Maximum Service Temperature: 2300°F.
4. Thickness: 1-1/2 inch., 0.9 lb/sq.ft.
5. Density: 6 PCF.
6. 2-hr rated.

2.6 RIGID POLYISOCYANURATE

A. Pre-formed closed-cellular foam, rigid molded.

B. Pipe:

1. Product meeting ASTM C591, rigid molded, noncombustible.
2. 'K' Value: 0.19 -in/ft2 hr. °F at 75°F mean temperature.
3. Maximum Service Temperature: 300°F.
4. Vapor Retarder Jacket: Dow Saranex Vapor Retarder Film and Tape.
5. Fittings shall match pipe requirements.

C. Board:
1. Product meeting ASTM C1289 Type I, Class I.
2. "K" value: 0.17 -in/ft2 hr. °F at 75°F mean temperature.
3. Density: As required to meet specified R-value in Exhibit, unless otherwise noted.

2.7 FIELD APPLIED JACKETS

A. PVC: High-impact UV resistant PVC; roll stock ready for shop or field cutting and forming.
1. Thickness: 30 mil.
2. PVC Jacket Color: White.

B. Aluminum: Factory cut and rolled to indicated sizes. Product meeting ASTM B 209/C 1729.
1. Material: 3003-alloy, and H-14 temper.
2. Finish: Bare Stucco Embossed 3/16" Corrugated finish.
3. Thickness (including insulation):
a. Rigid insulation installations: 0.016 (up to 24-in overall diameter) and 0.024 (greater than 24-in overall diameter).
b. Flexible insulation installations: 0.016 (up to 8-in overall diameter); 0.020 (9-in to 11-in overall diameter); 0.024 (12-in to 24-in overall diameter); 0.032 (25-in to 36-in overall diameter); 0.040 (greater than 36-in overall diameter).
4. Moisture Barrier: 3 mil thick, heat-laminated polyethylene and Surlyn.
5. Elbows: Preformed multi-piece, 45 and 90-degree, short and long-radius elbows; same material, finish, and thickness as roll.
6. Banding: 304SS, 0.020" thick, 0.75" wide. Provide same material wing seals. Screws, rivets, stapes or any other fastener capable of penetrating vapor barrier are not allowed.

C. Alumaguard: Self-adhesive, rubberized asphalt, multi-ply, UV-resistant, aluminum foil/polymer laminate with self-healing foil-faced weather barrier.
1. Thickness: 54 mil, 0.3 lb/sq-ft.
2. Peel Adhesion: >12 lb/in (144 oz/in).
3. Tensile Strength: 35 lb/in.
4. Puncture resistance: 15 lb.
5. Permeance: 0.00, Product meeting ASTM E 96.
6. Warranty: Minimum 10 years.

2.8 ADHESIVES, COATINGS, MASTICS, SEALANTS

A. Provide per manufacturer product requirements for associated system and application/installation location.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. All materials shall be installed by skilled labor regularly engaged in this type of work and installed in strict accordance with manufacturer's recommendations, building codes, and industry standards. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system per manufacturer requirements. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

B. Locate insulation and cover seams in the least visible location. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation. No glass fibers shall be exposed to the air. Install insulation with longitudinal seams at top and bottom of horizontal runs. Install multiple layers of insulation with longitudinal and end seams staggered and with the least number of joints possible.

C. All pipe and duct insulation shall be continuous through hangers.

D. Provide thermal insulation on clean, dry surfaces and after piping, ductwork and equipment (as applicable) have been tested. Do not cover pipe joints with insulation until required tests are completed.

E. All cold surfaces that may "sweat" must be insulated. Vapor barrier must be maintained; insulation shall be applied with a continuous, unbroken moisture and vapor seal. All hangers, supports, anchors, or other projections that are secured to cold surfaces shall be insulated and vapor sealed to prevent condensation.

F. Items such as boiler manholes, handholds, clean-outs, ASME stamp, and manufacturers' nameplates, may be left uninsulated unless omitting insulation would cause a condensation problem. When such is the case, appropriate tagging shall be provided to identify the presence of these items. Provide neatly beveled edges at interruptions of insulation.

G. Provide protective insulation as required to prevent personnel injury: Piping from zero to seven feet above all floors and access platforms including hot (above 140□F) piping and any other related hot surface.

H. If any insulation material has become wet because of transit or job site exposure to moisture or water, the contractor shall not install such material and shall remove it from the job site.

I. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

J. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

K. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.

3.2 PENETRATIONS

A. Aboveground Exterior Wall and Roof Penetrations: Install insulation continuously through penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above through surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall/roof flashing at least 2-in. beyond flashing. Seal jacket to flashing with flashing sealant per roofing manufacturer requirements.

B. Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Interior Floor, Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Fire-Rated Floor, Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.3 PIPE INSULATION

A. All pipes shall be individually insulated. Cover valves, fittings and similar items in each piping system with insulation as applied to adjoining pipe run. Extra care must be taken on piping appurtenances to insure a tight fit to the piping system.

B. Piping insulation is allowed to be reduced in thickness only when a specific UL assembly detail for piping passing thru a rated wall indicates a maximum insulation thickness that is less than this specification section calls for. In this case reduce the insulation thickness just for the rated wall penetration. The reduction of insulation thickness shall be limited to the length of the penetration only.

C. Coordinate insulation installation requirements for heat tracing that may apply.

3.4 DUCTWORK INSULATION

A. Provide external thermal insulation for ductwork. Not required where ducts have internal acoustical insulation. Make special provisions at dampers, damper motors, thermometers, instruments, and access doors.

B. Provide factory ASJ jacket for ductwork required to be insulated and to be painted.

C. Kitchen Hood Exhaust Duct Wrap: Install fire-rated duct wrap in strict accordance with the manufacturer's written installation methods.

3.5 EQUIPMENT INSULATION

A. Apply insulation with joints firmly butted as close as possible to the equipment surface.

3.6 EXISTING INSULATION

A. Patch existing insulation damaged during the course of the work.

EXHIBIT "I" - PIPE INSULATION MATERIALS

Service	Insulation Material	Thickness	Remarks
Dual temperature water (greater than 40□F and less than 200□F)	Rigid Fiberglass	1-1/2 inch. and Larger: 2 inch. 1-1/4 inch. and Smaller: 1-1/2 inch.	Provide with vapor barrier per cold water service requirements.

NOTES FOR EXHIBIT "I":

NOTE 1: Use cork insulation tape equal to K-flex Cork Tape for cold service piping where installed inside equipment valve compartment (unit ventilator, fan coil, etc.).

NOTE 2: All interior exposed piping below ceilings and above finished floor in occupied spaces shall be insulated with rigid polyisocyanurate insulation (for cold services) and rigid fiberglass (for hot services) with rigid fiberglass fittings and PVC jacket.

NOTE 3: All interior exposed piping, valves, fittings, and specialties less than 8'-0" above finished floor in mechanical/electrical rooms, penthouses, and services aisles/pipe chases shall be jacketed with PVC.

EXHIBIT "II" - DUCT INSULATION MATERIALS

Service	Insulation Material	Thickness	Remarks
Supply (concealed)	Flexible Fiberglass	2 inch.	Min. installed R value of 6
Supply (within mechanical rooms or exposed at 8'-0" or less above finished floor)	Rigid Fiberglass	1-1/2 inch.	Min. installed R value of 6
Outside air ducts and plenums, connections and mixing boxes, combustion air ductwork	Rigid Fiberglass	2 in.	Min. installed R value of 8
Return and exhaust within heated building envelope	Not insulated	Not insulated	
Exhaust, relief or vent ducts and plenums (concealed)	Flexible Fiberglass	2 in.	Min. installed R value of 6 Insulate ducts 15 feet from exterior opening and plenums.
Exhaust, relief or vent ducts and plenums (exposed)	Rigid Fiberglass	1-1/2 inch.	Min. installed R value of 6 Insulate ducts 15 ft. from exterior opening and plenums.

Service	Insulation Material	Thickness	Remarks
Interior ductwork indicated to be lined (L); exterior ductwork indicated to be lined (2L)	Not insulated	Not insulated	
Exterior supply or return ducts	Rigid Polyisocyanurate	3 inch.	Min. installed R value of 12
Concealed kitchen hood exhaust	Fire rated insulation blanket	Two (2) layers at 1-1/2 inch.	

NOTES FOR EXHIBIT "II":

NOTE 1: Exterior Ductwork: Finish with Alumaguard jacketing. Insulation shall be installed to shed water and secured per manufacturer prior to jacketing.

END OF SECTION 230710

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SECTION 230923 - BUILDING MANAGEMENT SYSTEM - DDC LOGIC

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. UL 916 - Energy Management Equipment; Current Edition, Including All Revisions.

1.2 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Drawings. Extend existing Building Management System (BMS), to perform the functions described in this Section. All new equipment shall be compatible with the existing system. Provide wiring and conduit required to connect devices furnished as a part of, or accessory to, this automatic control system. Control wiring is defined as wiring up to and including 120 volts. Install wiring in accordance with requirements of "Electrical Wiring" in Section 230504, and the National Electrical Code. Provide all required devices for proper system operation, including special electrical switches, transformers, relays, pushbutton stations, etc.

1. All Actuation of valves and dampers shall be electric unless specifically called out elsewhere in the specifications or drawings.

B. The Mechanical Contractor shall be responsible to provide the services to develop the BMS System documentation, programming, installation of the equipment, and commissioning such that the project has a complete and workable Building Management System that is fully compliant with the requirements of this specification section.

C. The BMS System shall have the following capabilities as described in these specifications:

1. The network controllers and operator's workstations shall be connected directly to the Owner's Ethernet Network. The network controller shall also contain SNMP for integration to the Owner's Network Controllers System.
2. Off site access for Owner's personnel shall be provided and shall have full workstation capability from remote location. Identical graphical displays shall be provided for offsite access to match the displays at the on-site Operator's Workstation. Connection to the site shall be via a high speed Ethernet connection.
3. The Network Controller must act directly as the WEB server. It must directly generate the HTML code to the requesting user (i.e. WEB browser), eliminating the need and reliance on any PC-based WEB server hardware or software.

4. The system shall be capable of sending both emails and text messages, and calling landline/cell phone numbers for alarms. A minimum of six (6) email addresses and phone numbers (for text and phone call messages) must be supported by the system. Coordinate with the Owner for email addresses, phone numbers and alarms.
5. All system variables in the temperature control system shall be Microsoft variables allowing them to be displayed and manipulated in other Microsoft products.
6. Network controllers shall all be flash upgradeable and not require changing chips for upgrades.
7. Short term logging of historical data shall be provided for every DDC input and output in the system. Each point shall be capable of being logged for a minimum of two (2) weeks.

D. The BMS shall consist of PC-based workstations and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions. Further, the system shall be the backbone framework for the Security/Card Access/CCTV system through the front-end software.

E. The system shall consist of the following components:
1. Provide one (1) File Server, one (1) Operator Workstation Computer(s), and printer(s) as described in this specification. The Workstations shall be running the standard workstation software developed and tested by the manufacturer of the network controllers and the standalone controllers. No third party front-end workstation software will be acceptable.
2. Provide Ethernet-based network controllers as described in this specification. Controllers shall connect directly to the Operator Workstation over Ethernet, provide communication to the Standalone Digital Control Units and/or other Input/Output Modules and serve as a gateway to equipment furnished by others.
3. Provide the necessary quantity and types of standalone controllers to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each standalone controller shall operate completely standalone, containing all of the I/O and programs to control its associated equipment.
4. A high speed Ethernet connection to the site shall be used for offsite access to the site. Coordinate with the Owner's IT professionals for high speed system access and shall comply with Owner's requirements to maintain the level of security required by the Owner. Coordinate with Owner and provide VPN (Virtual Private Network) as required, to comply with the Owner's IT professionals requirements.
5. BACnet Protocol Integration - BACnet:
   a. The neutral protocol used between systems will be BACnet over Ethernet and comply with ASHRAE BACnet standard 135-2003.

b. A complete Protocol Implementation Conformance Statement shall be provided for all BACnet system devices.
c. The ability to command share point object data, change of state data and schedules between the host and BACnet systems shall be provided.

1.3 QUALITY ASSURANCE

A. The complete automatic temperature control system shall be comprised of electric control devices with a microprocessor based Direct Digital Control System. All work shall be installed only by skilled mechanics employed by the BMS Contractor or Subcontractor.

B. The BMS Contractor/Subcontractor shall have a minimum of five (5) years experience in systems of similar size, type and complexity installed within a 100 mile radius.

C. The BMS Contractor/Subcontractor shall have a local service department (within a 50-mile radius) and have available a minimum of three (3) factory trained technicians within a 24 hour period.

D. All components shall be fully tested and documented to operate as a complete system.

E. Supplier must guarantee that all replacement parts will be carried in stock for a period of ten (10) years minimum from the date that the system is commissioned.

F. Electrical standards: Provide electrical products that comply with the following agency approvals:
1. UL 916; Energy Management Systems for Temperature Control components and ancillary equipment.
2. UL 873; Temperature Indication and Regulating Equipment.
3. FCC, Part 15, Subpart J, Class A Computing Devices.

G. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National codes.

1.4 ACCEPTABLE MAKES

A. The following control equipment in the existing buildings shall be the same make as the existing equipment:
1. Stark Tech

1.5 SUBMITTALS

A. Submit for review, a brochure containing the following:
1. Detailed piping and wiring control diagrams and systems description for each system under control.

2. Detailed layout and nameplate list for component control panels and DDC panels.
3. Submit a valve and damper schedule showing size, pressure drop configuration, capacity, and locations. Provide apparatus bulletins and data sheets for all control system components.
4. A complete listing of input and output points, control loops and/or routines, including time of day functions, and facilities management system functions for each controlled system. This listing shall include point logical names, identifiers, and alarmable ranges.
5. Provide as part of a separate submittal a hard copy of all graphics showing system components, sensor locations, setpoints and fixed/variable data. Engineer shall review and approve graphic format prior to final acceptance of system.

1.6 SCOPE OF WORK

A. Except as otherwise noted, the control system shall consist of all Ethernet Network Controllers, Standalone Digital Control Units, workstations, software, sensors, transducers, relays, valves, dampers, damper operators and other accessory equipment, along with a complete system of electrical interlocking wiring as required to fill the intent of the specification and provide for a complete and operable system.

B. The BMS Contractor/Subcontractor shall review and study all HVAC drawings and the entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.

C. All interlocking, wiring and installation of control devices associated with the equipment shall be provided under this Contract. The BMS Contractor/Subcontractor shall demonstrate the operation of the system to the Owner and prove that it complies with the intent of the drawings and specifications.

D. Provide services and manpower necessary for commissioning of system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative. Commissioning reports showing the testing of each DDC point on the system shall be submitted to the Engineer for review and approval upon completion of the commissioning process. Refer to the Commissioning Specification Section019113.

1.7 CONTROL SYSTEM GUARANTEES

A. Guarantee the new control system to be free from defects in material and workmanship, for a period of one (1) year after final acceptance. Guarantee system to:
1. Maintain temperatures within 1□F above and below setting.
2. Humidity devices shall maintain relative humidity conditions within 3% of span 0-100% RH.

B. Provide one (1) year maintenance service of control components, to start concurrently with the guarantee specified above. Such service shall include software updates and 24 hour, 7 day emergency and seasonal inspection and adjustment of operating controls and replacement of parts or instruments found deficient and defective during this period.

C. Provide monitoring of the DDC system as soon as the system is operating and then for a minimum of one (1) year (24 hours/day, 7 days/week) after the acceptance date. A monthly report will be sent to the Owner with a description of general system status and any alarms or off-normal conditions.

D. Guarantee future availability of continuous, 24 hour, 7 day a week service for the systems through available maintenance contracts.

1.8 SYSTEM ADJUSTMENT AND CALIBRATION

A. When the Work has been completed, completely adjust and calibrate the control system. Review the operation of each system input and output, control loops and/or software routings, timing functions, operator entered constants and facilities management functions and observe that they perform their intended functions. Provide a complete values and points log, printed every hour, for one week to demonstrate control functions and programming. Provide one point log for summer operation and one winter. Points to be trended shall be selected by the Engineer. When above procedure has been completed and the control system is operating satisfactorily, submit a letter with one (1) copy of completed values and points log to the Owner's Representative advising them that the control system is 100% complete and operates in accordance with the Contract Documents.

B. After review and approval of points log by the Engineer, the BMS Contractor shall schedule a technician on site for field review of system components, operation and graphics as part of final system appearance.

1.9 INSTRUCTIONS TO THE OWNER'S REPRESENTATIVE

A. Provide competent control technicians to instruct the Owner's operating personnel and turn over three (3) copies of maintenance manual. Provide a total of 32 hours of instruction at the site, 16 hours during start-up and 16 hours after six (6) months. Instruction sessions shall be scheduled at the Owner's convenience and shall be limited to four (4) hours per session. The instructions shall include, but not be limited to, the following:
   1. System Overview.
   2. System Software and Operation:
      a. System Access.
      b. Software Features Overview.
      c. Changing Setpoints and Other Attributes.

d. Scheduling.
e. Editing Programmed Variables.
f. Displaying Color Graphics.
g. Running Reports.
h. Workstation Maintenance.
i. Application Programming.

3. Operational sequences including start-up, shutdown, adjusting and balancing.
4. Equipment maintenance.

PART 2 - PRODUCTS

2.1 CONTROL DEVICES

A. Control Valves:
1. Sized by BMS Contractor/Subcontractor and guaranteed to meet the heating and cooling requirements. Water valves shall be sized on the basis of 15% of the total system pressure drop, but not more than 10 feet of head drop. Steam valves shall be sized for no more than a 5 psig pressure drop, or 30% (max.) of design steam pressure, whichever is smaller. Pressure drop for valves shall be submitted for review, including all CV values.
2. Valves shall be equal percentage type, equipped with characteristic type throttling plug, #316, stainless steel or Monel stem, removable composition discs, and rubber diaphragms. Provide with necessary features to operate in sequence with other valves or damper operators and adjustable throttling range as required by the sequence of operations.
3. Valves in 2 inch. and smaller shall be screwed bodies; 2-1/2 inch. and larger shall be flanged bodies; designed for 125 psi operating pressure. Arranged to fail-safe as called for; tight closing and quiet operating.
4. Electric Operators:
a. Provide 24 VAC control operators which are 0-10 VDC input proportional with spring return as needed by control sequence and designed for water service valve bodies. Operator shall be synchronous motor driven with up to 150 inch. lb. force and force sensor safety stop.

B. Temperature Sensors:
1. All temperature devices shall use precision thermistors accurate to ± 0.36°F over a range of -30 to 230°F.
2. Standard space sensors shall be provided in an off white, or white, enclosure for mounting on a standard electrical box.
3. Provide manual adjustment slider with ± programmable scale. Programmable scale shall have the capability to be limited via the DDC System.
4. Provide a local LCD display for viewing the space temperature.

5. Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless steel tube. Probe style duct sensors shall be used in air handling applications where the air stream temperature is consistent and is not stratified. Averaging sensors shall be employed in all mixing plenum and coil discharge applications and in any other application where the temperature might otherwise be stratified. The averaging sensor tube shall contain at least four thermistor sensors.
6. Immersion sensors shall be employed for measurement of temperature in all chilled water, hot water and glycol applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250°F and 300 series stainless steel for all other applications.

C. Humidity Sensors:
1. Humidity sensors shall be polymer resistance type.
2. Space humidity sensors shall have a sensing range of 05 to 95% with accuracy of +/ 3% RH.
3. Duct sensors and Outdoor air humidity sensors shall have a sensing range of 5 to 95% RH with accuracy of +/ 3% RH. Sensors shall be suitable for ambient temperature conditions of -40 to 212°F.

D. Electric Thermostats:
1. Provide a low voltage thermostat for control of single zone heating and air conditioning unit as specified in the sequence of operation. Electric thermostats shall include a display of the current space temperature as well as a mechanism for adjusting the setpoint locally. Aquastats on unit heaters shall stop the fan when the water temperature is below 100°F.

E. Electric Operators (Damper):
1. Provide 24 VAC control operators which are 0-10 VDC input proportional or two position with spring return as needed by control sequence and designed to operate control dampers. Operator shall by synchronous motor driven with up to 150 inch. lb. force sensor safety stop and return as required.

F. Control (Motorized) Dampers:
1. Provide control dampers as shown on the drawings and diagrams, to meet the following minimum construction standards.
2. Leakage: Class 1, 4 CFM/sq. ft. at 1 inch. W.C., tested per AMCA Standard 500-D-98 and AMCA Standard 511 and bearing AMCA's Certified Ratings for both air performance and air leakage.
3. Frame: 16 gauge galvanized steel structural hot channel with tabbed corners for reinforcement to meet 13 gauge criteria.
4. Blades: 14 gauge (equivalent thickness galvanized steel) roll forward air foil type for low pressure drop and low noise generation. Blades shall be parallel for two-position dampers and opposed, for modulating dampers.

5. Blade Seals: Ruskiprene, suitable for -72°F to +275°F mechanically locked into the blade edge.
6. Jamb Seals: Flexible metal, compression type.
7. Blade Axles: 1/2 inch. plated steel hexagonal positively locked into the damper blade. Linkage conceded out of the air stream.
8. Bearings: Corrosion resistant, permanently lubricated stainless steel sleeve.
9. Dampers subject to corrosive fumes or humidity shall be constructed of stainless steel.
10. Dampers over 48 inch. length and height shall be made in multiple sections.
11. Where damper sizes are not specifically indicated, they shall be sized by the Temperature Control Contractor. Maximum velocity shall be 1500 fpm and maximum pressure drop 0.1 inch. w.g.
12. Dampers shall be as manufactured by Ruskin CD60 Control Damper, or equivalent Tamco or Greenheck.

G. High Performance Thermally Broken and Insulated Control (Motorized) Dampers:
1. Provide high performance thermally broken and insulated control dampers as shown on the drawings and diagrams, to meet the following minimum construction standards.
2. Leakage: Shall not exceed 4 CFM/sq. ft. at 1in. W.C. (Leakage Class 1), tested per AMCA Standard 500-D-98 and AMCA Standard 511 and bearing AMCA's Certified Ratings for both air performance and air leakage. Holding torque shall not exceed 5 inch. lbs./sq. ft. on opposed blade dampers, and 7 inch. lbs./sq. ft. on parallel blades with a minimum torque of 40 inch. lbs.
3. Frame: .125 inch. extruded aluminum structural hat channel with tabbed corners for reinforcement.
4. Blade Seals: Ruskiprene II, suitable for -40°F and with locked into the blade edge extruded silicone, down to -70°F.
5. Jamb Seals: Flexible polycarbonate type.
6. Blade Axles: 1/2 inch. plated steel hexagonal positively locked into the damper blade. Linkage conceded out of the air stream.
7. Bearings: Corrosion resistant, permanently lubricated molded synthetic.
8. Dampers over 48 inch. length and height shall be made in multiple sections.
9. Where damper sizes are not specifically indicated, they shall be sized by the Temperature Control Contractor. Maximum velocity shall be 1500 fpm and maximum pressure drop 0.1 inch. w.g.
10. Dampers shall be as manufactured by Ruskin TED50 low temperature control damper, or equivalent Tamco or Greenheck.

H. Pressure Sensors:

1. Air pressure or differential air pressure measurements in the range of 0 to 10 inch. water column shall be accurate to ± 1% of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Acceptable manufacturer shall be Setra model C-264.
2. Liquid pressure or differential liquid pressure measurements shall be accurate to ± 0.25% of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Unit shall be provided with isolation and bypass manifold for start-up and maintenance operations. Acceptable manufacturer shall be Setra Model C-230.
3. Steam pressure measurements shall be accurate to ± 0.13% of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Unit shall be provided with isolation and bypass manifold for start-up and maintenance operations. Acceptable manufacturer shall be Setra Model C-207.
4. Room pressure sensors shall be bi-directional, bleed airflow thermistor type. Sensor assembly shall contain three (3) individually wired, hermetically sealed bead-in-glass thermistors. The operating range shall be +3,000 FPM to -3,000 FPM, and device shall have an accuracy of +2% of readings over the entire operating airflow range. Acceptable manufacturer shall be Ebtron Model GTC116-B.

I. Current Measurement Devices:
1. Measurement of three-phase power shall be accomplished with a kW/kWh transducer. The instrument shall utilize direct current transformer inputs to calculate the instantaneous value (kW) and a pulsed output proportional to the energy usage (kWh). Provide Veris Model 6000 Power Transducer or approved equal.

J. Carbon Monoxide Sensing Devices:
1. Wall mounted carbon monoxide (CO) sensor shall be microprocessor based (12 bit accuracy) and shall monitor CO over a range of 0-300 PPM. The device shall have an accuracy of ±5% of reading and operate within the range of -4 to 122°F and 15 to 95% RH. The sensor shall have a calibration accuracy of 2%.
    a. Accessories:
        1) Alarm Relay with remote Audible/Visual alarm.
        2) Make: Greystone Product # CMD or equivalent.
2. Relative Humidity (RH) Sensor Design and Performance:
    a. Each RH sensor node shall measure ambient RH using planar laminated, electrolytic polymer capacitor technology.
    b. RH measurement range shall be 0 – 100% RH, non-condensing.
    c. RH measurement accuracy shall be ±2% from 20% – 80%RH at 77° F (25° C). Outside of this normal RH operating range, accuracy shall be ±3%.

d. RH output resolution shall be at least 0.4% of Reading.

3. Temperature Sensor Design and Performance:
   a. Each temperature sensor node shall sense changes using integral bandgap voltage reference circuitry and perfectly proportional to absolute temperature (PTAT) ΔV technology.
   b. Temperature measurement accuracy shall be equal to or greater than ±1.08° F at 77° F (±0.6° C at 25° C).
   c. The operating temperature range shall be at least -58° F to 302° F (-50° C to 150° C).
   d. Output resolution shall be at least 0.36° F (0.2° C).
4. Power, Connectivity and Communications:
   a. The BACnet combination sensor shall be capable of communicating with other devices using an RS-485 standard interface and BACnet-MS/TP protocol, implemented as a Master.
      1) Communication speed shall be field-selectable between 9.6, 19.2, 38.4 and 76.8 kBaud.
   b. BACnet devices shall implement the open protocol in compliance of the requirements of ASHRAE Standard 135-2008 and all BACnet products shall be BTL Listed.
   c. The BACnet combination sensor shall be capable of field set-up and configuration using a simple dip-switch interface.
   d. The BACnet combination sensor shall operate on 24 VAC (22.8 to 26.4 VAC), 50/60Hz.
      1) The combination sensor design shall include protection from over voltage, over current transients and power surges.
      2) The combination sensor shall use "watch-dog" circuitry to assure automatic processor reset after power disruption, transients and brown-outs.
   e. The BACnet combination sensor design shall be capable of communicating to the network if one of the sensor functions becomes faulty, and will continue to operate the remaining CO2 or RH/Temp sensor nodes.
5. The BACnet combination sensor enclosure shall be a low profile wall mount type, compatible in size for mounting with a standard single-gang electrical box or for surface mount applications.
   a. The sensors shall be installed at locations that are protected from weather and/or water.
6. The manufacturer’s authorized representative shall review and approve wall-position placement for each measurement location indicated on the plans.
   a. A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer's recommendations or requirements.
7. Acceptable manufacturer shall be Ebtron Model IAQ-300-N.

K. Airflow Stations (DP Type):
   1. Duct Mounted Air Flow Stations:
      a. Rectangular: 16 gauge galvanized casing, 8 inch. deep, with formed 1-1/2 inch. integral 90° connecting flanges.
      b. Oval: 18 gauge galvanized casing, 8 inch. long between beads with 1 inch. connecting sleeve on each end (10 inch. overall length). Actual O.D. dimensions are 1/4 inch. less than specified duct I.D. dimensions.
      c. Accuracy: Within 2% throughout the velocity range of 600 FPM and over, when installed in accordance with published recommendations.
      d. Temperature: 350°F continuous operation, 400°F intermittent operation.
      e. Humidity: 0-100% continuous operation.
      f. Corrosion Resistance: Good salt air, excellent solvent and aromatic hydrocarbon resistance.
      g. Element Material: 6063-T5 anodized aluminum.
      h. Connection Fittings: 1/4 inch. compression, suitable for use with thermoplastic or copper tube.
      i. Design Equipment: Paragon Controls FE-1500.
      j. Make: Paragon, Cambridge, Air Monitor.
   2. Fan Inlet Air Flow Stations:
      a. Material: 6063-T5 anodized aluminum, galvanized mounting brackets.
      b. Accuracy: Within 2% throughout the velocity range of 600 FPM and over, when installed in accordance with published recommendations.
      c. Temperature: 350°F continuous operation; 400°F intermittent operation.
      d. Humidity: 0-100% continuous operation.
      e. Connection Fittings: 1/4 inch. compression, suitable for use with thermoplastic or copper tube.
      f. Corrosion Resistance: Good salt air and mild acid resistance, excellent solvent and aromatic hydrocarbon resistance.
      g. Design Equipment: Paragon Controls FE-1050.
      h. Make: Paragon, Cambridge, Air Monitor.
   3. Outside Air Flow Station:
      a. Material: Element 6063-T5 anodized aluminum and casing 16 gauge G90 galvanized steel.
      b. Accuracy: Within ± 0.5% of actual flow through the velocity range of 200 to 12,00 fpm when installed in accordance with published recommendation and within ±5% at a velocity of 100 fpm. Operating velocity range 100 to 2,800 fpm.
      c. Temperature: 350°F continuous operation and 400° intermittent operation.
      d. Humidity: 0 to 100%.
      e. Design Equipment: Paragon Controls mode OAFE-1500.
      f. Make: Paragon, Ruskin.

4. Air Volume/Velocity Transducers for Duct Outside Air and Fan Inlet Airflow Stations:
    a. The transducer shall be a combination differential pressure transmitter, square rood extractor, scaling multiplier, and output filter with process indication, complete in a single package.
    b. The measured air volume shall be locally indicated on a door mounted LED display meter scaled in CFM.
    c. The transducer package shall be a factory calibrated for the flow-measuring element being served.
    d. A transducer shall be provided for each individual airflow station.
    e. Accuracy shall be plus or minus 0.25%.
    f. An output signal of 0-10 VDC or 4-20 mA shall be generated for monitoring by the DDC system.
    g. Design Equipment: Paragon Controls Microtrans.
    h. Make: Paragon, Cambridge, Air Monitor.

L. Miscellaneous Devices:
1. Provide necessary, relays, transformers, required for a complete and operable system.

2.2 CONTROL CABINETS

A. BMS control panels shall be fully enclosed cabinet, baked enamel, steel, aluminum or composite material construction and shall meet the requirements of NEMA 1 enclosures. Panels shall have hinged door with a locking latch. Cover exposed electrical connections. Each component on front panel shall have an appropriate engraved label describing its function. Components inside the panel shall be appropriately labeled for ease of identification. Stick-on labels are not acceptable. Panels shall be either free-standing or wall-mounted. Provide support steel framing.

2.3 BUILDING MANAGEMENT SYSTEM

A. The BMS system shall consist of Network Controllers, standalone or application specific controllers, input/output unit modules, operator workstations, and file servers to support system configurations. The BMS system shall provide control, alarm detection, scheduling, reporting and information management for the entire facility.

B. The BMS shall be capable of being segmented, through software, into multiple local area networks per floor of building, distributed over a wide area network or sharing a single file server. This enables workstations to manage wide area network, and/or the entire system with all devices being updated and sharing the most current database. In the case of a single workstation system, the workstation shall contain the entire database - with no need for a separate file server.

C. For multi-workstation systems, a file server shall be utilized capable of residing directly on the Owner's Ethernet TCP/IP preferred network with no required gateways. This network may be dedicated for temperature control systems only so it does not interfere with other networks.

D. In addition to the above local area network and wide area network, the workstation software shall be capable of managing remote systems via remote high speed network as a standard component of the software.

E. The BMS system shall be scalable and expandable at all levels of the system using the same software interface and controllers.
   1. The BMS system shall include Security and Access Control functions with no additional workstations, front-end software or controllers required. Standalone, or application specific, Digital Control Units or modules shall be able to be added to the existing controller's field bus(es), to perform security and card access applications.
   2. The system shall use the same application programming language for all equipment: Operator Workstation, Network Controllers, Remote Site Controllers and Standalone, or application specific, Digital Controllers.

F. The BMS system design shall include solutions for the integration of the following "open systems" protocols: BACnet, LonTalk and digital data communication to third party microprocessors such as chiller controllers, fire panels and variable frequency drives (VFD's).
   1. The system shall also provide the ability to program custom ASCII communication drivers, which shall reside in the network control unit, for communication to third party systems and devices. These drivers shall provide real time monitoring and control of the third party systems.

2.4 NETWORK CONTROLLERS

A. Network Controllers shall be microprocessor based, multi-tasking, multi-user, and employ a real time operating system. Each Network Controller panel shall consist of modular hardware including power supply, CPU board, and input/output modules. A sufficient number of Network Controllers shall be supplied to fully meet the requirements of this specification and the point list on the drawings.

B. All Network Controllers on the Ethernet TCP/IP LAN/WAN shall be capable, out-of-the box, to be set up as a Web Server. The Network Controllers shall have the ability to store HTML code and "serve" pages to a web browser. This provides the ability for any computing device utilizing a TCP/IP Ethernet connection and capable of running a standard Internet browser (Microsoft Internet Explorer, Netscape Navigator, etc.) to access real-time data from the entire Temperature Control System via any Network Controllers.

1. Graphics and text-based web pages shall be constructed using standard HTML code. The interface shall allow the user to choose any of the standard text or graphics-based HTML editors for page creation. It shall also allow the operator to generate custom graphical pages and forms.
2. The WEB server interface shall be capable of password security, including validation of the requesting PC's IP address. The WEB server interface shall allow the sharing of data or information between any controller or process or network interface (BACnet, LonTalk and TCP/IP) that the Temperature Control System has knowledge of, regardless of where the point is connected on the Temperature Control System network or where it is acquired from.
3. The network controller shall act directly as the WEB server. It shall directly generate HTML code to the requesting user (i.e. WEB browser), eliminating the need for and reliance on any PC-based WEB server hardware or software. To simplify graphic image space allocation, HTML graphic images, if desired, shall be stored in any shared network device. The Web server shall have the ability to acquire any necessary graphics using standard pathing syntax within the HTML code mounted within the Temperature Control System WEB server. External WEB server hardware and software are not acceptable.

C. Hardware Specifications:
1. A minimum quantity of storage (RAM) consistent with industry standards and sufficient for job requirements shall be provided for Network Controllers.
2. Each Network Controller shall provide communication to both the Workstation(s) and the field buses. In addition, each Network Controller shall have at least three other communications ports that support a telephone modem, portable service tool, serial printer and connection to third party controllers such as a chiller control panel. On a LAN/WAN system, the Network Controller shall be provided with a 10Mbps plug-in Ethernet TCP/IP network interface card (NIC).
3. Input/Output (I/O): Each Network Controller shall support the addition of the following types of inputs and outputs:
    a. Digital Inputs for status/alarm contacts.
    b. Counter Inputs for summing pulses from meters.
    c. Thermistor inputs for measuring temperatures in space, ducts and thermowells.
    d. Analog inputs for pressure, humidity, flow and position measurements.
    e. Digital Outputs for on/off equipment control.
    f. Analog Outputs for valve and damper position control, and capacity control of primary equipment.
4. The system shall employ a modular I/O design to allow easy expansion. Input and output capacity is to be provided through plug-in modules of various types or DIN-mountable IOU modules. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.

5. Each Network Controller shall include a battery-backed, real time clock, accurate to 10 seconds per day. The Real Time Clock shall provide the following: time of day, day, month, year, and day of week. In normal operation, the system clock shall be based on the frequency of the AC power. The system shall automatically correct for daylight savings time and leap years.
6. The power supply for the Network Controllers shall be auto sensing, 120-220VAC, 60/50 Hz power, with a tolerance of ±20%. Line voltage below the operating range of the system shall be considered outages. The controller shall contain over voltage surge protection, and require no additional AC power signal conditioning. Optionally, if indicated on the drawings, the power supply shall accept an input voltage of (-48 VDC).
7. Upon restoration of power after an outage, the Network Controller shall automatically and without human intervention: Update all monitored functions; resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
8. Each Network Controller with the standard 120-220VAC power supply shall include a programmable DC power backup system rated for a minimum of 72 hours of battery backup to maintain all volatile memory or, a minimum of two (2) hours of full UPS including modem power. This power backup system shall be configurable such that at the end of a settable timeframe of running on full UPS, the unit shall shut off full UPS and switch to memory retention-only mode for the remainder of the battery power. The system shall allow the simple addition of more batteries to extend the above minimum battery backup times.

D. Software:
1. The Network Controller shall contain flash ROM as the resident operating system. Application software shall be RAM resident. Application software shall only be limited by the amount of RAM memory. There shall be no restrictions placed on the type of application programs in the system. Each Network Controller shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage.
2. The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be English language-based and programmable by the user. The language shall be structured to allow for the easy configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, passwords, and histories. The language shall be self-documenting. Users shall be able to place comments anywhere in the body of a program. Program listings shall be configurable by the user in logical groupings.

E. Control Software:

1. The Network Controller shall have the ability to perform the following pre-tested control algorithms:
    a. Proportional, Integral plus Derivative Control (PID).
    b. Two Position Control.
    c. Digital Filter.
    d. Ratio Calculator.
    e. Equipment Cycling Protection.
2. Mathematical Functions: Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as ???, ???, =, and, or, exclusive or, etc. These shall be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.
3. Energy Management Applications: Network Controllers shall have the ability to perform any or all of the following energy management routines:
    a. Time of Day Scheduling
    b. Calendar Based Scheduling
    c. Holiday Scheduling
    d. Temporary Schedule Overrides
    e. Optimal Start
    f. Optimal Stop
    g. Night Setback Control
    h. Enthalpy Switchover (Economizer)
    i. Peak Demand Limiting
    j. Temperature Compensated Duty Cycling
    k. CFM Tracking
    l. Heating/Cooling Interlock
    m. Hot/Cold Deck Reset
    n. Free Cooling
    o. Hot Water Reset
    p. Chilled Water Reset
    q. Condenser Water Reset
    r. Chiller Sequencing
    s. Static Pressure Reset/Optimizing
    t. Demand Controlled Ventilation
    u. Supply Air Temperature Reset

4. Each controller shall be capable of logging any system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system variables (inputs, outputs, math calculations, flags, etc.) can be logged in history. A maximum of 25,000 values can be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logs can be automatic or manual. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.
5. Alarm Management: For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms shall be tested each scan of the Network Controller and can result in the display of one or more alarm messages or reports.
    a. Up to eight (8) alarms can be configured for each point in the controller.
    b. Messages and reports can be sent to a local terminal, to the front-end workstation(s), or via modem to a remote-computing device.
    c. Alarms shall be generated based on their priority. A minimum of 255 priority levels shall be provided.
    d. If communication with the Operator Workstation is temporarily interrupted, the alarm shall be buffered in the Network Controller. When communications return, the alarm shall be transmitted to the Operator Workstation if the point is still in the alarm condition.
6. The Network Controller shall be able to generate user-definable reports to a locally connected printer or terminal. The reports shall contain any combination of text and system variables. Report templates shall be able to be created by users in a word processing environment. Reports can be displayed based on any logical condition or through a user command.

2.5 STANDALONE CONTROLLERS

A. Standalone Controllers shall provide control of HVAC and lighting. Each controller shall have its own control programs and shall continue to operate in the event of a failure or communication loss to its associated Network Controllers.

B. Standalone Controllers programs shall be stored in battery backed-up RAM and EPROM. Each controller shall have a minimum of 32K bytes of user RAM memory and 128K bytes of EPROM.

C. Standalone Controllers shall provide a communication port to the field bus. In addition, a port shall be provided for connection of a portable service tool to support local commissioning and parameter changes with or without the Network Controllers online. It shall be possible from a service port on any Standalone Controller to view, enable/disable, and modify values of any point or program on any controller on the local field bus, any Network Controller or any Standalone Controller on a different field bus.

D. Support BACnet standard MS/TP bus protocol ASHRAE SS PC-15, Clause 9 on the control network.

E. Each Standalone Controller shall support the addition of the following types of inputs and outputs:
   1. Digital Inputs for status/alarm contacts.
   2. Counter Inputs for summing pulses from meters.
   3. Thermistor Inputs for measuring temperatures in space, ducts and thermowells.
   4. Analog inputs for pressure, humidity, flow and position measurements.
   5. Digital Outputs for on/off equipment control.
   6. Analog Outputs for valve and damper position control, and capacity control of primary equipment.

F. Input and output capacity shall be expandable through the use of plug-in modules. A minimum of two (2) modules shall be added to the base Standalone Controller before additional power is required.

G. Each Standalone Controller shall be able to exchange information on a peer to peer basis with other Standalone Controllers during each field bus scan. Each Standalone Controller shall be capable of storing and referencing global variables (on the LAN) with or without any workstations online. Each Standalone Controller shall be able to have its program viewed and/or enabled/disabled either locally through a portable service tool or through a workstation connected to a Network Controller.

H. Standalone Controllers shall have as a minimum, LED indication of CPU status, and field bus status.

I. Standalone Controllers shall have a real time clock in either hardware or software. The accuracy shall be within 10 seconds per day. The Real Time Clock shall provide the following information: time of day, day, month, year, and day of week. Each Standalone Controller shall receive a signal over the network from the Network Controllers, which synchronizes all Standalone Controllers real time clocks.

J. Upon restoration of power, the Standalone Controller shall automatically and without human intervention, update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

K. Each Standalone Controller shall have at least three (3) years of battery back up to maintain all volatile memory.

L. For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms shall be tested each scan of the Standalone Controllers and can result in the display of one or more alarm messages or reports.

1. Up to eight (8) alarms can be configured for each point in the controller enabling the escalation of the alarm priority (urgency) based upon which alarm(s) is/are triggered.
2. Alarm messages can be sent to a local terminal or modem connected to a Network Controller or to the Operator's Workstation(s).
3. Alarms shall be generated based on their priority. A minimum of 255 priority levels shall be provided.
4. If communication with the Network Controller is temporarily interrupted, the alarm shall be saved in the Standalone Controller. When communications return, the alarm shall be transmitted to the Network Controller if the point is still in the alarm condition.

M. Air Handler Controllers shall be capable of meeting the requirements of the sequence of operation intended for each system and allow for future expansion.
1. Air Handling Unit Controllers shall support all the necessary point inputs and outputs as required by the sequence and operate in a standalone fashion.
2. Air Handling Unit Controllers shall be fully user programmable to allow for modification of the application software.
3. An LCD display shall be optionally available for readout of point values and to allow operators to change setpoints and system parameters.
4. A manual override switch shall be provided for all digital and analog outputs on the Air Handling Unit Controller. The position of the switch shall be monitored in software and available for operator displays and alarm notification.

N. Air Terminal Unit Controllers:
1. Air Terminal Unit Controllers shall support, but not be limited to the control of the following configurations of Air Terminal Units to address current requirements as described in the Execution portion of this specification, and for future expansion:
   a. Single Duct Cooling Only
   b. Single Duct Cooling with Reheat (Electric or Hot Water)
   c. Fan Powered (Parallel or Series)
   d. Dual Duct (Constant or Variable Volume)
   e. Supply/Exhaust
2. Air Terminal Unit Controllers for single duct applications shall be provided with a built-in actuator for modulation of the air damper. The actuator shall have a minimum torque rating of 35 inch.-lb., and contain an override mechanism for manual positioning of the damper during startup and service.
3. Air Terminal Unit Controllers shall contain an integral velocity sensor accurate to ±5% of the full range of the box's CFM rating.
4. Each controller shall perform the sequence of operation described in Part 3 of this specification, and have the capability for time of day scheduling, occupancy mode control, after hours operation, lighting control, alarming, and trending.

5. Air Terminal Unit Controllers shall be able to communicate with any other Standalone Controllers on the same field bus with or without communication to the Network Controllers managing the field bus. Systems that fail to provide this (true peer-to-peer) capability will be limited to a maximum of 32 Air Terminal Unit Controllers per field bus.

O. Unitary Controllers:
1. Unitary Controllers shall support, but not be limited to, the control of the following systems as described in the Execution portion of this specification, and for future expansion:
   a. Unit Ventilators
   b. Heat Pumps (Air to Air, Water to Water)
   c. Packaged Rooftops
   d. Fan Coils (2 or 4 Pipe)
2. The I/O of each Unitary Controller shall contain the sufficient quantity and types as required to meet the sequence of operation found in the Execution portion of this specification. In addition, each controller shall have the capability for time of day scheduling, occupancy mode control, after hour operation, lighting control, alarming, and trending.

2.6 OPERATOR HARDWARE

A. The BMS workstation software shall be configurable as either a single workstation system (with a local database) or multi-workstation system where the database is located on a central file server. The client software on multi-workstation system shall access the file server database program via an Ethernet TCP/IP network running at either 100MBPS or 1024MBPS.
1. All Workstations shall be Intel Core Processor based personal computers operating under the Microsoft Windows Server 2012 R2. The application software shall be capable of communication to all Network Controllers and Standalone Controllers, feature high-resolution color graphics, alarming, reporting, and be user configurable for all data collection and data presentation functions.
2. For multi-workstation systems, a minimum of 256 workstations shall be allowed on the Ethernet network along with the central file server. In this client/server configuration, any changes or additions made from one workstation shall automatically appear on all other workstations without the requirement for manual copying of files. Multi-workstation systems with no central database will not be acceptable. Multi-workstation systems with distributed/tiered file servers and a central (master) database will be acceptable.

2.7 WORKSTATION SOFTWARE

A. General Description:

1. The software architecture shall be object-oriented in design, a true 32-bit application suite utilizing Microsoft's OLE, COM, DCOM and ODBC technologies. These technologies shall make it easy to fully utilize the power of the operating system to share, among applications (and therefore to the users of those applications), the data available from the Temperature Control System.
    a. The workstation functions shall include monitoring and programming of all BMS controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.
    b. Programming of controllers shall be capable of being done either off-line or on-line from any operator workstation. All information shall be available in graphic or text displays. Graphic displays shall feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the BMS system. All operator functions shall be selectable through a mouse.
2. The file server database engine shall be Microsoft SQL Server, or another ODBC-compliant, relational database program. This ODBC (Open Database Connectivity) compliant database engine shall allow for an Owner to utilize "their" choice of database and due to its "open" architecture, shall allow an Owner to write custom applications and/or reports that communicate directly with the database avoiding data transfer routines to update other applications. The system database shall contain all point configurations and programs in each of the controllers that have been assigned to the network. In addition, the database shall contain all workstation files including color graphic, alarm reports, text reports, historical data logs, schedules, and polling records.
3. The BMS workstation software shall allow the creation of a custom, browser-style interface linked to the user that has logged into the workstation software. This interface shall support the creation of "hot-spots" that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface shall be able to be configured to become a user's "PC Desktop" - with all the links that a user needs to run other applications. This, along with the Microsoft Office Professional 2010 user security capabilities, shall enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BMS software but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.

4. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system shall allow a minimum of 256 users to be configured per workstation. There shall be an inactivity timer adjustable in software that automatically logs off the current operator after the timer has expired.
5. The workstation software shall use a familiar Windows Explorer style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a "network map" of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions. Object names shall not be required to be unique throughout the system allowing for point naming convention consistency. For example, each Air Temperature Unit Controller can have an input called Space Temperature and a setpoint called CFM Setpoint.
    a. The configuration interface shall also include support for template objects. These template objects shall be used as building blocks for the creation of the BMS database. The types of template objects supported shall include all data point types (input, output, string variables, setpoints, etc.), alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of template object types shall be able to be set up as template subsystems and systems. The template system shall prompt for data entry if necessary. The template system shall maintain a link to all "child" objects created by each template. If a user wishes to make a change to a template object, the software shall ask the user if he/she wants to update all of child objects with the change. This template system shall facilitate configuration and programming consistency and afford the user a fast and simple method to make global changes to the BMS.
6. Color Graphic Displays: The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition, operators shall be able to command equipment or change setpoints from a graphic using the mouse. Requirements of the color graphic subsystem include:
    a. LCD active matrix, resolution 1366 x 768 displays. The user shall have the ability to import AutoCAD generated picture files as background displays.

b. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, and graphs which can be "dropped" on a graphic using a software configuration "wizard". These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
c. Status changes or alarm conditions shall be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
d. Graphic panel objects shall be able to be configured with multiple "tabbed" pages allowing an operator to quickly view individual graphics of equipment, which make up a subsystem or system.
e. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators shall be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.

7. The software shall allow for the automatic collection of data and reports from any controller through either a hardwire or modem communication link. The frequency of data collection shall be completely user-configurable.
8. The software shall be capable of accepting alarms directly from controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) shall be integrated into the overall alarm management system and shall appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports. Alarm management features shall include:
    a. A minimum of 255 alarm notification levels, or classes of alarms. Each notification level shall establish a unique set of parameters for controlling alarm display, acknowledgment, keyboard annunciation, alarm printout and record keeping.
    b. Automatic logging in the database of the alarm message, point name, point value, connected controller, timestamp, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement).
    c. Automatic printing of the alarm information or alarm report to an alarm printer or report printer.
    d. Playing an audible beep or audio (wav) file on alarm initiation or return to normal.

e. Sending an email or text message to anyone listed in a workstation's email account address list on either the initial occurrence of an alarm and/or if the alarm is repeated because an operator has not acknowledged the alarm within a user-configurable timeframe. The ability to utilize email and texting of alarms shall be a standard feature of the software integrated with the operating system's mail application interface (MAPI). No special software interfaces shall be required.

f. Individual alarms shall be able to be re-routed to a workstation or workstations at user-specified times and dates. For example, a critical high temperature alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.

g. An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.

h. The font type and color, and background color for each alarm notification level as seen in the active alarm viewer shall be customizable to allow easy identification of certain alarm types or alarm states.

i. The active alarm viewer can be configured such that an operator shall type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.

9. The software shall contain a built-in custom report generator, featuring word processing tools for the creation of custom reports. These custom reports shall be able to be set up to automatically run or be generated on demand. Each workstation shall be able to associate reports with any word processing or spreadsheet program loaded on the machine. When the report is displayed, it shall automatically spawn the associated report editor, which shall be the most recent version of Microsoft Office.

a. Reports can be of any length and contain any point attributes from any controller on the network.

b. The report generator shall have access to the user programming language in order to perform mathematical calculations inside the body of the report, control the display output of the report, or prompt the user for additional information needed by the report.

c. It shall be possible to run other executable programs whenever a report is initiated.

d. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.

e. Standard reports shall include:

1) Points in each controller.

2) Points in alarm.

3) Disabled points.

4) Overridden points.
5) Operator activity report.
6) Alarm history log.
7) Program listing by controller with status.
8) Network status of each controller.

10. Spreadsheet-Style Reports: The software shall allow the simple configuration of row/column (spreadsheet-style) reports on any class of object in the system. These reports shall be user-configurable and shall be able to extract live (controller) data and/or data from the database. The user shall be able to set up each report to display in any text font, color and background color. In addition, the report shall be able to be configured to filter data, sort data, and highlight data that meets user-defined criteria.
11. HTML Reporting: The above spreadsheet-style reports shall be able to be run to an HTML template file. This feature shall create an HTML "results" file in the directory of the HTML template. This directory can be shared with other computer users, which shall allow those users with access to the directory to "point" their web browser at the file and view the report.
12. Scheduling: It shall be possible to configure and download from the workstation schedules for any of the controllers on the network.
    a. Time of day schedules shall be in a calendar style and shall be programmable for a minimum of one year in advance. Each standard day of the week and user-defined day types shall be able to be associated with a color so that when the schedule is viewed it is very easy, at-a-glance, to determine the schedule for a particular day even from the yearly view. To change the schedule for a particular day, a user shall simply click on the day and then click on the day type.
    b. Each schedule shall appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.
    c. Schedules shall be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation shall be automatically updated to the corresponding schedule in the controller.
13. The programmer's environment shall include access to a superset of the same programming language supported in the controllers. In this environment, the programmer shall be able to configure application software off-line (if desired) for custom program development, write global control programs, system reports, wide area networking data collection routines, and custom alarm management software. On the same screen as the program editor, the programming environment shall include dockable debug and watch bars for program debugging and viewing updated values and point attributes during programming. In addition, a wizard tool shall be available for loading programs from a library file in the program editor.

14. The workstation software shall have an application to save and restore field controller memory files. This application shall not be limited to saving and reloading an entire controller - it shall also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.
15. The workstation software shall have the capability to easily configure groups of data points with trend logs and display the trend log data. A group of data points shall be created by drag-and-drop method of the points into a folder. The trend log data shall be displayed through a simply menu selection. This data shall be able to be saved to file and/or printed.
16. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
17. Fault Tolerant File Server Operation: The system shall provide the option to provide fault tolerant operation in the event of the loss of the CPU, disk drives, or other hardware required to maintain the operational integrity of the system. Operational integrity includes all user interfaces, monitoring of alarm points and access points, and executing access control functions. Fault tolerant technology is not provided unless specifically stated.
    a. The switchover mechanism provided shall be automatic. Should the failure be caused by hardware, then the system shall immediately switch to the Backup computer. Should the system failure be caused by software (instruction or data), the system shall not pass the faulted code to the Backup computer, otherwise the Backup shall fail in the same manner of the Primary computer.
    b. Switchover to the Backup computer shall be initiated and effective (complete) in a manner and time frame that precludes the loss of event data, and shall be transparent to the system users, except for an advisory alarm message indicating that the switchover has occurred.
    c. When the system fails-over from the Primary to the Backup computer, no alarm or other event shall be lost, and the Backup computer shall take control of all system functions.
    d. A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.
    e. The Primary computer shall provide continual indication that the Backup computer is unavailable until such time that the fault has been purged.

2.8 WEB BROWSER INTERFACE

A. Provide a web browser interface that will be accessible to any computer on the Owner's Intranet with Microsoft Internet Explorer 8.0 or higher. The system shall support a minimum of 5 simultaneous users to access the system. The Web Browser Interface shall include the following features.
   1. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any site in the system from anywhere on the network.
   2. The browser-based interface must share the same graphical displays as the Operator Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall also support commands to change setpoints, enable/disable equipment and start/stop equipment.
   3. Through the browser interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a copy stored in the system database.
   4. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
   5. Through the browser interface, operators must be able to change schedules - change start and stop times, and add new times to a schedule.
   6. Through the browser interface, operators must be able to create and edit card access personnel records, and assign the card to any and all sites for access, in any combination.
   7. Through the browser interface, operators must be able to view reports of access events and access privileges. Reports must be available based on start and end time, door, area, and person. Invalid attempts must be color-coded red in the report.
   8. Through the browser interface, operators must be able to view live and recorded video from any digital video recorder on the network. The interface must offer an easy method of selecting the camera to view, and for recorded video, must offer selections for start and stop time when searching video clips.
   9. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.
   10. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.
   11. The system shall be expandable to up to 25 concurrent browser-based users per server.

2.9 UTILITY METERING

A. General Requirements:
   1. The following meters shall be included in this system:

a. Electric Meter (Quantity one (1) per building).
b. Gas Meter (Quantity one (1) per building).
c. Water Meter (Quantity one (1) per building).

2. Provide all hardware, software, installation labor and information required to all contractors involved in the project to affect the installation of an Automated Controller Polling system as specified herein. The system shall be capable of providing information to the facility operational staff and others empowered to have and use the information as directed by the administration. The system shall be complete in every respect as specified and shall provide all information required to affect the output of the reports defined in the relevant section of this specification. The supplier shall provide two certifications that the system is tracking with the utility meters. One certification shall be provided as the system is turned over to the owner. The second certification shall be provided after six to eight months of operation. The protocol for the certification process is included in this specification and shall be rigidly adhered to. The system information sensors cross contract section responsibilities, and as such require coordination. The system supplier shall be responsible for coordinating the proper contractors to see that the utility sensors required by their respective sections are provided and work properly. The system supplier is not responsible for the provision or installation of the primary sensing elements of this system. They are the responsibility of the section that provides the utility service to the facility and are specified under the appropriate sections. Further, it is not the responsibility of the system supplier to coordinate with the utility company to see that the sensors are supplied and are provided with the necessary information. That responsibility is also specified in the appropriate sections.

B. System Field Hardware and Installation:

1. Provide and install all hardware required to connect to utility primary meter auxiliary output sensors provided by others to collect information required to generate reports as defined in the report section of this document. The hardware shall collect and store data for retrieval by a central server through the facility intranet and over the Internet. A 10BaseT network tap with a Fixed IP address for the building controller shall be provided by others to provide system connectivity to the Intranet.
2. Contract with the utility companies to install auxiliary pulse contacts on all meters monitored.
3. The building controller shall be connected to an application controller that shall receive pulses proportional to utility use. Provide and install the application controller with necessary input characteristics to be compatible with the primary utility sensing equipment. Connect controller inputs to the meter auxiliary outputs at the point shown on the drawings where the utility meter sensor terminations are shown to be connected.

C. System Polling Server:

1. Provide at the system supplier facility a polling server service that will poll every meter for the consumption of utility commodity every sixty (60) minutes.
2. Data shall be stored in an approved supported SQL database such as Microsoft SQL Server. The server polling process shall be self-healing so as to automatically recover back data in conditions where Internet outages occur for an adjustable period of minimum six (6) hours to a maximum of seven days.
3. The data collection application controllers that interface directly with the meter pulsing head sensors shall be capable of storing data for a minimum period of the previous seven (7) days so as to provide the source for the data recovery outlined above.
4. The system shall incorporate a temperature-sensing device and collect data from the same for outdoor air. This data shall be used to provide for the calculation of degree-day information for use in daily energy analysis formats.

D. User Report Interface:
1. The system shall provide the user with a menu driven interface, which shall contain a menu driven interface for the purpose of report configuration, storage and advanced analysis.

E. The application shall provide the following:
1. Provide a Site Manager interface to browse building sites and the meter sources, grouped by commodity. Information displayed shall provide for the ability to map meter sources back to their related software points at the data input interface for ready field identification and system cross reference.
2. Provide a Rate Manager interface, permitting the user to enter and store a unit cost for each commodity tracked in the system, giving the user the ability to analyze financial impact, as provided for in reports listed in the Energy Reports section of this specification.
3. Provide a Report Manager interface, which provides the user with the ability to select the desired Commodity to be examined and between Daily and Hourly Reports. The report manager interface shall be calendar driven to provide for easy selection of data set date ranges. The report manager interface shall permit the user to dynamically choose any number of building sites to include in a report, as well as save reports that can be easily recalled for the purposes of analysis against events such as billing cycles.
4. Provide a function to allow the user to create and save groups of buildings to allow for ease of use when benchmarking buildings against each other.
5. Daily reports shall contain:
   a. Summary Report page plotting all buildings polled against each other for Consumption, Consumption per square foot, and Load Consumption Ratio.
   b. Summary Data page charting all buildings polled against each other for Consumption, Consumption per square foot, and Load Consumption Ratio.
   c. Building Area page ranking buildings from highest to lowest square footage.

d. Energy Mark page ranking all buildings polled from highest to lowest energy savings potential based upon Energy per square foot, Load Ratio, and Energy used.
e. Weather Data page providing daily weather history including outside air temperature, heating degree days, and cooling degree days.
f. Page for each building polled containing:
1) Total Consumption for period polled.
2) Consumption per square foot of building area for period polled.
3) Daily Consumption Total.
4) Daily Consumption per square foot of building area.
5) Daily Peak Demand and time.
6) Daily Low Demand and time.
7) Night Consumption as total.
8) Night Consumption as a percentage of total consumption.
9) Daily Night Consumption Total.
10) Daily Night Consumption per square foot of building area.
11) Day Consumption as total.
12) Day Consumption as a percentage of total consumption.
13) Daily Day Consumption Total.
14) Daily Day Consumption per square foot of building area.
15) Load Ratio comparing night and day consumption totals.
16) Daily Load Ratio comparing daily night and day consumption.

6. Hourly reports shall contain:
a. Page for each building polled containing:
1) Total Consumption for period polled.
2) Night Consumption as percentage of total consumption.
3) Day Consumption as percentage of total consumption.
4) Load ratio comparing night and day consumption totals.
5) Consumption for each hour of period polled.

2.10 SURGE SUPPRESSION (SP) RECEPTACLE

A. Provide at each DDC panel and operator workstation locations, a surge suppression receptacle with metal oxide varister to dissipate the electrical energy of voltage spikes. 20 ampere, duplex, NEMA 5-20R configuration. Back and side wiring, high impact nylon body.

B. Acceptable Make: Hubbell 5352-S.

2.11 GRAPHICS

A. System Graphic:

1. The equipment drawing will be three-dimensional. The values on the screen shall be reported in real time as well as dynamic to be updated as the value changes.
2. All components of the drawing will show their actual field location and position. Sensors will be in the exact location in reference to piping and air stream. Icons or "library" images imported during the construction of the drawing will be accurate in depiction of the device and any interaction with other components of the drawing, i.e. don't draw piping into the motor of a pump icon.
3. If there are size limitations or clutter from the number of components a link to a sub graphic having the same layout will be used to clarify.

B. Space Graphic:
1. Floor plan drawings will be linked to the supplying air handling unit or in some cases to the exhaust fan. Electronic floor plans to be provided by Architect/Engineer.
2. Floor plans showing areas served by more than one air handling unit will have the areas color-coded by air handling unit. If the air-handling unit serves different floors the color will be consistent for an air-handling unit for all floors.
3. If an area has control other than DDC it will be noted with text and left white in the background.
4. A temperature zone serving more than one space shall have a unique pattern, to distinguish that zone from other temperature zones. The patterns should slight enough as to not obscure the space temperature, room number and borders detail but visible enough to be able to distinguish between different zones. A different "peppering" of symbols (of + ˆ * ≈) or patterns (hex, herringbone, verticals, etc.) will be used to define the zones.
5. Temperature zones dedicated to only one space will not have to be detailed.
6. Remote physical points such as differential monitors and the like shall be shown in their installed location.

C. The second level of graphics shall be all the DDC points to be installed under the contract overlaid on building floor plan and the Air Handling Unit and its associated systems. Electronic floor plans to be provided by Architect/Engineer.

D. Description of Operation:
1. The approved description of operation will appear on a text graphic in 12-point text written in paragraph form.
2. Additional notes may appear on the equipment graphic in an appropriate location.

E. Layout:
1. The subject device of equipment graphic will be centrally located on the drawing.
2. At the top center, the name of the equipment device will be displayed with its room number. Immediately below the PM# will be displayed. On a third line will be the capacity of the device in units common to that device i.e. air handling units in CFM, pumps in GPM.

3. The top right-hand corner will contain links to associated graphics. The Description of Operation, submittal graphic, space graphic and graphic index page will be typical. Other links may be required. All graphic pages will have backward link to return to the main System Graphic.
4. The top left-hand corner will contain global data. Outside Air would be the most common other values may be required when related to the device operation. If the global data functions within the program of this unit, the point referenced in the program will be displayed.
5. The lower left-hand corner will display the operational modes of the device. Occupied, warm up, winterized and economizer would be common. Other modes will be displayed if the unit uses them.
6. In the upper right-hand area, just below the links, the setpoints of the device will be displayed. All setpoints in the various control loops of the device, DA temp, static pressure, MA will be placed in columns as the drawing permits.
7. The date of the last revision of the graphic will be displayed in the lower right corner.

F. Text:
1. Text will contrast with the background for easy reading.
2. The text will be free floating without borders or boxes unless specifically required.

G. The graphics shall include approved schematic of the equipment, sequence of operation and all wiring interface diagrams.

H. The graphic shall include all new and existing systems, equipment and spaces.

PART 3 - EXECUTION

3.1 GENERAL SYSTEM REQUIREMENTS

A. The control of each system shall be guaranteed to perform as described in the Sequence of Operation on the drawings. Equipment, remote switches, in finished rooms shall be flush-mounted, if possible. Interlock supply and return fans, humidifiers with fans, condensers or cooling towers with air conditioning equipment and similar situations demanding coordinated operation.

3.2 SYSTEM COMPONENTS

A. Valves: Union or flanged connected. Locate close to apparatus controlled with pipe reducers and increasers located closest to valve. Locate, arrange, and pipe per installation diagram.

B. Thermostats/Sensors: Room thermostats or sensors shall be mounted symmetrical with adjacent items such as light switches (nominally 44 inch to the center of the device and in accordance with ADA requirements). Verify exact room location to avoid doors, fixed and portable equipment. Install to minimize damage. Do not install adjacent to lighting dimmers or other heat generating equipment.

C. Dampers and Damper Operators: Tag dampers for proper location. Install per manufacturer's printed instruction as to motor size and quantity, linkage arrangement, drive connection point. Adjust to close tightly. Allow for conduit sleeve or blank space for roof fan dampers. Where ducts are insulated, set damper operators at least 2 inch. away from side of duct to allow for insulation.

3.3 SMOKE DAMPERS AND FIRE/FAN SHUT DOWN

A. Provide control for smoke dampers as required. Division 26 "Electric" to provide 120 volt power wiring and associated signal wiring to close all smoke partition smoke dampers associated with a particular air handling unit upon alarm at any duct smoke detector in that particular system. Coordinate the voltage of the EP switch with Division 26 "Electric".

B. Division 26 "Electric" to provide a signal to stop air handling unit fans and close air handling unit smoke dampers upon activation of the fire alarm system. Wiring to be directly to the motor starter.

C. Division 26 "Electric" shall also provide a signal to the DDC control system that the fire alarm system is activated.

3.4 LOW AND HIGH LIMIT SAFETY FUNCTIONS

A. Provide for all supply fan units. Wiring to be directly to the motor starter. High limit controller (firestat) shall be located in the unit discharge, set at 180□F and prevent the fan from operating until reset. High limit shall alarm DDC system. Low limit shall be strung on the discharge face of preheat coils set at 37□F. Low limit shall: prevent fan from operating, fully close the outside air damper, fully close the relief air dampers, open return air damper, and alarm DDC system until reset.

B. Provide for all unit ventilators. All sensors shall be multiple point type that are serpentined across entire airflow. The discharge air temperature sensor shall be programmed to act as high limit controller. High limit shall be set at 180□F for a hot water system and 210□F for a steam system. When high limit is exceeded the BMS system shall alarm and fan shall not operate until reset. The discharge air temperature sensor shall also act as a low limit controller, set at 40□F. The mixed air temperature sensor shall act as another low controller, set at 37□F. When either low limit is tripped the following shall occur:

1. BMS System alarms.

2. Set heating coil to full heat.
3. Close outside air damper.
4. Open return air damper.
5. Fan shall continue to operate. If after 90 seconds the mixed air or discharge air temperature does not increase then fan shall stop operating and a second BMS alarm shall occur.

3.5 SYSTEM TESTING AND COMMISSIONING

A. At the time of installation, systems shall be tested for control device operation prior to the systems acceptance. A report of each systems performance shall be submitted to the Owner's Representative. The report shall include:
   1. Field verification and demonstration checklist of analog input calibration, analog output operation, digital input function, and digital output operation.
   2. Trend log of inputs and output, printed every two (2) hours, for one (1) week.
   3. Refer to "Instructions and Adjustments".

3.6 SYSTEM DESCRIPTION - GENERAL

A. All systems shall maintain the scheduled or otherwise noted minimum outside air ventilation rate during building occupied hours.

B. Provide normally open hot water and normally closed cooling coil valves.

C. Provide normally open return air damper, normally closed relief air and normally closed outside air dampers and operators.

D. Mode of operation (occupied/unoccupied) including building warm-up and pull-down cycles, as well as all system functions shall be programmable and controlled by the BMS system.

E. Shutdown of air handling units and fans due to a fire alarm shall be by the Electrical Contractor. The fire alarm system will send a signal to the BMS system for monitoring purposes only of each air handling unit and exhaust system. The BMS system will provide a staggered restart of the units once the alarm is cleared.

F. All setpoints shall be adjustable.

G. Two (2) outside air temperature sensors are to be provided as general inputs to the BMS system. The pair of readings shall be averaged for use by the system. If an individual reading is found to be out of range by comparison, then the other reading shall be used, and an alarm shall be generated.

H. Where the normal sequence position or status of a device is allowed to be manually over-ridden by the building Owner/operator, the device shall be returned to its normal "system off" position, if the system is shut down by the BMS system or building fire alarm system. This includes overriding manually set and locked setpoints. Upon system restart, the device shall return to its manually over-ridden status. Returning devices to their normal "systems off" position shall be done to reduce the potential of damage to the systems.

3.7 CONTROL SEQUENCE

A. Refer to plans for control diagrams, sequences and points lists.

END OF SECTION 230923

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SECTION 232010 - PIPING SYSTEMS AND ACCESSORIES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 078413 - Penetration Firestop Systems.

1.3 SUBMITTALS

A. Schedule of pipe materials, fittings, and connections.

B. Grooved mechanical connection system:
   1. Grooved piping training report (Refer to Part 3).

C. Pressed mechanical connection system.

D. Welding certification (Refer to Part 3).

PART 2 - PRODUCTS

2.1 GENERAL

A. Pipe and fittings shall be new, marked with manufacturer's name and comply with applicable ASTM and ANSI Standards.

B. All adhesives, sealants, primers and paint used for piping in the interior of the building shall comply with the maximum Volatile Organic Compound (VOC) limits called for in the current version of U.S. Green Building Council LEED Credits EQ 4.1 and EQ 4.2.

2.2 STEEL PIPING AND FITTINGS

A. Pipe: ASTM A53, Schedule 40 weight black or galvanized finish as called for; ends chamfered for welding or roll grooved for grooved mechanical connections.

B. Fittings: Same material and pressure class as adjoining pipe.

1. Welded Fittings: Factory forged, seamless construction, butt weld type, chamfered ends. Where branch connections are two or more sizes smaller than main size, use of "Weldolets", "Thredolets", or "Sockolets" are acceptable. Socket weld type, 2000 psi wp, where required.
2. Threaded Fittings: Cast or malleable iron, black or galvanized, as required; drainage type where called for.
3. Shop Fabricated Connections and Fittings:
    a. Shop Fabricated Branch Connections: Fabricated branch connections constructed in strict conformance to the appropriate ASME B 31 Code of Construction may be acceptable as reviewed by the Engineer. All fabricated connections shall be constructed under controlled shop conditions using automated equipment. Calculations for all fabricated connections demonstrating conformance to ASME code and project design criteria shall be prepared and submitted for acceptance prior to fabrication. Certified welding procedures, shop quality control procedures and certifications of welders and inspectors shall be submitted to the Engineer prior to fabrication.

C. Flanges, Unions and Couplings:
1. Threaded Connections:
    a. Flanges: Cast iron companion type; for sizes 2-1/2 inch. and larger.
    b. Unions: Malleable iron, bronze to iron seat, 300 lb. wwp; for sizes 2 inch. and smaller.
    c. Couplings: Malleable iron, 150 or 300 lb. wwp, based on system pressure. Steel thread protectors are not acceptable as couplings.
2. Welded Connections:
    a. Flanges: Welding neck type.
    b. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents and working temperatures and pressures.
    c. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
3. Grooved Mechanical Connections:
    a. Couplings: Ductile iron, ASTM A536, with painted coating, designed for rolled grooved piping, hot dipped galvanized finish were required.
        1) Grade "EHP" EPDM synthetic rubber, -30°F to 250°F temperature range, suitable for water service.
        2) Gasket lubricant furnished by coupling manufacturer.
    b. Bolts and Nuts: Head treated, hex head carbon steel (((ASTM A183)) and A449) cadmium plated or zinc electroplated.

c. Fittings: Elbows, tees, laterals, reducers, adapters as required. Same construction as couplings. The use of mechanical tees is permitted only when a branch size is two or more sizes smaller than the main size. Reducing couplings, strapless mechanical tees and segment-welded elbows are not acceptable.

d. Design Equipment: Victaulic rigid system, Style 107N Quick Vic couplings for 12 inch. and smaller.

e. Victaulic AGS Piping System 14 inch. through 24 inch.: Rigid Style W07 with Grade "E" FlushSeal gasket.

f. Victaulic AGS Piping System 14 inch. through 24 inch.: Flexible Style W77 with Grade "E" FlushSeal gasket.

g. Make: Victaulic, Anvil, Tyco/Grinnell, Shurjoint.

D. Gauge and Instrument Connections: Nipples and plugs for adapting gauges and instruments to piping system shall be IPS brass.

E. Base Elbows:

1. Cast iron or steel type, flange connections; Crane 500 or equivalent. Made from welding elbows, with welded pipe support and steel base. Reducing elbows where necessary.

ELBOW SIZE	SUPPORT SIZE	BASE PLATE
2 inch. to 3 inch.	1-1/4 inch.	6 inch. x 6 in. x 1/4 inch.
4 inch. to 6 in.	2-1/2 inch.	8 inch. x 8 in. x 1/4 in.
8 in. and larger	6 in.	14 in. x 14 in. x 5/16 in.

2. Anchor bolt holes in each corner of base for securely bolting to floor or concrete base; minimum 3/4 inch. bolts.

2.3 COPPER TUBE AND FITTINGS - SOLDER JOINT

A. Pipe: ASTM B88; Type K, L or M, hard temper. Soft temper only where specified. Plans show copper tube sizes.

B. Tees, Elbows, Reducers: Wrought copper, ASME B16.22 or cast bronze; ASME B16.18 solder end connections.

C. Unions and Flanges: 2 inch. and smaller use unions, solder type, cast bronze, ground joint, 150 lb. swp: 2-1/2 inch. and over use flanges, cast bronze, companion type, ASME drilled, solder connection, 150 lb. swp.

D. Solder Materials: No-lead solder, using alloys made from tin, copper, silver and nickel.

E. Make: Harris "Stay-Safe 50" and "Bright", Engelhard "Silverbright 100", Willard Industries "Solder Safe (silver bearing), Canfield "Watersafe" or approved equal.

2.4 COPPER TUBE AND FITTINGS - PRESS FITTINGS

A. Tubing Standard: Copper tubing shall conform to ASTM B75 or ASTM B88.

B. Fitting Standard: Copper fittings shall conform to ASME B16.18, ASME B16.22, or ASME B16.26.

C. Press Fitting: Copper press fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. O-rings for copper press fittings shall be EPDM.

D. Make: Viega Pro-Press, Nibco, Tyco Grinnell, Elkhart Apolloxpress, Mueller.

2.5 COPPER DRAINAGE TUBE AND FITTINGS - SOLDER JOINT

A. Pipe: ASTM B306, Type DWV, hard temper.

B. Fittings: Wrought copper, ANSI B16.29 or cast bronze, ANSI B16.23; solder end connections.

C. Solder Materials: No lead solder, using alloys made from tin, copper, silver and nickel.

D. Make: Harris "Stay-Safe 50" and "Bright", Engelhard "Silverbright 100", Canfield "Watersafe" or approved equal.

2.6 COPPER TUBE AND FITTINGS - GROOVED MECHANICAL CONNECTIONS

A. Pipe: ASTM B88, Type K or L, hard temper.

B. Fittings: Wrought copper, roll grooved mechanical connections, ASTM B-75, ANSI B16.22 for sizes 2 inch. - 4 inch. Cast bronze, rolled grooved mechanical connections, ASTM B584, ANSI B16.18 for sizes 5 inch. - 8 inch., with copper tube dimensioned grooved ends designed to accept rolled grooved couplings (flaring of tube and fitting ends to IPS dimensions is not permitted).

C. Couplings: Ductile iron, ASTM A536, with copper colored alkyd enamel finish, designed for rolled grooved piping. Housings cast with offsetting, angle pattern, bolt pads to provide rigidity.

D. Gaskets: Grade "EHP" EPDM synthetic rubber, color-coded, -30°F to 250°F temperature range, suitable for water service.

E. Bolts and Nuts: Heat treated, hex head carbon steel, ASTM A183 and A449, cadmium plated or zinc electroplated finish.

F. Design Equipment: Victaulic Style 607 couplings.

G. Make: Victaulic, Anvil, Tyco/Grinnell, Shurjoint.

2.7 DIELECTRIC PROTECTION

A. Description: Assembly or fitting having insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion.

B. Dielectric unions shall not be used due to their tendency to leak. Provide a dielectric waterway fitting or a brass nipple for dielectric protection. A brass valve is also an acceptable method of dielectric protection.

C. Flanges: Factory-fabricated, companion-flange assembly, for 150 or 300 psig minimum pressure to suit system fluid pressures and temperatures with flange insulation kits and bolt sleeves.

D. Waterway Fittings: 300 psi maximum working pressure at 230°F, male threaded or grooved ends, electroplated ductile iron or steel body with LTHS high temperature polyolefin polymer liner.

E. Make: EPCO, Capitol Manufacturing, Watts, Surejoint, Victaulic, or approved equal.

F. The use of brass valves, brass nipples 3 inch. and larger) and Shurjoint epoxy coated transition coupling IPS-CTS may be used for dielectric isolation. Dielectric transition fittings shall be Shurjoint Model DE30-GG for sizes 2 inch. through 8 inch., which shall provide effective insulation between the steel and copper systems to avoid galvanic local cell and stray current problems. The dielectric transition fitting shall be made of ductile iron per ASTM A536 Gr. 65-45-12, electric deposition coated, with a virgin PP (propylene) lining.

2.8 HANGERS, INSERTS, AND SUPPORTS

A. Hangers, Inserts, Clamps: B-Line, Grinnell, Michigan Hanger, PHD Manufacturing, Anvil, Hilti.

B. Hangers:
1. Adjustable, wrought malleable iron or steel with electroplated zinc or cadmium finish. Copper plated or PVC coated where in contact with copper piping. Hot-dipped galvanized finish for exterior locations.
2. Adjustable ring type where piping is installed directly on hanger for piping 3 inch. and smaller.
3. Adjustable steel clevis type for 4 inch, and larger, and where insulation passes through hanger.
4. Hangers sized to permit passage of insulation through the hanger for all piping.
5. Nuts, washers and rods with electroplated zinc or cadmium finish. Hot-dipped galvanized finish for exterior locations.

C. Hanger Shields:
1. Pre-Insulated Type:

a. Insulated pipes shall be protected at point of support by a 360° insert of high density, 100 psi waterproof calcium silicate, encased in a 180° sheet metal shield. Insulation insert to be same thickness as adjoining pipe insulation and extend 1 inch. beyond sheet metal shield. Insulation shall be provided with a factory installed ASJ.

2. Field-Insulated Type:
   a. #18 USSG, galvanized steel shields, minimum 120° arc. Provide ICA-HAMFAB-BLOCK, 18# density molded fiberglass inserts, between pipe and hanger shield to maintain proper spacing for insulation. Insulation inserts shall extend 1 inch. beyond the sheet metal shields. Material shall comply with ASTM E84 25/50, have a thermal conductivity of K=.30 (stable) and have a service temperature of -120°F to +650°F. Install in accordance with manufacturer's printed instructions.
3. Shield Sizing:

PIPE SIZE	SHIELD LENGTH	MINIMUM GAUGE
1/2 inch. to 3-1/2 inch.	9 inch.	20
4 inch.	9 in.	20
5 inch. and 6 inch.	9 in.	20
8 inch. to 12 inch.	12 in.	18
14 in. to 24 in.	18 in.	16

4. Hanger shield gauges listed are for use with band type hangers only. For point loading (roller support), increase shield thickness by one gauge, and length by 50%.

D. Hanger Spacing Schedules: (Based upon most stringent requirement of MCNYS and ((ASME B31.9)))

COPPER OR PLASTIC PIPE SIZE	COPPER PIPE HANGER SPACING	PLASTIC PIPE HANGER SPACING	HANGER ROD SIZE
3/4 to 1 inch.	6 feet	3 feet	3/8 inch.
1-1/4 inch.	6 ft.	4 feet	3/8 in.
1-1/2 to 2 inch.	8 feet	4 ft.	3/8 in.
2-1/2 to 4 inch.	10 feet	4 ft.	1/2 in.
5 inch. and larger	10 ft.	4 ft.	3/4 in.

STEEL PIPE SIZE	STEEL PIPE HANGER SPACING	HANGER ROD SIZE
3/4 to 1 inch.	8 feet	3/8 inch.
1-1/4 inch.	10 feet	3/8 in.
1-1/2 to 2-1/2 inch.	12 feet	3/8 in.

3 to 4 inch.	12 ft.	1/2 inch.
5 inch. and larger	12 ft.	3/4 in.

E. Inserts: Carbon steel body and square insert nut, galvanized finish, maximum loading 1,300 lbs., for 3/8 inch. to 3/4 inch. rod sizes. Drill through decking for hanger rods and secure devices with integral support plate strap with sheet metal screws. Devices shall have a safety factor of four.

F. Beam Attachments:
1. C-Clamp, locknut, electroplated finish, UL listed, FM approved, for pipe sizes 2 inch. and smaller.
2. Center load style with clamp attachments that engage both edges of beam, electroplated finish, UL listed, FM approved, for pipe sizes larger than 2 inch., refer to "Supports" for additional requirements.
3. Welded beam attachments may be considered only upon the review and acceptance of the structural engineer of record with written confirmation of weld meet configuration, location and service/pipe size submitted to the Mechanical Engineer for review.

G. Supports:
1. Provide intermediate structural steel members where required for hanger attachment. Secure member to structure. Select size of members based on a minimum factor of safety of four.
2. For Weights Under 1000 lbs.: Insert, "U" shaped channel, beam clamps or other structurally reviewed support. The factor of safety shall be at least four. Follow manufacturer's recommendations.
3. For Weights Above 1000 lbs.: Drill through floor slabs and provide flush plate welded to top of rod or provide additional inserts and hangers to reduce load per hanger below 1000 lbs.
4. Make: Hilti, ITW Ramset, Phillips "Red Head", or approved equal.

H. Trapeze Hangers:
1. For use on 1-1/2 inch. and smaller piping only.
2. Hangers shall be supported with rod sized with a safety factor of four.
3. May be manufactured type "U" shaped channel, or suitable angle iron or channel. Round off all sharp edges.
4. Securely fasten piping to trapeze with "U" bolt or straps, dissimilar metals shall not touch, use isolation gaskets.
5. Make: B-Line, Kindorf, Unistrut, or approved equal.

2.9 PIPING ACCESSORIES

A. Escutcheon Plates: Provide escutcheon plates on uninsulated piping in exposed and finished areas. Steel or cast brass polished chrome, split hinge type with setscrew, high plates where required for extended sleeves.

B. Pipe Guides: Cylindrical steel guide sleeve, proper length for travel, integral bottom base anchor, top half removable. Split steel spider to bolt to pipe, copper plated spider for copper pipe. Insulated style where pipe is required to be insulated. Make: Tri-State Industries, or equal.

C. Anchors:
   1. Pipe support; same material as pipe; as manufactured by Pipe Shields Model C1000 or C2000, Keflex, Metraflex, Flexonics or Advanced Thermal Systems.
   2. Pipe Anchors:
      a. Anchors shall be designed and located as to prevent stress to piping or building structural components from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stressing to connected equipment.

D. Pipe Roll Stand: Cast iron roll stand. Make: Advanced Thermal Systems, Carpenter and Patterson, ITT Grinnell, Pipe Shields.

2.10 SLEEVES

A. Standard Type:
   1. Schedule 40 black steel pipe sleeves shall be used for sleeves in horizontal and vertical applications through structural surfaces. Sleeves shall extend a minimum of 1 inch. beyond both sides of the structure surface being penetrated. The sleeve shall be sized to account for the total diameter of the service, inclusive of insulation and the appropriate annular space for firestopping installation or requirements of the sealing element manufacturer.
   2. Full circle water stop collar for sleeves located in below grade walls, wet wells and waterproofed surfaces. The collar shall be fabricated from steel plate and welded to the sleeve around its entire circumference.
   3. Schedule 40, PVC sleeves or sheet metal sleeves for nonstructural surfaces and existing construction. Sheet metal sleeves shall be 18 gauge minimum and braced to prevent collapsing. Sleeves shall extend a minimum of 1/2 inch. beyond both sides of the non-structural vertical surface being penetrated. The sleeve shall be sized to account for the total diameter of the service, inclusive of insulation and the appropriate annular space for firestopping.

B. Pre-Insulated Type:
   1. Adjustable or fixed length metal cans, 24 gauge minimum sized for 1 inch. spacing between insulation and can. Insulation shall consist of a 360° waterproofed calcium silicate insert sized to extend 1 in. beyond wall or floor penetration. Calcium silicate insert shall be the same thickness as adjoining pipe insulation. Spacing between shield and can packed at each end with double neoprene rope positively fastened.

2.11 SEALING ELEMENTS

A. Expanding neoprene link type, watertight seal consisting of interlocking links with zinc plated bolts.
   1. Make: Thunderline "Link-Seal" Series 200, 300 or 400, Pyropac, Calipco.

B. Waterproof Type:
   1. Exterior Walls, Below Grade, Above Floor: Synthetic rubber material with zinc plated bolts. Make: "Link-Seal" Series 200, 300 or 400, Pyropac, Calipco.

2.12 FIRESTOP SYSTEM FOR OPENINGS THROUGH FIRE RATED WALL FLOOR ASSEMBLIES

A. Materials for firestopping seals shall be listed by an approved independent testing laboratory for "Penetration Firestop Systems". The system shall meet the standard fire test for Penetration Firestop Systems designated ASTM E814. Firestop system shall be provided at locations where piping passes through fire rated wall, floor/ceiling, or ceiling/roof assembly. Minimum required fire resistant ratings of the assembly shall be maintained by the Firestop System. Installation shall conform with the manufacturer's recommendations and other requirements necessary to meet the testing laboratory's listing for the specific installation.

2.13 PIPING MATERIALS AND SCHEDULE

A. See Exhibit "A", "Schedule of Piping Materials" at end of this Section for (HVAC) piping.

PART 3 - EXECUTION

3.1 EQUIPMENT AND SYSTEMS

A. Provide equipment and systems in accordance with laws, codes, and provisions of each applicable section of these specifications. Accurately establish grade and elevation of piping before setting sleeves. Install piping without springing or forcing (except where specifically called for), making proper allowance for expansion and anchoring. Arrange piping at equipment with necessary offsets, union, flanges, and valves, to allow for easy part removal and maintenance. Offset piping and change elevation as required to coordinate with other work. Avoid contact with other mechanical or electrical systems. Provide adequate means of draining and venting units, risers, circuits and systems. Install drains consisting of a tee fitting with a 3/4 inch. ball valve with hose end cap and chain, at low points in hydronic piping system mains, and elsewhere as required for system drainage.

B. Conceal piping unless otherwise called for. Copper tubing shall be cut with a wheeled tubing cutter or other approved copper tubing cutter tool. The tubing must be cut square to permit proper joining with the fittings. Ream pipes after cutting and clean before installing. Cap or plug equipment and pipe openings during construction. Install piping parallel with lines of building, properly spaced to provide clearance for insulation. Make changes in direction and branch connections with fittings unless submitted and accepted per Part 2. Do not install valves, union and flanges in inaccessible locations. Provide trap seal of adequate depth on drain pans.

C. Provide reducers at all control valves, where control valve is smaller than pipeline size. Reducers for steam control valves shall be eccentric type. Provide unions at each side of every control valve and reducers directly adjacent to the unions.

D. Provide reducers at all balance valves, where balance valve is smaller than pipeline size.

3.2 PIPING OVER ELECTRICAL EQUIPMENT

A. Contractor shall route piping to avoid installation directly over electric equipment, including, but not limited to panels, transformers, disconnects, starters, motor control center, adjustable speed drives and fused switches.

B. Piping shall not be installed in the dedicated electric and working space as defined by NEC 110. Dedicated electrical space is generally equal to the depth and width of electrical equipment, and extends 6 feet above the electrical equipment, or to a structural ceiling. Dedicated working space is a minimum of 30 inch. wide or the width of equipment (whichever is larger) a minimum of 6 ft.-6 inch. tall, with a depth of 3 feet to 9 feet depending on the voltage.

3.3 WATER SYSTEMS

A. Top connection for upfeed, bottom or side connection for downfeed. Grade off level; up in direction of flow and down toward drain.

3.4 HANGERS, INSERTS AND SUPPORTS

A. Piping shall not be supported by wires, band iron, chains, or from other piping. Support each pipe with individual hangers from concrete inserts, welded supports, or beam clamps of proper configuration and point loading design requirements for each location including the designated safety factor. Trapeze hangers are acceptable for racking of multiple pipes of 1-1/2 inch. or less in size. Follow manufacturer's safe loading recommendations. Suspend with rods of sufficient length for swing and of size as called for, using four nuts per rod. Provide additional rustproofed structural steel members, where required for proper support. Provide oversized hangers where insulation/supports must pass between pipe and hanger. Only concentric type hangers are permissible on piping larger than 2-1/2 inch., "C" types are permitted for piping 2-1/2 inch. and smaller. Provide riser clamps for each riser at each floor.

B. Provide a pipe hanger within 12 inch. of pipe unions and piping connections to equipment, in order to facilitate disconnections of piping without pipe sagging.

3.5 HANGERS ATTACHED TO JOISTS

A. Individual hangers may be suspended directly from the bottom chord panel point provided that the sum of the concentrated loads within the chord panel does not exceed 100 pounds and the attachments are concentric to the chord. (Eccentrically loaded joists using beam clamps or other attachment methods are not acceptable.)

B. For nominal concentrated loads between panel chords, which have been accounted for in the specified uniform design load for the joists, this Contractor is to provide struts to transfer the load to a panel point on the opposite chord as reviewed and acceptable by the Structural Engineer of Record.

3.6 PIPE CONNECTIONS

A. Solder Connections: Nonacid flux and clean off excess flux and solder.

B. Press Connections: Copper press fittings shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.

C. Brazed Connections: Make joints with silver brazing alloy in accordance with manufacturer's instructions. Remove working parts of valves before applying heat.

D. Threaded Connections: Clean out tapering threads, made up with pipe dope; screwed until tight connection. Pipe dope must be specific for each application.

E. Flanged Joints: Select appropriate gasket material, size, type and thickness for service applications. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

F. Dielectric Protection: Provide dielectric protection devices at ALL piping connections and ALL equipment connections, where dissimilar metals meet. Follow all applicable manufacturer's recommendations at equipment connections. Dielectric protection systems are not required for air or gas systems.

G. Grooved Mechanical Joints: Pipe to be prepared in accordance with the latest Grooving Specification of the manufacturer utilized. Pipe shall be checked to be sure it is free of indentations, projections; weld seams or roll marks on the exterior of the pipe over the entire gasket seating area. Pipe ends are to be square cut. Lubricant shall be applied to gasket and/or pipe ends and housing interiors to eliminate pinching the gasket. All grooved couplings, fittings, and specialties shall be the products of a single manufacturer. A factory-trained field representative of the mechanical joint manufacturer shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Provide a field report verifying that factory trained representative has provided on-site training and that Contractor has coupled recommended installation procedures. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

H. HDPE Pipe Connections: Shall be joined by heat fusion. All procedures shall meet the requirements of Title 49 of the Code of Federal Regulations 192.285 as it applies to heat fusion.

3.7 WELDING

A. Welding shall be performed in compliance with the welding procedure specifications prepared by the National Certified Pipe Welding Bureau. Welded pipe fabricated by certified welder. Contractor shall submit proof of current certification of each welder . Use full-length pipe where possible; minimum distance between welds, 18 inch. on straight runs. Welds must be at least full thickness of pipe inside smooth and remove cutting beads, slag and excess material at joints; chamfer ends. Minimum gap 1/8 inch., maximum 1/4 inch., for butt welds. One internal pass and one external pass minimum required on slip-on flanges. Do not apply heat to rectify distorted pipe due to concentrated welding; replace distorted pipe. When welding galvanized pipe, apply cold galvanizing on joint after welding.

3.8 HANGER SHIELDS

A. Provide at hangers for all piping. Pre-insulated type or field-insulated type at Contractor's option.

3.9 SLEEVES

A. Provide for pipes passing through floors, walls or ceilings.

B. Pre-Insulated Type: Required for piping.

C. Standard Type: Provide for piping, except as called for.

D. Extend 1/8 inch. above finished areas. In above grade mechanical and other areas with floor drains; use steel pipe sleeves 2 inch. above floor. Use pipe sleeves in bearing walls, structural slabs, beams and other structural surfaces, and where called for. Sleeves shall be as small as practical, consistent with insulation, so as to preserve fire rating. Fill abandoned sleeves with concrete. Provide rubber grommet seals for pipes passing through ducts or air chambers or built-up housings.

3.10 ANCHORS

A. Provide piping system anchors where shown on the plans, and as recommended by the expansion joint/loop manufacturer. Where an anchor is shown at a change in piping direction, it shall fully control movement in both directions. In lieu of a single anchor fabricated for two directional control, two (2) individual anchors may be provided. Provide detailed fabrication drawings for all field-fabricated anchors.

B. Design anchors and equipment and piping supports including comprehensive structural engineering analysis by a qualified professional engineer, licensed to practice in the State of New York using the performance and design criteria specific to this project.

3.11 ALIGNMENT GUIDES

A. Provide alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install two (2) or more guide(s) on each side of flexible expansion loop. Install guides nearest to expansion joint not more than four (4) pipe diameters from expansion joint.

C. Attach guides to pipe and secure guides to building structure.

3.12 SLEEVE PACKING

A. Seal void space at sleeves as follows:
   1. Interior Locations: Firmly pack with fiberglass and caulk.
   2. Exterior Walls and Below Grade Cored Holes: Use sealing element.
   3. Fire Rated, Partitions and Floor Slabs: Use fire rated sealing elements, materials and methods. Provide per manufacturer's instructions to maintain firestop.
   4. Waterproofed Walls and Floors: Use waterproof sealing element, device, or compound.

3.13 ESCUTCHEON PLATES

A. Provide polished chrome escutcheon plates for uninsulated exposed piping passing through floors, walls or ceilings in finished areas.

3.14 TESTS

A. Test piping and accessories before insulation, connection to existing piping or concealment. Repeat as many times as necessary to prove tight system. Notify Owner's Representative at least seven days in advance of each test. Isolate valves and equipment not capable of withstanding test pressures. Make leaks tight; no caulking permitted. Remove and replace defective fittings, pipe or connections. Furnish necessary pumps, gauges, equipment, piping, valving, power and labor for testing. Certify that tests have been successfully completed.

B. Test: No change in pressure under stable temperature conditions.

C. Schedule of Test Requirements:
   1. Dual Temperature Water: Hydrostatic, 100 psig at high point of system; two (2) hours duration.
      a. If utilizing a pressed mechanical connection system, test at 15 to 85 psig prior to testing at a higher pressure.
   2. Equipment: Test at working pressures.

3.15 PROTECTION AGAINST PHYSICAL DAMAGE

A. In concealed locations where piping, other than cast-iron or steel, is installed through holes or notches in studs, joists, rafters or similar members less than 1-1/2 inch. from the nearest edge of the member, the pipe shall be protected by shield plates. Protective steel shield plates having a minimum thickness of 0.0575 inch. (No. 16 gage) shall cover the area of the pipe where the member is notched or bored, and shall extend no less than 2 inch. above sole plates and below top plates.

3.16 PIPE LINE SIZING

A. Pipe sizes called for are to be maintained. Pipe sizing changes made only as reviewed by Owner's Representative. Where discrepancy in size occurs, the larger size shall be provided.

EXHIBIT "A" - PIPING MATERIALS (HVAC)

(NOTES ARE AT END OF EXHIBIT "A")

SERVICE	PIPE MATERIALS	FITTINGS	CONNECTIONS
Dual Temperature water heating	Schedule 40, black steel	Malleable iron and butt weld	Screwed 2 inch. and smaller; Welded 2-1/2 inch. and larger; (SEE NOTE 1)
Dual Temperature water heating (optional)	Schedule 40, black steel	Grooved, rigid couplings	Mechanical with gasket, 1-1/2 inch. and larger (SEE NOTE 2)
Dual Temperature water heating (optional)	Type L copper	Wrought copper or cast bronze, solder end	No-lead solder for 2 in. and smaller; 95/5 for 2-1/2 inch. and larger
Dual Temperature water heating (optional)	Type L copper	Wrought copper or cast bronze	Viega Pro-Press, Nibco Press, Elkhart Apolloxpress
Dual Temperature water heating (optional)	Type L copper	Wrought copper or cast bronze	Mechanical with gasket, 1-1/2 inch. and larger (SEE NOTE 2)

NOTES FOR EXHIBIT "A":

NOTE 1: Screwed piping permitted in Crawl Spaces, Mechanical Rooms and Boiler Rooms.

NOTE 2: Grooved piping shall not be installed in shafts.

END OF SECTION 232010

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SECTION 232110 - WATER SYSTEMS SPECIALTIES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 SUBMITTALS

A. Submit product data on water system specialties.

1.3 GENERAL REQUIREMENTS

A. Equipment and accessories shall be rated for a minimum of 125 psi wwp, and 250□F temperatures, unless otherwise stated.

B. All equipment shall be installed in accordance with manufacturer's written installation instructions and schematics.

PART 2 - PRODUCTS

2.1 AIR ELIMINATING SUPPLY FITTING

A. Designed to eliminate air from supply water; located in supply header from heat generating devices; flanged or screwed.

B. Design Equipment: Bell & Gossett "Airtrol".

C. Manufacturers: Armstrong, Bell & Gossett, Patterson, Taco, Spirotherm.

2.2 RELIEF VALVES

A. To relieve the full heating capacity.

B. Provide an ASME labeled safety relief valve as called for on the plans/details.

C. Manufacturer: ITT, Bell & Gossett, Watts, Kunkle, Spence, Keckley.

2.3 FLOW BALANCERS

A. Balancing and flow meter stations suitable for use on heating and cooling systems. Constructed for 125 psi and 250□F.

B. 6 inch. and Smaller: Calibrated balance valve with provisions for connecting a portable differential pressure meter. Flow balancer is to be suitable as a service valve. Meter connections to have built-in check valves. An integral pointer shall register degree of valve openings. Valve shall have internal seals.

1. Balance valve sizes shall be based upon gpm range rather than pipe size.

Balance Valve Size	GPM Range
1/2 inch.	Up to 2.5
3/4 inch.	2.5 - 4.5
1 inch.	4.5 - 10
1-1/4 inch.	10 - 15
1-1/2 inch.	15 - 30
2 inch.	30 - 60
2-1/2 inch.	60 - 100
3 inch.	100 - 180
4 inch.	180 - 300
5 inch.	300 - 450
6 inch.	450 - 600

2. Design Equipment: Bell & Gossett "Circuit Setter"
3. Manufacturers: Bell & Gossett, Armstrong, Patterson, Taco, Tour & Anderson, Oventrop Hydrocontrol, Watts.

2.4 STRAINERS

A. Cast semi-steel body or cast iron construction for steel piping and bronze body construction for copper piping; equipped with removable, monel or stainless steel water screen; maximum pressure drop 2 psi with free area at least four times area of pipe. Provided with blow-off outlet.

B. Sizes 5 inch. and Smaller, Y-Pattern Strainer: 125 psig working pressure; flanged ends for NPS 2-1/2 inch. and larger, threaded connections for NPS 2 inch. and smaller, bolted cover, perforated stainless steel basket and bottom drain connection.

C. Sizes 6 inch. and Larger, Basket Strainer: 125 psig working pressure; flanged end connections, bolted cover, perforated stainless steel basket and bottom drain connection.

D. Design Equipment: Mueller.

E. Manufacturers: Elliott, Keckley, Mueller, Webster, Watts, Spirax-Sarco.

2.5 AIR VENTS

A. Manual air vents shall be a 3/4 inch. ball valve with bronze body, nickel plated bronze ball, hose end, cap and chain, Watts B6000CC.

B. Automatic air vents shall be float type, 35 psig rated, Armstrong No. 502CV OR float type, 150 psig rated, Armstrong No. 75 or Spirotop. Provide unit with an appropriate rating, as necessary for location.

C. High Capacity Automatic Air Vent:
   1. Cast iron body. 150 psig rated. Stainless steel float.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Obtain detailed instructions from each manufacturer for proper method of installation.

3.2 SYSTEM FILLING

A. After cleaning, fill each system from low point.

B. With pumps off, vent mains, risers, run-outs, and units, working consecutively from low to high point of building. Obtain approximately 2 psi at highest point. Obtain proper air cushion in compression/expansion tanks.

3.3 AIR VENTING

A. Provide where specifically called for in piping details and at all points in piping systems where air may collect due to changes in piping elevation.
   1. Manual air vent assembly consisting of 1-1/4 inch. x 4 inch. air collection chamber with 3/4 in. hose end ball valve with cap and chain.
   2. Automatic air vent with a ball valve for the purpose of isolation and service or replacement.
   3. Unless otherwise indicated, automatic air vents shall only be installed in Mechanical Rooms. Pipe high capacity air vent discharge down to floor.

B. Equipment Vents:
   1. When equipment is above mains: Connect run-outs or risers to upper quadrant or top of mains. Install vent assembly concealed within enclosure, consisting of 1 inch. diameter by 4 inch. to 6 inch. long air collection chamber with 1/4 in. soft copper tube to manual valve. Mount securely near bottom of enclosure, but not fastened to enclosure. For individual units, radiators, fan convectors and units with return grilled: Provide screwdriver operated manual valve, operated from discharge grille or access door. Drill enclosure and position valve for operating without removing enclosure.

2. When equipment is below mains: Connect piping run-outs or risers to bottom or lower quadrant of mains. Vent assembly not required in unit. Provide means of purging and draining each unit if required. Use tees instead of ells at low point of run-outs.

3.4 RELIEF VALVES

A. Hot Water System: Pipe discharge to floor drain and place hanger at elbow. Install piping so as not to introduce stress of PRV body.

3.5 STRAINERS

A. Install strainers on supply side of each control valve (as called for in the applicable detail), pressure reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 inch. nipple and ball valve in blowdown connection of strainers NPS 2 inch. and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2 in.

3.6 FLOW BALANCERS

A. Where flow balancers are smaller than pipe line size, provide reducers directly adjacent to flow balancers.

B. Provide on zone or riser returns, on each hydronic unit and where called for. Meter connection points shall not point downward.

C. On terminal heating and cooling unit details where a shut-off valve is shown in conjunction with the flow balancer 3 inch. and smaller), if the Armstrong "CBV" or Tour & Anderson "ST" is used, the shut-off valve may be deleted.

END OF SECTION 232110

SECTION 233100 - SHEET METAL AND DUCTWORK ACCESSORIES CONSTRUCTION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services required for the complete installation designed in Contract Documents.

1.2 QUALITY ASSURANCE

A. Ductwork shall be fabricated and installed in compliance with latest edition of the following standards and with the edition of the Codes in effect at the time the building permit is obtained.
   1. SMACNA Duct Construction Standards - Metal and Flexible Ductwork.
   2. SMACNA Duct Liner Application Standard.
   3. SMACNA HVAC Air Duct Leakage Test Manual.
   4. Mechanical Code of New York State.
   5. Energy Conservation Construction Code of New York State.
   6. SMACNA Kitchen Ventilation and Food Service Equipment Fabrication and Installation Guidelines.
   7. NFPA Standard 96.
   8. Plans and Specifications which exceed the requirements in any of the referenced standards.

B. All sheet metal shall be fabricated and installed by an experienced Contractor specializing in this type of work.

C. All ductwork and fittings shall have a computer-generated label affixed to the exterior surface of each section, detailing all applicable information including the duct dimensions, gauge, reinforcement type/class and connection type by systems manufacturer. Galvanizing thickness shall be clearly stenciled on each duct section.

D. All ductwork on the project shall meet the SMACNA Duct Cleanliness for New Construction Guidelines, "Advanced Level" of duct cleanliness for production, delivery, storage and installation of ductwork.

1.3 SUBMITTALS

A. Submit a complete shop standard manual including miscellaneous materials, and construction details for all shop fabricated materials, including, but not limited to, volume dampers, turning vanes, duct sealant, equipment flexible connections, access doors, flexible duct, acoustical duct lining, etc.

B. Ductwork Shop Drawings:
   1. Prepare minimum 1/4 inch. scale drawings:
      a. Detailed ductwork shop drawings shall include size, layouts and pressure classifications. Any ductwork installed without benefit of review by the Engineer of Record may be subject to replacement at the expense of the Contractor.
      b. Constructed from actual field inspections and measurements so as to assure a complete job.
      c. Incorporate dimensions of actual equipment proposed for use on the project.
      d. Showing adequate sections, elevations, and plan views and indicating the bottom of ductwork elevations from the finished floor.
      e. Indicating all volume dampers, fire dampers, smoke dampers, damper access doors and other accessories required for a completed project.
      f. Indicate roof, wall and floor opening dimensions and locations shown on shop drawings.
      g. Indicate the location of the duct smoke detectors, increase duct size, ensure the minimum straight ductwork upstream or/and downstream at smoke detectors, where required for proper installation, per smoke detector manufacturer's recommendations. Coordinate minimum duct size required with Division 26 "Electrical".
   2. Call to the attention of the Engineer immediately, any major deviations from the Contract Drawings, which must be made. All deviations shall be documented in writing. Resubmit with corrections for final Engineer review.

1.4 GENERAL

A. All adhesives, sealants, primers and paint used for ductwork in the interior of the building shall comply with the maximum Volatile Organic Compound (VOC) limits called for in the current version of U.S. Green Building Council LEED Credits EQ 4.1 and EQ 4.2.

1.5 DUCTWORK CLASSIFICATION

A. Duct systems are to be classified and constructed per the SMACNA Velocity-Pressure classification system as follows:
   1. All ductwork shall be constructed for a minimum pressure class of 2 inch. w.g., unless stated otherwise, for the following systems, as applicable:
      a. Supply duct downstream of terminal units.
      b. Typical low pressure supply ductwork.
      c. Typical return ductwork.
      d. Typical low pressure exhaust ductwork.

2. Supply duct upstream of terminal units shall be constructed for a minimum pressure class of 3 inch. w.g., unless otherwise stated, or required as per below.
3. Pressure classes above 3 inch. w.g. shall be provided as follows, based upon the external static pressure as scheduled for each specific fan.

Scheduled External Static Pressure	Pressure Class
Over 3 inch. up to 4 inch. w.g.	4 in. w.g.
Over 4 in. up to 6 inch. w.g.	6 in. w.g.
Over 6 in. up to 10 inch. w.g.	10 in. w.g.

B. Any new ductwork connected to existing systems must adhere to the requirements outlined above. Contractors are responsible for verifying the maximum static pressure of the existing systems to determine the appropriate pressure class for the new ductwork. Inform Owner's Representative and Engineer of any unknown conditions or discrepancies.

PART 2 - PRODUCTS

2.1 DUCTWORK MATERIALS

A. See Exhibit at the end of this section for where sheetmetal materials shall be applied, and remarks.
1. Galvanized Sheet Steel: Comply with ASTM A653 and A924, with G90/Z275 coating.
2. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in Exhibit "I"; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D or No. 3 as indicated in Exhibit "I".
3. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
4. Gauges per SMACNA HVAC Duct Construction Standards, Metal and Flexible.

B. Make: Semco, United Sheet Metal, unless noted otherwise, or approved equal.

2.2 SQUARE AND RECTANGULAR DUCTWORK

A. Transverse and longitudinal duct seams reinforcement shall conform to appropriate tables and figures per SMACNA Velocity-Pressure Classification for duct construction.
1. Transverse joints shall be sealed with duct joint sealant. "Ductmate" or "Nexus" 4-bolt connection systems may be used in lieu of standard construction.
2. Field assembled longitudinal seams shall be sealed with duct sealant. Factory or shop fabricated rolled or machine pressed longitudinal seams does not require sealant.

B. Corner closures shall be required as described and illustrated by SMACNA Duct Construction Standards.

C. Throat radius on all elbows shall not be less than the dimension of the duct plane of radius. Where this cannot be maintained, use shorter radius with internal guide vanes, or square elbow with turning vanes.

D. Bracing and hanging of ductwork shall be per SMACNA Standards for size and system class of ductwork being used.

E. Any transformations shall not reduce the ductwork cross-sectional area. Maximum angle in straight duct, 20□ for diverging flow and 30□ for contraction flow. Transformation from square to round or flat to oval seams welded or brazed.

2.3 ROUND DUCTWORK

A. Standard Round Ductwork:
   1. All spiral ducts shall have locked seams so made as to eliminate leakage under pressure for which this system has been designed. Longitudinal seams duct shall have fusion-welded butt seams.
   2. Longitudinal seam duct with snap lock longitudinal sealed seams may be used on ductwork where pressure class is 2 inch. w.g. or less. Round, low velocity ductwork shall be self-locking, pre-sealed snap lock duct, which incorporates a factory applied gasket in the longitudinal seam and on the female end of the transverse joint. Snap lock pipe shall be "Greenseam +" as manufactured by Ductmate Industries, or equal. Provide Flexmaster STO side takeoff fittings or Ductmate HETO take off fittings at duct mains for round duct takeoffs.
   3. Round Ductwork Fittings:
      a. All fittings fabricated per SMACNA Standards, material to match straight pieces of ductwork.
      b. Fittings shall have continuous, welded seams.
      c. 90□ tees shall be conical type. 90□ tees and 45□ laterals up to and including 12 inch. diameter tap size shall have a radiused entrance into the tap, produced by machine or press forming. The entrance shall be free of any restrictions.
      d. Round taps off the bottom of rectangular ducts down to diffusers shall be made with a 45□ square to round shoe-tap.
   4. Elbows:
      a. Diameters 3 inch. through 8 inch.: Two-section stamped and continuously welded elbows, material to match straight pieces of ductwork.
      b. Over 8 inch.: Gored construction with standing seam construction and internally sealed or continuously welded. Less than 35□ - two gores, 36□ to 70□ - three gores, over 71□ - five gores.
      c. Fabricated to a centerline radius of 1.5 times the cross-section diameter.

d. Adjustable elbows maybe used for round up to 12 inch. diameter in Velocity-Pressure Classes 2 inch. w.g. and below. Seal adjustable joints airtight after installation.

5. Joints:
   a. For duct construction pressure 3 inch. w.g. or greater:
      1) Round Joints:
         a) Unexposed Duct 3 inch. - 30 inch. Diameter: Connect round duct with a one piece interior slip coupling, at least two gauges heavier than duct wall, beaded at center and fastener to duct with screws. Seal joint with an approved sealant applied continuously around both end of coupler prior to assembling and after fastening.
         b) All Exposed Duct and Unexposed Duct 30 inch. - 72 inch. Diameter: Install using a three piece, gasket flanged-joint consisting of two internal flanges, with integral mastic sealant, and one external closure band, which compress the gasket between the internal flanges.
            1 Acceptable Manufacturer: Ductmate Industries "Spiralmate" system or approved equal.
         c) Above 72 inch. Diameter: Install using companion angle flanged joints as defined in Figure 3-1 of the 2005 SMACNA Manual, "HVAC Duct Construction Standards, Metal and Flexible" Third Edition. Refer to manual for proper sizing and construction details.
      2) Clothes dryer exhaust duct connections shall be made with Ductmate Quick-Sleeve Round Duct Connector, or an approved equal, for use with round duct sizes ranging from 3 inch. through 14 inch. in diameter. The installation of the connector shall be in accordance with the manufacturer's instructions. The connector shall consist of galvanized metal sleeve, complete with fastening system to compress gasket. Sleeve will properly retain and compress gasket while providing rigidity to duct upon assembly. A polyethylene gasket shall have sufficient elasticity to accommodate the spiral duct seam.
   b. Pipe-to-pipe joints in diameters up to 60 inch. shall be by the use of sleeve couplings, reinforced by rolled beads.
   c. Pipe-to-fitting joints in diameters up to 60 inch. shall be by slip-fit of projecting collar of the fitting into the pipe.
   d. Insertion length of sleeve coupling and fitting collar shall be 2 inch. up to 36 inch. diameter and 4 inch. above 36 in. diameter.

e. Pipe-to-pipe and pipe-to-fitting connections in ductwork above 60 inch. in diameter shall be made by angle ring flanges. The flange on the pipe shall be a 2 inch. x 2 in. x 3/16 inch. angle attached to the pipe with a continuous weld. The fittings shall have a loose ring "Van Stone" flange. A 5/8 inch. flange shall be provided to act as a gasketing surface for sealing with the angle ring being a rolled, welded ring 2 in. x 2 in. x 3/16 inch. Bolt hole spacing for angle rings shall be 6 in. centers.

f. If longitudinal seam duct greater than 60 inch. in diameter is supplied in lengths greater than 4 feet, one angle ring must be welded to the duct on 4 ft. centers for support.

2.4 DUCTWORK SEALING

A. SMACNA Duct Sealing Classification shall be used for duct systems using the following criteria:

1. Ductwork and all plenums with pressure class ratings shall be constructed to Seal Class A, as required to meet the requirements of SMACNA Duct Construction Standards and with standard industry practice, including transverse joints, longitudinal seams, fitting connections, and all penetrations of the duct wall.
2. Openings for rotating shafts shall be sealed with bushings or other devices that seal off air leakage. Pressure sensitive tape shall not be used.
3. All connections shall be sealed, including but not limited to spin-ins, taps, other branch connections, access doors, access panels and duct connections to equipment.
4. Sealing that would void product listings is not required.
5. Spiral lock seams need not be sealed.

B. Sealants and tapes shall be listed and labeled in accordance with UL 181A or UL 181B and marked according to type, and per manufacturer product requirements for associated system and application/installation location.

1. Duct sealant for indoor applications shall be non-fibrated, water based, Hardcast Iron-Grip IG-601, Ductmate PRO Seal, Foster 32-17 or Childers CP146, or approved equal.
2. Duct sealant for outdoor applications shall be fibrated, water based, Hardcast Versa-Grip VG-102, Ductmate Fiberseal, Foster 32-17 or Childers CP148, or approved equal.

2.5 TURNING VANES

A. Provide in mitered elbows as shown on contract drawings. Vanes 36 inch. or longer shall be double wall air foil type. All turning vanes shall be installed as per the latest SMACNA Standards. Turning vane size and spacing shall be as per SMACNA. Turning vane spacing greater than SMACNA Standards is not acceptable.

B. Turning vanes shall be Harper or equivalent double wall turning vanes fabricated from the same material as the duct.

C. Turning vane front and back panels shall be securely locked together with adequate crimping to prevent twisting of vane. Vane shall be capable of withstanding 250 pounds of tensile load when secured according to the manufacturer's instructions.

D. Rails for mounting turning vanes shall have self locking, friction fit tabs designed to facilitate proper alignment of vanes. Tab spacing shall be as specified in Figure 4-3 of the 2005 SMACNA Manual, "HVAC Duct Construction Standards, Metal and Flexible". Rail systems with non-compliant tab spacing shall not be accepted.

E. Acoustical Turning Vane: Shall be used in applications that require quiet operating systems. Mounting rails shall have friction insert tabs that align the vanes automatically.

F. Acceptable Manufacturer: Ductmate Industries PRO-Rail Turning Vane or approved equal.

2.6 DAMPERS IN DUCTWORK

A. Blade Type Volume Dampers: Constructed per SMACNA, one gauge heavier than duct material, securely fastened to 3/8 inch. sq., cold rolled steel operator rod. Provide Ventlock 639 elevated dial regulator for 2 inch. insulated ductwork.

B. Multiple Blade Type Volume Dampers: Provide multiple blade volume dampers in ductwork above 12 inch. in height.
   1. Heavy duty, manual balancing dampers suitable for application in HVAC systems with velocities to 1,500 feet per minute, open position and max. pressure of 3 inch. w.g. close position. Ruskin MD 35 or equivalent.
   2. Fabrication:
      a. Frame: 5 inch. x minimum 16 gauge roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 gauge U-channel.
   3. Blades:
      a. Style: Single skin with 3 longitudinal grooves.
      b. Action: Opposed
      c. Orientation: Horizontal
      d. Material: Minimum 16 gauge equivalent thickness, galvanized steel.
      e. Width: Nominal 6 inch.
   4. Bearings: Molded synthetic sleeve, turning in extruded hole in frame.
   5. Linkage: Concealed in frame.
   6. Axles: Minimum 1/2 inch. diameter, plated steel, hex-shaped, mechanically attached to blade.
   7. Control Shaft: 3/8 inch. square plated steel.

8. Finish: Mill galvanized.
    a. Actuator: Hand quadrant for 3/8 inch. square extended shaft.
    b. Hand Quadrant Standoff Bracket: 2 inch. standoff for insulated ductwork.
    c. Oillite bearings.
    d. Factory Sleeve: Minimum 20 gauge thickness, minimum 12 inch. length.

C. Automatic Air Dampers: Furnished as part of "Building Management System" Section 230923 and installed by this Contractor.

2.7 FLEXIBLE AIR DUCTS

A. Flexible air ducts and connectors shall be constructed in compliance with NFPA Bulletin 90A, 90B and UL Standard 181 and shall be listed and labeled as Class I Air Duct.

B. Flexible air ducts and connectors shall be tri-laminate:
1. Consisting of corrosion resistant galvanized steel helix encapsulated by a double lamination of polyethylene or spun bond nylon.
2. Factory applied (R 6.0) fiberglass exterior insulation, sheathed in a seamless, tri-directionally reinforced, metalized polyester, exterior vapor barrier.
3. R-value shall be classified by Underwriters Laboratories, and certified by the Air Diffusion Council, in accordance with ADC Flexible Duct Performance and Installation Standard (1991), using ASTM C518, at installed wall thickness, on flat insulation only. Comply with ASHRAE/IESNA 90.1.
4. Recommended operating pressure for flexible ductwork shall be three times maximum system press but not less than 6 inch. w.g. positive pressure for 4 inch. - 20 inch. dia., 5 inch. w.g. negative pressure through 16 in. dia., 1 inch. negative pressure for 18 inch. and 20 in. dia. Maximum velocity of 5500 fpm.
5. Operating temperature range - 20°F to 250°F, intermittent @1/2 inch. pos. w.g. max., -20°F to 140°F, continuous at maximum pressure.
6. Flame Spread: 25 max. smoke developed rating: 50 max.
7. Porous inner core flexible duct shall not be used.

C. Static pressure and thermal performance shall be tested and certified in accordance with Air Diffusion Council (ADC) Test Code FD-72-R1 under conditions of 140°F for 164 hours and 180°F for 4 hours.

D. Acoustical performance shall be certified in accordance with ASTM E477 and/or Air Diffusion Council Test Code FD-72-R1.
1. Minimum Acoustic Performance:
    a. The insertion loss (dB) of a 6 foot length of duct when tested in accordance with ASTM E477 at a velocity of 1000 feet per minute shall be at least:

	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
8 inch dia.	26	27	27	31	32	27
12 inch dia	22	26	24	31	31	20

E. Friction loss and leakage for flexible duct only shall be certified in accordance with Air Diffusion Council Test Code FD-72-R1. Leakage for connections shall be accordance with UL 181 requirements.

F. Basis-of-Design: Flexmaster 6B (R-6.0)

G. Acceptable Manufacturers:
1. Dundas-Jafine Type SPC R6.0
2. Hart & Cooley Type F216 (R-6.0)
3. Flexible Technologies, Inc. Thermaflex Type M-KE (R-6.0)
4. Atco Rubber Products, Inc. Type 036 (R-6.0)

2.8 FLEXIBLE CONNECTIONS TO FANS AND EQUIPMENT

A. Basis of Deign: Ventfabrics, Inc.

B. Acceptable Manufacturers: Ductmate Industries, Inc., Duro Dyne Inc., Elgen Manufacturing, Ward Industries, Inc.; a division of Hart & Cooley, Inc.

C. Materials: Flame-retardant or noncombustible fabrics, water and mildew resistant UL Standard 214.

D. Coatings and Adhesives: Comply with UL 181, Class 1.

E. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inch. wide attached to two (2) strips of 2-3/4-in. wide, 0.028-in. thick, galvanized sheet steel or 0.032 inch. thick aluminum sheets. Provide metal compatible with connected ducts.

F. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/in. in the warp and 360 lbf/in. in the filling.
3. Service Temperature: Minus 40 to plus 200°F.

G. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
1. Minimum Weight: 24 oz./sq. yd.
2. Tensile Strength: 530 lbf/in. in the warp and 440 lbf/in. in the filling.
3. Service Temperature: Minus 50 to plus 250°F.

H. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-in. movement at start and stop.

2.9 ACCESS DOORS

A. General:
1. Provide access doors of adequate size to allow easy access to the equipment that will require maintenance. Provide insulated or acoustically lined doors to prevent condensation where applicable.
2. Manufacturer to provide an installed neoprene gasket around perimeter of access door for airtight seal.
3. Systems 3 inch. w.g. or less shall utilize a hinged, cam, or hinged and cam square framed access door.
4. Systems 4 inch. w.g. and above shall utilize a sandwich type access door. Construct doors in accordance with Figure 7-3 of the 2005 SMACNA Manual, "HVAC Duct Construction Standards, Metal & Flexible" Third Edition.
5. Approved Manufacturer: Ductmate Industries "Sandwich" style door or approved equal.
6. All access doors shall be continuous piano hinged type, unless noted otherwise.
7. Non-hinged only allowed where clearance to ceiling does not allow a full 90□ swing.
8. Double panel insulated type when used in insulated duct.
9. Single panel uninsulated type allowed in un-insulated duct.
10. Pressure rated according to system in which being installed. Door-to-frame and frame-to-duct gasketing.
11. Provide specified Seal Class A or B ductwork sealing around frame, and hand adjust the latch tension for proper seal, on all access doors other than sandwich panel (Ductmate) style.
12. MINIMUM access door size for ducts 12 inch. or less in depth is 12 in. x 8 inch.
13. MINIMUM access door size for ducts 12 inch. to 18 inch. in depth is 18 in. x 14 inch.
14. MINIMUM access door size for ducts more than 18 inch. in depth is 24 inch. x 18 in.
15. In ducts which require multiple section fire dampers due to duct size, provide one access door for each fire damper section.
16. Access doors for fire and smoke dampers shall be permanently labeled with 1 inch. high lettering reading "SMOKE DAMPER", "FIRE DAMPER" or FIRE/SMOKE DAMPER".

17. Grease exhaust duct doors shall be grease and air tight, UL 1978 listed, meet NFPA 96 standards and all mechanical codes. Grease duct access doors can be sandwich type or with a weld on frame, with/without hinge. Approved Manufacturer: Ductmate Industries "Ultimate" style door or approved equal.
18. All grease duct access doors used must be accompanied by independent testing in conjunction with each manufacturer's respective wrap system for high temperature applications.

B. Door Types:
1. Low Pressure Systems 2 inch. w.g. pressure class): National Controlled Air ADH-1, Ruskin ADH22, Vent Products 9701, Air Balance FSA-100, Safe Air SAH, Nailor.
2. Medium and High Pressure Systems 3 inch. w.g. pressure class and higher):
   a. Rectangular Duct: Ductmate Industries "Ultimate" Style Door, or equal.
   b. Round Duct: Ductmate Industries Round Sandwich type, or equal. 8 inch. x 4 inch. for ducts 14 in. and less in diameter. Ductmate Industries Round Sandwich type 16 inch. x 12 inch. for ducts more than 14 in. in diameter.
   c. Furnish and install factory supplied protector molding on cut medal edge for all Ductmate access doors.
3. Kitchen Hood Exhaust Systems: In accordance with the latest requirements of NFPA 96, grease-tight, flanged and bolted. Approved Manufacturer: Ductmate Industries "Ultimate" style door or approved equal.

2.10 EXHAUST HOODS AND HOOD CONNECTIONS

A. General Requirements:
1. Provide hoods and/or duct connections to hoods/fans where furnished by others.
2. Duct material, thickness and joints as required for gases and vapors involved and per SMACNA.
3. Clearance between bottom of hood and floor shall be 78 inch.
4. Provide continuous internal channel brackets for supporting lighting fixtures, coordinate with and install to suit Division 26 "Electrical".

B. Kitchen Hood Duct Connections:
1. Exposed duct shall be 304 stainless steel, #3 polish finish, welded construction.
2. Concealed duct shall be black steel, welded, flanged and gasketed.
3. Metal gauges comparable to similar duct sizes with adequate stiffening, 16 gauge minimum thickness.
4. Support from building structural members.

2.11 ACOUSTIC-THERMAL DUCT LINING IN DUCTWORK

A. General: Comply with NFPA Standard 90 and NAIMA Standard AHC-101.

B. Materials: ASTM C1071, Type I. Glass mineral wool insulation coated with an anti-microbial EPA registered coating that seals the airstream surface fibers into a smooth, low-friction surface acoustic ductliner shall be of thickness shown in the table. Density at 1.5 PCF. Maximum "K" value to be 0.24 btu/in. /sq. ft. /degrees F. /hr. when tested in accordance to ASTM C177. Acoustic duct liner to be suitable for use up to 6000 feet per minute air velocity and temperatures up to 250°F. The acoustic duct liner shall not accelerate the corrosion of steel, copper or aluminum. The liner shall not absorb greater than 3% by weight when tested per ASTM C1104. Acoustic duct liner shall provide the minimum sound absorption coefficients shown below when tested per ASTM C423 and ASTM E795, Mounting Type A.

Octave Band Frequencies Hz							
Thickness	125	250	500	1000	2000	4000	NRC
1-1/2 inch.	.23	.50	.87	.92	.93	.93	.80
2 inch.	.37	.76	1.02	1.00	.98	.92	.95

C. Thickness: Unless otherwise noted, all supply air ductwork indicated to be acoustically lined, shall have 1-1/2 inch. thick liner with a minimum R value of 6. Return or exhaust ductwork, if acoustically lined, shall be of a thickness specifically noted. Note that per the symbol list (L) equals 1-1/2 inch. thick. If called for on the plans, (2L) equals 2 inch. thick.

D. Fire Hazard Classification: Flame spread rating of not more than 25 and a smoke developed rating of no higher than 50, when tested in accordance with ASTM E84, UL 723, UL/ULC S102-M88 and NFPA 255.

E. Liner Adhesive: Comply with NFPA Standard 90A, ASTM C919, and maximum VOC requirements of LEED EQ 4.1 and EQ 4.2.

F. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct. Provide fasteners that do not damage the liner when applied as recommended by the manufacturer, that do not cause leakage in the duct, and will indefinitely sustain a 50 pound tensile dead load test perpendicular to the duct wall.
   1. Fastener Pin Length: As required for thickness of insulation, and without projecting more than 1/8 inch into the airstream.
   2. Adhesive for Attachment of Mechanical Fasteners: Comply with the "Fire Hazard Classification" of duct liner system.

G. Design Equipment: Knauf Atmosphere.

H. Acceptable Makes: Knauf Atmosphere, Certainteed ToughGard R.

I. For duct velocities above 4000 fpm, provide metal "build-outs" of proper height, welded to the ductwork for turning vanes and dampers.

2.12 CABLE SUSPENSION SYSTEM (NOT FOR USE WITHIN THE POOL LOCKER ROOM SCOPE AREA)

A. Ductwork not required to be exterior insulated in exposed installations may be installed using a cable suspension system.

B. Ductwork shall be installed using load rated, stainless steel cable suspension systems. Cables shall be pre-cut lengths, type 316 stainless steel with fused ends, and pre-made end attachments.

C. Cable grips shall be of 316 stainless steel and have an internal tamperproof cable release mechanism.

D. Stress distribution saddles shall be prescribed in addition for the support of rectangular duct on corners as necessary.

E. Hangers shall have a manufacturer's published safe working load and have a 5 to 1 safety factor.

F. Hang and support ductwork as defined in the latest edition of SMACNA Manual, "HVAC Duct Construction Standards, Metal & Flexible".

G. Adjustable steel cable hanging system consisting of spring loaded, serrated clamping mechanism shall be tested and certified in compliance with all applicable SMACNA standards for upper and lower attachment methods.
   1. All approved systems must be installed using matching components including steel cable, clamping mechanism and hardware approved by the manufacturer for its corresponding load rating. No Substitution of manufacturer's components is permitted.
   2. Approved systems must be installed per the manufacturer's specific instructions and must not exceed the stated working load rating at any point throughout the system.

H. Supports, bar/angle reinforcements, and other products that are not part of the duct that are manufactured of uncoated mild steel shall either be painted with two (2) coats of primer or shall be manufactured of a galvanized equivalent material.

I. Approved Manufacturer: Ductmate Industries "Clutcher" Cable Hanging System or Gripple Inc.

2.13 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Ventlock 699 or 699-2 based upon insulation thickness.

C. Install duct test holes where required for duct traverse testing and balancing purposes.

PART 3 - EXECUTION

3.1 REQUIREMENTS

A. Equipment and systems shall be installed in accordance with local and state codes and regulations having jurisdiction. Bracing and hanging of ductwork shall be per SMACNA - HVAC Duct Construction Standard.

B. Install all ductwork concealed and tight to the structure above unless noted otherwise on shop drawings. Fabricate only after the approval of shop drawings, and in locations to avoid interferences.
   1. Ductwork installed without approved shop drawings, which requires removal/modification and/or reinstallation due to conflicts or improper installation shall be repaired at no cost to the Owner.

C. Sizes given on contract drawings are inside dimensions.

D. Keep openings continuously closed and sealed with protective plastic wrapping during construction to prevent entrance of dirt and debris.

E. Extend access openings, damper rods and levers, to outside of external insulation make systems airtight.

F. No piping, conduit or other obstruction to airflow is permitted in ductwork.

G. Provide necessary openings, hanger inserts, framing, chases, and recesses, not provided by other trades.

H. Exposed exhaust or return registers and grilles shall be flush with face of duct; exposed supply registers and grilles shall be mounted outside airstream with 45□ shoe-tap extension collars.

I. Where a return or exhaust duct is shown to be left open ended, provide hardware 0.5inch aluminum mesh screen at opening.

J. Do not utilize flexible ductwork or connection in any way to connect single duct variable or constant volume boxes to ductwork.

K. Penetrations:
   1. Provide 14 gauge sleeves for ducts passing through Mechanical Room floors. Set sleeves 4 inch. above finished floor in Mechanical Rooms, seal watertight to floor.

2. For duct penetrations of non-rated walls, provide sheet metal angle framing or sheet metal closure panels around the entire perimeter of each duct wall penetration on both sides of the wall, where the gap exceeds 1/4 inch. Where the gap is less than 1/4 inch, the gap may be caulked on both sides of the wall. Non-rated wall penetrations SHALL NOT be fire caulked under any circumstances.
3. For duct penetrations of rated walls, see Specification Section 230500 - Basic Mechanical and Electrical Requirements.

L. Ductwork that is called for to be welded shall be fully welded, continuous around the entire perimeter at all joints/seams, and shall be fully airtight and watertight.

3.2 TEST OF DUCTWORK

A. Conduct duct leakage tests per SMACNA "HVAC Air Duct Leakage Test Manual" and in compliance with latest edition of the Energy Conservation Construction Code of New York State, for ductwork systems as indicated below. Positive pressure leakage testing is acceptable for negative pressure ductwork. The rate of air leakage (CL) must be less than or equal to 4.0 for rectangular ductwork and 2.0 for round ductwork, as determined by the equation in the code referenced above, which reads: CL=F/P0.65 where F = measured leakage rate in CFM per 100 sq. ft. of duct surface, and P = static pressure of the test. When leakage above stated limits occurs, ascertain location of leaks and rebuild, repair, or seal the ductwork as required. Repeat tests as required to obtain allowable leakage rates. Prepare a report similar to that suggested by SMACNA and submit for review. Duct testing shall be conducted in the presence of the Owner's Representative.

B. Systems designed to operate at static pressures of 3.0 inch. w.g. or greater: Representative sections totaling no less than 25% of the total duct area, per system, for the designated pressure class shall be tested as well as all associated ductwork located out-of-doors. All areas to be tested shall be coordinated with the engineer based on the approved ductwork shop drawings.

C. Provide test reports indicating pressure tests performed. Include date, approved shop drawings with the section tested highlighted, test pressure and leakage rate.

D. Ductwork not required to be tested for leakage, shall be checked and guaranteed to meet the standards of the specified SMACNA Duct Seal Class A. All joints and connections on this ductwork shall be sealed using the approved ductwork sealant. Air balancing and testing shall be used to determine satisfactory operation of duct systems. Balancing reports indicating excessive leakage amounts shall be required to rebuild, repair or seal ductwork having excessive leakage.

3.3 INSTALLATION OF ROUND DUCTWORK

A. Use factory-fabricated couplings for joints.

B. After the joint is slipped together, sheet metal screws are placed 1/2 inch. from the joint bead for mechanical strength.

C. Sealer is applied to the outside of the joint and covering the screw heads.

D. Flanged joints shall be made with neoprene rubber gaskets.

3.4 DUCT SEALING

A. Preparation:
1. Clean surfaces of dirt, oil, grease and loose of foreign matter that could impair adhesion, using soap and water or solvent.
2. Allow surfaces to dry completely before proceeding.

B. Installation of Sealant System:
1. Apply sealant system to duct joints, fasteners, and seams in accordance with manufacturer's instructions.
2. Apply sealant by brush, putty knife or caulk gun, to full coverage. Remove excess adhesive immediately.
3. Completely seal duct joint, fasteners and seams without voids, to a minimum 20 mil thick wet film.
4. Apply and store at ambient temperature of 40□F to 100□F; and protect from freezing until dry.

C. Field Quality Control:
1. Allow duct sealant system to cure a minimum of 72 hours before operating the system.
2. Do not apply external duct insulation or coatings until the joints have been inspected by the Owner's Representative.

3.5 AIR AND WATERTIGHT DUCTWORK

A. Where water and snow may accumulate on ductwork or where odors or corrosive gasses may collect, ductwork and plenums shall be made watertight by soldering, brazing or welding of joints. Grade ducts down toward waste points and/or toward louvers. Provide valve and drain piping from low point to waste point.
1. Kitchen hood exhaust ductwork.
2. Shower room exhaust ductwork.
3. Intake and exhaust plenums.
4. Swimming pool locker room exhausts and return air systems.
5. Dryer exhaust ductwork.

B. Test for Watertightness: Before concealment, apply water by hose to check for leaks, witnessed by Owner's Representative.

3.6 TURNING VANES

A. Install only in square elbows.

B. Install as per latest SMACNA Standards.

C. Secure vane runners to duct with spot welding, riveting or sheet metal screws.

D. When installing in ductwork with internal insulation.
1. Install runners in ductwork inside insulation and bolt through insulation and duct sides, welding bolts to insure rigid installation. Provide build-outs for duct Velocity-Pressure classes above 2 inch. w.g.

3.7 DAMPERS AND AIR CONTROL DEVICES

A. Provide volume dampers at all air outlets, diffusers, grilles and as noted on plans. Provide volume dampers at all low pressure supply, return and exhaust, branch ducts and as noted on the plans.

B. Provide dampers necessary to permit proper balancing of air quantities. Comply with code requirements for smoke and fire control. Prevent introduction of uncontrolled outside air into building through roof and wall openings.

C. When dampers are installed in acoustically lined ductwork, install with insulated "build-outs" per SMACNA.

D. Install fire dampers in accordance with "Fire Dampers" Section and applicable codes.

E. Install all dampers furnished as part of "Building Management System" Section.

3.8 FLEXIBLE AIR DUCTS

A. "Air duct" applies to conduit or passageway for conveying air to or from heating, cooling, air conditioning or ventilating equipment but not including the plenum as defined in NFPA 90A. "Air connector" applies to conduit for transferring air between an air duct or plenum and an air terminal device or an air inlet or an air outlet as defined by the NFPA 90A.

B. For round to oval connections, provide round-oval flexible adapter.

C. Flexible air ducts and connectors shall be provided in fully extended condition, free from kinks.

D. Flexible air ducts and connectors shall not be used in systems with entering air temperatures in excess of 250°F.

E. Flexible air ducts and connectors shall use only the minimum length required to make the connection and shall be installed in the horizontal or vertical position. Flexible elbows are not acceptable. Do not exceed a maximum length of 48 inch., fully extended.

F. Flexible air ducts and connectors shall use minimum 1/2 inch. wide positive locking, steel worm drive clamp, or nylon plenum rated straps for joints and connections. One clamp or strap for the inside core liner and one clamp or strap for the outer jacketing. When non-metallic (nylon) straps are used, they should be listed and labeled to standard UL 181B. Fastener package should be marked UL 181B-C.

G. Collars to which flexible duct is attached shall be beaded and a minimum of 2 inch. in length. Wrap twice with UL 181 tape and secure with clamp or strap. Sleeves used for joining two sections of flexible duct shall be beaded and a minimum of 4 inch. in length. The draw band shall be positioned behind the bead on the metal collar.

H. Outer vapor barrier and insulation shall be slid over inner core and collar, wrapped twice with UL 151 tape and secured with a clamp or strap.

I. Connections shall be per SMACNA "HVAC Duct Construction Standards - Metal and Flexible", Air Diffusion Council "Flexible Duct Performance and Installation Standards" and NAIMA Installation Standards.

J. Flexible duct shall be supported at manufacturer's recommended intervals, but no greater distance than 2'-6" on center and prior to all 90 degree bends. Maximum permissible sag shall be 1/2 inch. per foot of support spacing. Provide a minimum of one hanger on each run of flexible duct.

K. A connection to rigid duct or equipment shall be considered a support joint. Long horizontal duct runs with sharp bends shall have additional supports before and after the bend approximately one duct diameter from the centerline of the bend.

L. Hanger or saddle material in contact with the flexible duct shall be of sufficient width to prevent any restriction of the internal diameter of the duct when the weight of the supported section rests on the hanger or saddle material. In no case shall the material contacting the flexible duct be less than 1-1/2 inch. wide. Factory installed suspension systems integral to the flexible duct are an acceptable alternative hanging method when the manufacturer's recommended procedures are followed.

M. The hanger shall be strapped around the flexible duct and secured to the structure above. Hangers shall not be attached to other mechanical or electrical objects. Hangers may be attached to an approved trapeze. Ceiling grid shall not be used to fabricate a trapeze. Support hangers shall be installed horizontal. Screws shall not be used to penetrate the flexible duct to attach to the hanger.

N. Provide flexible duct connections and splices in accordance with manufacturer's recommended installation instructions.

O. Seal flexible duct connections with sealing materials listed and labeled in accordance with UL 181B. Mechanically secure connections with approved clamping materials.

3.9 FLEXIBLE CONNECTIONS TO FANS AND EQUIPMENT

A. Provide flexible connections for the intake and discharge connections of duct connected to fans and air handling equipment.

B. Round connections are to be made with adhesive and metal drawbands with ends tightly bolted.

C. Rectangular connections shall be made with material securely held in grooved seam between flanges. Attach with adhesive and mechanical fasteners on 6 inch. centers.

D. Connections shall be made with a minimum of 2 inch. space between duct and equipment collars, installed in line, and with 1 inch. excess material folded so as not to interfere with airflow through connection.

E. Mechanically fastened and sealed, with specified duct sealant, at duct and equipment connections.

3.10 DUCT CLEANLINESS AND CLEANING AFTER INSTALLATION

A. Duct Cleanliness:
1. All ductwork on the project shall meet the SMACNA Duct Cleanliness For New Construction Guidelines, "Advanced Level" of duct cleanliness for production, delivery, storage and installation of ductwork.
2. Prior to shipment to the jobsite, all duct ends and openings must be covered with a heavy duty, dual-ply, clear polyethylene protective film. Open ends are to be kept covered during transport, storage, and installation. As ductwork is installed at the job site, open ends are to be covered to maintain cleanliness. All air outlets shall also be covered until the end of construction.
3. The film must be securely affixed to protect against dirt and debris and must be translucent to facilitate inspection of interior surfaces without removing the film. The film shall have a elongation rating of 600% and a break strength of 13.1 lbs./in. The film shall contain no VOC's, and shall leave no residue on duct after removal.
4. Manufacturer: Ductmate Industries ProGuard (heavy duty grade clear).

B. Cleaning After Installation:
1. Interior surfaces shall be free of dust and debris prior to initial startup. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes. Any cleaning of duct systems shall comply with recommendations of NAIMA and NADCA.

2. Clean external surfaces of foreign substances that might cause corrosion, deterioration of the metal, or where ductwork is to be painted.
3. Clean debris from system before fans are turned on.
4. Keep openings continuously closed during the construction period.
5. Pay damages resulting from dirt blown on painted or other finished surfaces.
6. Repair or replace damaged fan wheels, dampers, or other system parts damaged as a result of debris.
7. Clean system as many times as required until the entire system is dirt free.

3.11 ACCESS DOORS

A. Provide for access to upstream side of duct mounted reheat coils, dampers, damper motors, fire dampers, smoke dampers, smoke detectors, control devices, fan bearings, and equipment requiring periodic inspection or service. Provide labels for fire and smoke dampers as called for in Part 2 - Products.

B. For ducts that are too small to install an access door of the minimum specified size, provide a 12 inch. long section of removable ductwork for maintenance and inspection access. Removable ductwork shall be fastened between device requiring access and next duct section with duct flanges or Donaldson Torit clamp with PVC foam seal. For ducts that are required to be insulated, provisions shall be made to allow insulation to be easily removed and re-installed.

C. Provide access service openings as required by NFPA 96 at 20 feet intervals along horizontal ducts and at each vertical riser for kitchen hood exhaust.

3.12 ACOUSTIC-THERMAL DUCT LINING

A. Increase metal duct dimensions to accommodate lining. Adhere lining to interior side of duct; minimum 90% coverage of Benjamin Foster 85-20 fire retardant adhesive, UL approved. Stapling method of attaching will not be permitted. Mechanical fasteners shall not pierce the sheet metal. Installing fasteners with spacing as per SMACNA Standards. Multiple layers of liner to achieve indicated thickness is prohibited.

B. Abutting edges of acoustic linings shall be sealed with a fire resistant neoprene coating, and exposed edges of acoustic linings shall be installed with sheet metal nosing to prevent erosion.

C. Lining shall not impart odor to the air, delaminate or be loosened by the airstream under normal operating conditions. Lining which is damaged during fabrication or shipment shall not be installed.

D. Supply ductwork downstream of terminal units shall have 1-1/2 inch. thick acoustical lining for a minimum of 8 feet. All air outlets shall be installed downstream of this minimum distance.

E. Provide 1-1/2 inch. thick acoustical lining for a minimum of 10 feet downstream of all supply and return fans.

3.13 DUCT SUPPORTS

A. Provide per SMACNA, same material as duct. Hanger bands to extend down sides and turn under bottom 2 inch. Minimum two metal screws per hanger. Angle iron on larger duct spaced per building structural system but not greater than 8 feet Provide extra support angles as required.

B. Provide additional supports as required to support reheat coils, air terminal units, filter enclosures, and any other duct mounted equipment independent from the associated ductwork system.

3.14 SMOKE DETECTION

A. Smoke detectors shall be furnished by Division 26 "Electrical". This Contractor shall install detectors located in ductwork. Clearly indicate locations of smoke detectors on the sheet metal shop drawings.

B. Increase duct size, ensure the minimum straight ductwork upstream or/and downstream at smoke detectors, where required for proper installation, per smoke detector manufacturer's recommendations. Coordinate minimum duct size required with Division 26 "Electrical".

3.15 CLOTHES DRYER EXHAUST DUCTWORK AND LAUNDRY ROOMS

A. There shall be no fasteners of any kind protruding into the duct airstream.

B. Flexible ducts (code defined as transition ducts) used to connect the dryer to the exhaust duct system shall be metal, and shall be a single length that is listed and labeled for such use, in accordance with UL 2158A. The length of the transition duct shall not exceed 48 inch.

C. Protective plates shall be placed where nails or screws from finish work are likely to penetrate the clothes dryer exhaust ductwork. Shield plates shall be placed on the finished face of all framing members where there is less than 1-1/4 inch. between the duct and the finished face of the framing member. Protective shield plates shall be constructed of 0.062 inch. (16 gauge) and extend a minimum of 2 inch. above the framing sole plates and below the framing top plates.

EXHIBIT “I” - DUCTWORK MATERIALS

SERVICE	MATERIAL	SPECIAL REQUIREMENTS
Supply, return, outside, and exhaust	Lock forming quality, galvanized steel ASTM A653	Joints and features as called for

SERVICE	MATERIAL	SPECIAL REQUIREMENTS
	and A924, galvaneal/paint grip if not insulated and exposed	
Exterior ductwork	Galvaneal/paint grip (ready for paint) if not insulated, otherwise same as above	Horizontal top surfaces crossbroken for positive water drainage, Ductmate joints, seal Class A, and outdoor duct sealant per spec
Exposed Kitchen hood and exposed laundry room exhaust	Type 304 stainless steel, with #3 polished finish where exposed	Braze or weld airtight/watertight
Pool Locker Room Area supply, return, and exhaust duct systems in their entirety.	Aluminum	Aluminum fasteners
Concealed kitchen hood exhaust	16 gauge black steel	Joints welded airtight/watertight, flanged and gasketed at connections to hood
Commercial laundry equipment exhaust	Type 304 stainless steel with #3 polished finish where exposed	Joints welded airtight/watertight, flanged and gasketed at connections. Inside surfaces smooth.
Accessories, dampers and air turns	Same material and gauge as parent duct	----------

END OF SECTION 233100

SECTION 233400 - FANS

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2019.

B. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2024.

C. UL 705 - Power Ventilators; Current Edition, Including All Revisions.

1.2 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Drawings.

1.3 SUBMITTALS

A. Submit product data for all fans, motors, drives, and accessories. Include all fan curves fan operating point, and sound data.

1.4 QUALITY ASSURANCE

A. Capacity, size and arrangement, static pressure, brake horsepower, component parts and accessories shall be provided as called for or scheduled. Guaranteed full capacity delivery through duct systems finally installed and under conditions listed. The manufacturer shall guarantee sound-power level ratings not exceeding those of the design equipment. All equipment shall be statically and dynamically balanced to acceptable tolerances with weights permanently fastened. Fan wheels shall be rebalanced in the field, if necessary.

B. Pressure Classification:
   1. Maximum Total Sp Class
   2. Up to 3-3/4 inch. WG-STD I
   3. Up to 6-3/4 inch. WG-STD II
   4. Up to 12-3/4 inch. WG-STD III

C. Conventional Motors:
   1. Motor sizes shall be as scheduled. Refer to Specification Section 230513 for motor types, efficiency requirements, and acceptable motor manufacturers. All belt-driven fan motors shall be mounted on either an adjustable slide base or a pivoting base.

D. EC Motors:
   1. Motors shall be Electronically Commutated Type (EC), variable speed, DC, brushless motors specifically designed for use with single phase, 277 volt (or 120 volt), 60 hertz electrical input.
   2. Motor shall be complete with and operated by a single-phase integrated controller/inverter that operates the wound stator and senses rotor position to electronically commutate the stator.
   3. Motors shall be designed for synchronous rotation. Motor rotor shall be permanent magnet type with near zero rotor losses. Motor shall have built-in-soft start and soft speed change ramps.
   4. Motor shall be able to be mounted with shaft in horizontal or vertical orientation. Motor shall be permanently lubricated with ball bearings. Motors shall be direct coupled to the blower.
   5. Motor shall maintain a minimum of 85% efficiency over its entire operating range and have a turndown to 20% of full speed, (80% turndown).
   6. Provide manual fan speed output control for field adjustment of the fan airflow setpoint.
   7. Inductors shall be provided to minimize harmonic distortion and line noise.
   8. Provide isolation between the fan motor assembly and unit casing to eliminate any vibration from the fan to the terminal unit casing.
   9. Provide a motor that is designed to overcome reverse rotation and not affect life expectancy.
   10. The fan manufacturer shall provide a factory installed PWM controller for either manual or DDC controlled fan CFM adjustment. The manual PWM controller shall be field adjustable with a standard screwdriver. The remote PWM controller shall be capable of receiving a 0-10 VDC signal from the DDC controller (provided by the controls contractor) to control the fan CFM. When the manual PWM controller is used, the factory shall present the fan CFMs as shown on the schedule.
   11. Acceptable Manufacturers: Emerson Ultratech, U.S. Motors-Nidec, GE-ECM, A.O. Smith or equivalent.

E. Drive Systems:
   1. Provide fans with belt or direct drive systems as scheduled. V-belt drives as recommended by drive manufacturer, unless otherwise specified or scheduled.
      a. Size drive for 200% of motor rating when motor is 10 HP and larger. Size for 150% of motor rating when motor is less than 10 HP.
      b. Motors 5 HP and larger shall be provided with a minimum of two (2) belts. All belt sets shall be matched.
      c. Cast iron or cast steel pulleys.
      d. Provide belt and shaft guards for each driven device. Provide openings in both the motor and fan sections of the guard so that the motor and fan speeds can be checked without removing the belt guard.

e. Belts shall be oil and heat resistant, non-static type.
f. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts.
g. All belt drive fan motor selections must include an allowance for medium drive losses as established by AMCA Publication 203.
h. Motors shall be isolated from the primary exhaust air stream and shall be visible from the fan exterior for inspection and service.

F. Motor Pulleys:
1. 5 HP and Smaller: Adjustable type to produce 15% speed change above and below scheduled fan speed. 7-1/2 HP and Larger: Fixed type.
2. 5 HP and Smaller: "A" section, 2.6 inch. minimum pitch diameter.
3. 7-1/2 HP to 20 HP: "B" section, 4.6 inch. minimum pitch diameter.
4. 25 HP and Larger: "C" section 7.0 inch. minimum pitch diameter.
5. Drive ratio not over 4:1.

G. Bearings:
1. Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball type in a pillow block cast iron housing selected for a minimum L50 life in excess of 200,000 hours as maximum cataloged operating speed.

H. Wheels and Propellers:
1. All wheels and propellers shall be balanced in accordance with AMCA Standard 204-96, balance quality and vibration levels for fans. Wheel shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency.
2. Blades on all sizes shall be continuously welded to the backplate and deep spun inlet shroud.
3. All hubs shall be keyed and securely attached to the fan shaft.

I. Blower Shafts:
1. All blower shafts shall be AISI-C-1045 hot rolled and accurately turned, ground and polished. Shafting shall be sized for a critical speed of at least 125% of maximum cataloged operating speed.

J. Coating:
1. All steel fan components shall contain an electrostatically applied, baked polyester powder coating. Paint must exceed 1,000 hour salt spray under ASTM B117 test method.

K. Vibration isolation for units shall be furnished by the fan manufacturer unless otherwise noted. Provide guided spring type vibration isolators.

L. Certifications:

1. Fan shall be listed by Underwriters Laboratories (((UL 705))) and UL listed for Canada (CUL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.
2. All units shall bear an engraved aluminum nameplate and shall be shipped in ISTA certified transit-tested packaging.

PART 2 - PRODUCTS

2.1 INLINE BLOWERS/INLINE FANS

A. Manufacturers: Subject to compliance with requirements of this section, provide products by one of the following:
   1. Acme, Cook, Greenheck, Hartzell, New York Blower, Twin City, PennBarry.

B. Ceiling, Wall or Inline Mounted, Direct Driven, Centrifugal Exhaust Fan:
   1. Construction:
      a. The fan housing shall be minimum 20 gauge galvanized steel and acoustically insulated.
      b. Blower and motor assembly shall be mounted to a minimum 14 gauge reinforcing channel. Motor shall be resiliently mounted.
      c. Unit shall be supplied with integral wiring box.
      d. Discharge position shall be convertible from right angle to straight through by moving interchangeable panels. The outlet duct collar shall include reinforced aluminum dampers with continuous aluminum hinge rods and brass bushings. To accommodate different ceiling thickness, an adjustable prepunched mounting bracket shall be provided.
      e. A powder painted white steel grille shall be provided as standard.
   2. Wheel:
      a. Wheels shall be twin DWDI centrifugal forward curved type, constructed of galvanized steel.
   3. Accessories:
      a. Disconnect switch - Factory mounted and wired.
      b. Fan Speed Controller (For Direct Drive Models Only) - Factory mounted and wired.
   4. Basis-of-Design: Cook Gemini.

2.2 ROOF FANS

A. Manufacturers: Subject to compliance with requirements of this section, provide products by one of the following:
   1. Acme, Cook, Greenheck, Twin City, PennBarry.

B. Spun Aluminum Downblast Centrifugal Exhaust Ventilator:
   1. Construction:

a. The fan shall be bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure.
b. The aluminum base shall have continuously welded curb cap corners for maximum leak protection, and shall be tall enough to cover the wood nailer on roof curb.
c. The discharge baffle shall have a rolled bead for added strength.
d. An integral conduit chase shall be provided through the curb cap and into the motor compartment to facilitate wiring connections.
e. Bearings and drives shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream.
f. Hinged at curb so that entire fan can be tilted upward for maintenance, access to dampers, and access to damper motor.
g. 1/2 inch. x 1/2 in. aluminum wire mesh bird screen.

2. Wheel:
a. Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub.

3. Accessories:
a. Roof Curb - In accordance with Section 230530.
b. Disconnect Switch - Factory wired and mounted.
c. Fan Speed Controller (For Direct Drive Models Only) - Factory wired and mounted.

4. Basis-of-Design: Cook ACE.

C. Spun Aluminum Upblast Centrifugal Kitchen Exhaust Ventilator:
1. Construction:
a. The fan shall be bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of heavy gauge aluminum, bolted to a rigid aluminum support structure.
b. The aluminum base shall have continuously welded curb cap corners for maximum leak protection.
c. The discharge baffle shall have a rolled bead for added strength.
d. An integral conduit chase shall be provided through the curb cap and into the motor compartment to facilitate wiring connections.
e. Bearings and drives shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. A 1 inch. thick, three pound density foil back heat shield shall be utilized to protect the motor.

f. Hinged at curb so that entire fan can be tilted upward to permit inspection and cleaning, as required for commercial cooking equipment by NFPA 96. Provide service hold-open cables.

2. Wheel:
   a. Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub.
3. Certifications:
   a. For grease laden vapor applications, fan shall be listed by Underwriters Laboratories (((UL 762))) and UL listed for Canada (Power ventilator for restaurant exhaust applications).
4. Accessories:
   a. Hinged Base.
   b. Weatherproof saferty Disconnect Switch.
   c. Grease cup for kitchen-duty
   d. Gasketing Kit
   e. VFD factory mounted and wited in unit control vestibule.
   f. VFD mounting bracket.
   g. Insulated heat baffle for exhaust fans.
5. Basis-of-Design: Captiveaire DU180HFA

D. Laundry Box Ventilator:
1. Fan shall be designed for exhausting lint-laden air from laundry dryer systems.
2. Construction:
   a. Housing shall be double wall with 2" fiberglass insulation.
   b. Motor and impeller installed on a hinged door to provide access for service and cleaning.
   c. Rated for indoor or outdoor installation. Unit shall be able to be curb mounted.
   d. Fan and impeller to be statically and dynamically balanced.
3. Material:
   a. Housing: Galvanized Steel
   b. Impeller: Welded Aluminum
4. Certifications:
   a. UL 705, CSA C22.2 NO. 113-12, ANSI/AMCA Standard 211, AMCA Standard 301
   b. Unit shall be type B spark resistant construction per AMCA Standard 99-0401
5. Accessories:
   a. As called for on drawings and equipment schedules.
6. Basis-of-Design: Enervex

2.3 CONTROL (MOTORIZED) DAMPERS

A. Manufacturers: Subject to compliance with requirements of this section, provide products by one of the following:
   1. Ruskin, Tamco, Greenheck.

B. Provide control dampers as shown on the drawings and diagrams, to meet the following minimum construction standards:
   1. Leakage: Class 1, 4 CFM/sq. ft. at 1 inch. w.c., tested per AMCA Standard 500-D-98, and AMCA Standard 500-D-98, and AMCA Standard 511 and bearing AMCA's Certified Ratings for both air performance and air leakage.
   2. Frame: 16 gauge galvanized steel structural hat channel with tabbed corners for reinforcement to meet 13 gauge criteria.
   3. Blades: 14 gauge (equivalent thickness galvanized steel) roll forward air foil type for low pressure drop and low noise generation. Blades shall be parallel for two-position dampers and opposed, for modulating dampers.
   4. Blade Seals: Ruskiprene, suitable for -72°F to 275°F mechanically locked into the blade edge.
   5. Jamb Seals: Flexible metal compression type.
   6. Blade Axles: 1/2 inch. plated steel hexagonal positively locked into the damper blade. Linkage concealed out of the airstream.
   7. Bearings: Corrosion resistant, permanently lubricated stainless steel sleeve.
   8. Dampers subject to corrosive fumes or humidity shall be constructed of stainless steel.
   9. Dampers over 48 inch. in length and height shall be made in multiple sections.
   10. Where damper sizes are not specifically indicated, they shall be sized by the Building Management System Contractor. Maximum velocity shall be 1500 FPM and maximum pressure drop 0.1 inch. w.g.
   11. Where shown or required for proof of closure or open position, provide factory installed damper positioning switch package Ruskin Model SP-100.
   12. Dampers shall be as manufactured by Ruskin CD 60 control damper, or equivalent Tamco, Greenheck or Nailor.
   13. Basis of Design: Ruskin CD60

PART 3 - EXECUTION

3.1 INSTALLATION OF EQUIPMENT

A. Provide equipment in accordance with manufacturer's instructions. All fans shall meet the intent of the system performance requirements. Provide rubber in-shear vibration isolation for all fans unless otherwise called for. Provide necessary support steel for equipment. Provide guards for all exposed belts, shafts, and fan wheels. Change pulley sizes or adjust sheaves as required to make systems deliver specified quantities of air as listed on the Contract Drawings.

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SECTION 233713 - REGISTERS AND DIFFUSERS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services required for the complete installation designed in Contract Documents.

1.2 SUBMITTALS

A. Registers/Grilles/Diffusers: Submit product data including room schedule listing size, CFM, throw, direction of throw, accessories, finish, material type, color chart, pressure drop, and noise criteria.

1.3 GENERAL REQUIREMENTS

A. Each manufacturer shall check noise level ratings for registers and diffusers to insure that the sizes selected will not produce noise to exceed N.C. - 24, measured at occupant level; notify Owner's Representative of problems prior to submittal.

B. Pressure drop, airflow and noise criteria selection is based on design equipment. Manufacturers not submitting design makes must provide written certification in front of submittal that equipment submitted has been checked against and performs equal to the design make.

C. Borders and frames shall be coordinated with materials and ceiling systems to integrate with architectural ceiling details and finishes scheduled.

D. Locations of ceiling mounted air terminal devices shall be coordinated with locations shown on architectural reflected ceiling plans.

E. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw and pressure drop. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

1.4 REQUIREMENTS FOR REGISTERS

A. General:
   1. A register is defined as a grille plus a volume damper.

2. Registers shall be installed "sight-proof" where possible, i.e.: High wall register with horizontal blades inclined up, or along a wall with blades facing the wall.
3. Borders and frames shall be of the same material as register face unless specified otherwise.

B. Mounting Frames:
1. Provide with screw holes in register face punched and countersunk at factory, and mounting frame drilled and tapped to suit. Sponge rubber gasket between frame and wall or ceiling for all surface mounted frames.
2. Frame shall be overlap type and shall be suitable for type of ceiling where register is to be installed.

C. Finishes:
1. Baked enamel (of colors as selected from the manufacturer's standard color chart) as scheduled.

D. Design Equipment: Titus unless otherwise noted.

E. Manufacturers: Anemostat, Carnes, Krueger, Titus, Price, Tuttle and Bailey, Nailor.

1.5 REQUIREMENTS FOR DIFFUSERS

A. General:
1. Provide four way blow unless otherwise noted.
2. Where manufacturer's size recommendations require duct sizes or connections differing from design, Contractor shall provide at no change in contract price.
3. Suitable for recessed mounting unless otherwise indicated.
4. Provide square to round neck transitions as required.
5. Provide sponge rubber gasket for all surface mounted frames.

B. Finishes:
1. Baked enamel (of colors as selected from the manufacturer's standard color chart) as scheduled.

C. Frame style shall be suitable for ceiling type in which diffuser is to be installed.

D. Design Equipment: Titus unless otherwise noted.

E. Manufacturers: Anemostat, Carnes, Krueger, Titus, Price, Tuttle and Bailey, Nailor.

PART 2 - PRODUCTS

2.1 SUPPLY TYPES

A. Type 1 - (Smooth Face Type):

1. Steel construction with 22 gauge back pan and 22 gauge face panel with rolled edges that finishes flush with ceiling system.
2. Round neck - minimum 1-1/4 inch. collar for duct connection.
3. Frame suitable for ceiling type.
4. With optional directional air flow pattern controllers that are concealed behind the face or in the neck.
5. Face panel shall be removed and securely held in place to the back pan without noise or vibration.
6. Horizontal airflow pattern.
7. Panel Size: 24 inch. x 24 in.
8. Model: Titus OMNI

B. Type 2 - (Supply Air Grille):
1. Steel 20 gauge frame construction with single deflection capability and the front blades shall be parallel to the long dimension. Solid extruded aluminum air foil blades mounted in friction pivots for individual blade adjustment, spaced on 3/4 inch. centers.
2. 1-1/4 inch. wide flange with sponge rubber gasket.
3. Model: Titus 271-FL

C. Type 3 - (Linear Diffuser):
1. Adjustable 180□ pattern controllers to change both direction and volume at discharge air.
2. Multiple 1 inch. slots and lengths as specified.
3. Border type shall be suitable for ceiling.
4. Extruded aluminum frames with black 16 gauge steel pattern controllers.
5. Provide insulated plenum.
6. Model: Titus Model ML-39.

2.2 RETURN/EXHAUST TYPES

A. Type A - (Exhaust and Return Grilles):
1. Steel construction with 22 gauge frame and blades, with horizontal bars on a 1/2 inch. spacing set at 35□ fixed deflection.
2. 1-1/4 inch. wide flange.
3. The blades shall be parallel to long dimension.
4. Model: Titus 355-RL

B. Type B and C - (Exhaust and Return Grilles):
1. Aluminum construction with 22 gauge frame and blades, with horizontal bars on a 1/2 inch. spacing set at 35□ fixed deflection.
2. 1-1/4 inch. wide flange.
3. The blades shall be parallel to long dimension.
4. Model: Titus 355-FL

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in strict accordance with manufacturer's instructions. Rough in or install per reflected ceiling plan or in location instructed by Owner's Representative.

B. Provide approved air extractors behind all duct mounted supply registers in exposed ductwork.

C. When the final connection to an exhaust or return grille is made, a 12 inch. minimum height plenum box must be supplied to all grilles. Plenum dimensions shall match grille size. Paint inside of plenum box flat black.

D. Seal all supply and return registers, grilles and diffusers during construction operations to limit dust entering HVAC systems and ductwork. Seals may be removed just prior to testing and balancing, but not without the approval of the Owner's Representative.

END OF SECTION 233713

SECTION 237413.10 - PACKAGED ROOFTOP UNIT

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. ANSI Z21.47 - American National Standard for Gas-Fired Central Furnaces; 2021.

B. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2019.

C. ASTM D1929 - Standard Test Method for Determining Ignition Temperature of Plastics; 2020.

D. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.2 WORK INCLUDED

A. Provide labor, materials, equipment, and services as required for the complete installation as shown on the Contract Documents.

1.3 SUBMITTALS

A. Submit unit performance data including: capacity, nominal and operating performance.

B. Submit Mechanical Specifications for unit and accessories describing construction, components, and options.

C. Submit shop drawings indicating overall dimensions as well as installation, operation and services clearances. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation and operating weights including dimensions.

D. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or MCA, sequence of operation, safety and start-up instructions.

1.4 QUALIFICATIONS

A. Complete unit and accessories shall comply with the New York State Energy Conservation Construction Code. Unit shall have UL and AGA label.

1.5 MANUFACTURER'S WARRANTY

A. Provide parts warranty (excluding refrigerant) for one year from start-up or 18 months from shipment, whichever occurs first.

B. Provide five (5) year extended warranty for compressors.

C. Provide five (5) year heat exchanger limited warranty.

PART 2 - PRODUCTS

2.1 PACKAGED ROOFTOP UNITS

A. General:
1. Units shall conform to ANSI Z21.47/UL 1995 for construction of packaged air conditioner.
2. The contractor shall furnish and install package rooftop unit(s) as shown and scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the specified conditions as scheduled.
3. Units furnished and installed shall be packaged rooftops as scheduled on contract documents and these specifications. Cooling capacity ratings shall be based on ARI Standard 210. Units shall consist of insulated weather-tight casing with compressors, air-cooled condenser coil, condenser fans, evaporator coil, return-air filters, supply motors and unit controls and drives.
4. Units shall be 100% factory run tested and fully charged.
5. Units shall have labels, decals, and/or tags to aid in the service of the unit and indicate caution areas.
6. Wiring internal to the unit shall be colored and numbered for identification.

B. Unit Casing:
1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
2. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.
3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, reduces heat transfer through the panel, and prevents exterior condensation on the panel.

4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
5. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
6. Access to filters, dampers, cooling coils, reheat coil, energy recovery wheels, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
7. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B117-95 test procedure.
8. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
9. Unit shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
10. Unit shall include lifting lugs on the top of the unit.
11. Unit base pan shall be provided with 1/2 inch thick foam insulation.
12. The base of the unit shall have three (3) sides for forklift provisions. The base of the units shall have rigging/lifting holes for crane maneuvering.
13. Provide an un-powered convenience outlet.

C. Air Filters:
1. Unit shall include 4 inch thick, pleated panel filters with an ASHRAEMERV rating of 13, upstream of the cooling coil. Unit shall also include 2 inch thick, pleated panel pre filters with an ASHRAE MERV rating of 8, upstream of the 4 inch standard filters.
2. Unit shall include a clogged filter switch.
3. Unit shall include a Magnehelic gauge mounted in the controls compartment.

D. Fans and Motors:
1. Supply Fan
    a. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.
    b. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.
2. Exhaust Fan:
    a. Exhaust dampers shall be sized for 100% relief.

b. Fans and motors shall be dynamically balanced.
c. Unit shall include barometric relief dampers.
d. Access to exhaust fans shall be through double wall, hinged access doors with quarter turn lockable handles.

E. Electric Heating Section (RTU-BAND-1 AND RTU-BAND-2 ONLY):
1. Unit shall include an electric heater consisting of electric heating coils, fuses and a high temperature limit switch, with capacities as shown on the plans.
2. Electric heating coils shall be located in the reheat position downstream of the cooling coil.
3. Electric heater shall have full modulation capacity controlled by an SCR (Silicon Controlled Rectifier). Supply air temperature sensor shall be factory provided and field installed in the supply air ductwork. A 0-10 VDC terminal block shall be factory provided for external control.
4. Electric heater shall have full modulation capacity controlled by an SCR (Silicon Controlled Rectifier). A 0-10 VDC heating control signal shall be field provided to control the amount of heating.

F. Emergency electric heating capacity shall be sized to meet heating leaving air temperature setpoint when heat pump heating is not in operation. Auxiliary electric heating capacity shall be sized to meet heating leaving air temperature setpoint when heat pump heating is in operation. Unit shall include 1 stage of auxiliary electric heating capacity (RTU-BAND-1 AND RTU-BAND-2 ONLY).

G. Cooling Coil:
1. Evaporator Coils:
a. Coils shall be designed for use with R-454B refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
b. Coils shall be 6 row high capacity.
c. Coils shall be hydrogen or helium leak tested.
d. Coils shall be furnished with factory installed expansion valves.
2. Unit shall be factory charged with R-454B refrigerant.
3. Refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.
4. Unit shall be configured as an air-source heat pump (RTU-BAND-1 AND RTU-BAND-2 ONLY). Refrigeration circuit shall be equipped with a factory installed liquid line filter drier with check valve, reversing valve, accumulator, and expansion valves on both the indoor and outdoor coils. Reversing valve shall energize during the heat pump cooling mode of operation.
5. Refrigeration circuit shall be equipped with a liquid line sight glass.

6. Heat pump outdoor coil shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.

H. Refrigeration System:
1. Compressors: Provide scroll compressor with direct drive operating at 3600 rpm. Integral centrifugal oil pump. Provide suction gas cooled motor with winding temperature limits and compressor overloads. Capable of 10%-100% capacity control.
2. Units shall have cooling capabilities down to 0-degree F as standard. For field-installed low ambient accessory, the manufacturer shall provide a factory-authorized service technician that will assure proper installation and operation.
3. Provide each unit with refrigerant circuits factory-supplied completely piped with liquid line filter-drier, suction and liquid line pressure ports.
4. Refrigeration System Options:
   a. Dehumidification (hot-gas reheat) option.
   b. High-pressure refrigeration control.
   c. Crankcase Heater.

I. Gas Heating (RTU-LOCKER-1 AND RTU-LOCKER-2 ONLY):
1. Stainless steel heat exchanger furnace shall carry a 25 year non-prorated warranty, from the date of original equipment shipment from the factory.
2. Gas furnace shall consist of stainless steel heat exchangers with multiple concavities, an induced draft blower and an electronic pressure switch to lockout the gas valve until the combustion chamber is purged and combustion airflow is established.
3. Furnace shall include a gas ignition system consisting of an electronic igniter to a pilot system, which will be continuous when the heater is operating, but will shut off the pilot when heating is not required.
4. Unit shall include a single gas connection and have gas supply piping entrances in the unit base for through-the-curb gas piping and in the outside cabinet wall for across the roof gas piping.
5. High Turndown Modulating Natural Gas Furnace shall be equipped with modulating gas valves, adjustable speed combustion blowers, stainless steel tubular heat exchangers, and electronic controller. Combustion blowers and gas valves shall be capable of modulation. Electronic controller includes a factory wired, field installed supply air temperature sensor. Sensor shall be field installed in the supply air ductwork. Supply air temperature setpoint shall be adjustable on the electronic controller within the controls compartment. Gas heater shall be capable of capacity turndown ratio as shown on the unit rating sheet. Heat trace shall be include on the condensate drain

J. Outdoor Air Section:

1. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 inch. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return DDC actuator. Unit shall include outside air opening bird screen and outside air hood. Unit, except for horizontal series, shall also include barometric relief dampers.
2. Ebtron Gold Series OA Airflow Stations

K. Energy Recovery (RTU-BAND-2 ONLY):
1. Unit shall contain a factory mounted and tested energy recovery wheel. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings. Frame shall slide out for service and removal from the cabinet.
2. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.
3. Units shall contain two 64 inch. energy recovery wheels with a 2 inch. minimum media thickness oriented in a "V" formation in the factory assembled cabinet.
4. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the AHRI Certified Products.
5. Energy recovery wheel cassette shall carry a 5-year non-prorated warranty, from the date of original equipment shipment from the factory. The first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less, shall be covered under the standard AAON limited parts warranty. The remaining period of the warranty shall be covered by Airxchange. The 5-year warranty applies to all parts and components of the cassette, with the exception of the motor, which shall carry an 18-month warranty. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided the Airxchange written instructions for Installation, Operation, and Maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts. Refer to the Airxchange Energy Recovery Cassette Limited Warranty Certificate.
6. Unit shall include 2 inch thick, pleated panel outside air filters with an ASHRAE MERV rating of 8, upstream of the wheels.
7. Hinged service access doors shall allow access to the wheel.
8. Polymer Energy Recovery Wheels

9. Shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
10. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive.
11. Polymer Energy recovery wheel cassette shall carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory. The first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less, shall be covered under the standard AAON limited parts warranty. The remaining period of the warranty shall be covered by Airxchange. The 5-year warranty applies to all parts and components of the cassette, with the exception of the motor, which shall carry an 18 month warranty. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided the Airxchange written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts. Refer to the Airxchange Energy Recovery Cassette Limited Warranty Certificate.
12. Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.

L. Operating Controls:
1. Field installed DDC controls by others.

M. Accessories:
1. Unit shall be provided with a safety shutdown terminal block for field installation of a smoke detector which shuts off the unit's control circuit.
2. Unit shall include refrigerant leak detection safeties factory installed and an onboard sequence of unit operation for refrigerant dissipation.

N. Basis of Design Equipment: AAON.

O. Acceptable Makes: Carrier, Daikin Applied, Trane, York, AAON.

PART 3 - EXECUTION

3.1 PACKAGED ROOFTOP UNIT

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

B. Protect units from physical damage. Leave factory-shipping covers in place until installation.

C. Contractor shall verify that proper power supply is available.

D. Provide for roof openings and framing as called for. Set and secure curb to roof, and unit to curb. Shim roof curb level.

E. Pipe coil drains to spill to roof, provide "P" trap of proper depth.

F. Install unit in strict accordance with manufacturer's instructions.

G. Arrange to have equipment manufacturer's technician to verify installation for compliance with manufacturer's recommendations.

H. Arrange to have equipment manufacturer's technician perform start-up of equipment, instruct Owner's Representative in the proper operation of the equipment.

END OF SECTION 237413.10

SECTION 237423.16 - ROOFTOP INDIRECT-FIRED GAS MAKE-UP AIR UNIT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment, and services as required for the complete installation as shown on the Contract Documents.

1.2 SUBMITTALS

A. Submit product data for packaged make-up air unit and accessories. Include installation details, complete installation drawings, installation and start-up instructions, wiring diagrams, and instruction manuals from manufacturer of equipment.

1.3 QUALIFICATIONS

A. Complete unit and accessories shall comply with the New York State Energy Conservation Construction Code. Unit shall have UL, AGA and IRI labels.

1.4 MANUFACTURER'S WARRANTY

A. Ten (10) year extended warranty for furnace heat exchanger.

PART 2 - PRODUCTS

2.1 ROOFTOP MAKE-UP AIR UNIT

A. General:
   1. RTU with indirect fired heat and 18” direct drive plenum fan, electronic full modulation, constant 81% Efficiency, 6:1 turndown for NG, stainless steel burner and heat exchanger.
   2. Single point electrical connction for RTU.
   3. RTU blower door switch.
   4. 2" MERV 13 filters
   5. VFD factory mounted and wired in unit control vestibule.
   6. Freezestate
   7. Control panel enclosure heater.
   8. Factory assembled heated drain kit for RTU.

B. Design Equipment: Captiveaire.

PART 3 - EXECUTION

3.1 PACKAGED ROOFTOP UNIT

A. Provide roof openings and framing as called for. Set and secure unit to curb. Shim roof curb level. Pipe coil drains to spill to roof, provide "P" trap of proper depth. Install unit in strict accordance with manufacturer's instructions. Coordinate installation with work as part of "Control Systems" Section. Start-Up:
   1. Arrange to have equipment manufacturer's technician to verify installation for compliance with manufacturer's recommendations.
   2. Arrange to have equipment manufacturer's technician perform start-up of equipment, instruct Owner's Representative in the proper operation of the equipment.

END OF SECTION 237423.16

SECTION 238216.11 - COILS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 SUBMITTALS

A. Submit product data for coils

1.3 GENERAL REQUIREMENTS

A. Provide coils of proper size and rows to fit intended use and capacity as scheduled and specified. Location as shown on Plans. Designed for 125 psi. Same end or opposite end connections as required to fit installation shown on Plans. Vertical mounted coils shall have bottom drain headers. Duct mounted coils shall be equipped with flanges. Tag each coil at factory giving number and location. Coils completely drainable with auxiliary drain headers, if necessary. Minimum 1/2 inch. drain and vent connections. Aluminum fins shall be a minimum of .0075 inch. thick unless otherwise noted. Coils shall have brazed return "U" bends; bent tubes are not acceptable. Performance certified in accordance with ARI Standard 410.

PART 2 - PRODUCTS

2.1 HOT WATER HEATING COIL

A. Non-ferrous heating coils, 125 psi working pressure, designed to relieve expansion and contraction strains. Minimum 16-gauge galvanized casing, non-ferrous or cast iron headers, .025 inch. thick copper tubes with .025 in. thick "U" bends, aluminum fins, for coils. Coils tested at 300 psig then leak tested at 200 psig with air pressure under water. Hot water heating coils, serpentine type, number rows and arrangement as called for; same end connections with vent chamber on return end and completely drainable.

B. Design Equipment: Nortek.

C. Make: Aerofin, Carrier, Daikin Applied, Trane, Heatcraft, Marlo, Nortek.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in strict accordance with manufacturer's instructions and so as to be compatible with intent of the respective system performance requirements. Provide supporting ironwork and sheet metal safing to assure proper installation without any bypass air around coil.

B. Provide a stainless steel drip pan under each cooling coil section extended a minimum of 12 inch. beyond downstream side of coil. Provide with 1-1/4 inch. tapped drain connection pipe to nearest floor drain.

C. Provide ample space during installation to allow for the removal of the coil. Provide all necessary unions, isolation valves, flexible connectors and accessories to allow for the removal and service of the coil.

D. Provide an access door upstream of all coils for inspection. Access door shall be minimum 16 x 12.

END OF SECTION 238216.11

SECTION 238235 - GRAVITY HEATING EQUIPMENT (HYDRONIC)

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation designed in Contract Documents.

1.2 SUBMITTALS

A. Submit product data on gravity heating equipment with color selection chart. Clearly indicate which equipment is being submitted.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. All equipment shall be free from expansion, noises and strains. Exposed parts to be cleaned and parkerized or phosphate coated before prime coating or baked enameling. Finish colors as selected from manufacturer's standard colors during the submittal process. Factory-boxed and tagged by room numbers. Access doors shall be provided in cabinet at locations of valves, flow balancers and air vents. Verify at site, the space available for each piece of equipment. Top of heating unit enclosures shall be at least 1 inch. below top of windowsill. Bottom of heating unit enclosures, unless otherwise called for, approximately 6 inch. above floor and above the base molding. Refer to Owner's Representative at once, any correction, discrepancy or suggested change in size or location. This Contractor responsible for proper location and size of recesses. Coordinate dimensions from floor to bottom of recess with other trades. Provide framing in recess and shims, if required.

B. Ratings of elements shall be in accordance with approved I=B=R test methods.

C. Access doors shall be provided for adjustment of self-contained control valves, where applicable.

2.2 CONVECTORS

A. Heating Elements:
   1. Seamless copper tubes, nonferrous fins, with cast iron headers.
   2. Tubes mechanically expanded to fin collars for permanent metal-to-metal contact.
   3. Properly supported with pitch adjustment water up.

4. Top and bottom header connections at both ends; plug unused openings.

B. Cabinets and Enclosures:
1. Cold rolled furniture steel, constructed of minimum 20 gauge stock.
a. Exposed corners and edges rounded.
2. Shower and Drying Room enclosures, all parts nonferrous and noncorrosive. Bolts and fasteners nonferrous.
3. Return grilles for all units except those which are wall hung.
4. Provide cam-type catches on access doors. Access doors are not required on convectors with hinged-type mounting of cabinet front panel.

C. Recessed or semi-recessed units:
1. 14 gauge front and sides, 20 gauge back.
2. Fronts over 48 inch. in length, to have reinforcing members welded to back of front plate.

D. Wall hung type:
1. Sloping Top.
2. 14 gauge, one-piece front; 20 gauge back, 16 gauge sides.
3. Enclosures over 36 inch. in length to have reinforcing members welded to back of cover. Submit details for approval.
4. Enclosure front shall be mechanically fastened to enclosure sides or back. Friction fit fastening is not acceptable.

E. Dampers:
1. Provide in locations where automatic control is not installed.
2. Worm gear type nonferrous construction with two dissimilar metals and 1-1/2 inch. diameter knurled aluminum knob.

F. Design Equipment: Sterling.

G. Acceptable Make: Daikin, Airtherm, Rosemex, Sterling, Vulcan.

2.3 FIN RADIATION

A. General Requirements:
1. Complete enclosure, continuous supporting channel backplate, heating element, hangers and accessories, as specified and shown on the Contract Drawings.
2. Enclosures to run from wall-to-wall unless otherwise called. Provide necessary corner pieces, end caps, column enclosures, butt trims, wall sleeves, with access doors. Do not leave any enclosure installed without an end trim piece.

B. Heating Element:
1. Hot Water System: Seamless copper tube with non ferrous fins, 125 lbs. minimum hydrostatic test pressure. 020 inch. tube wall thickness, minimum. 020 in. fin thickness, minimum.

2. Tube mechanically expanded to fin collars for permanent metal to metal contact.
3. Properly support with pitch adjustment. Silent element and pipe support. Locate a maximum of 2 feet 0 inch. apart. Support shall allow for lateral movement for expansion and contraction of heating equipment.

C. Enclosures:
1. Enclosure fronts, 18 gauge furniture steel.
a. Sloping top with stamped grille as scheduled on drawings.
b. Edges and corners rounded. Individual sections not over 6 feet No exposed areas shall have sharp edges.
c. Mechanically fastened to wall bracket.
d. Continuous interlocking slip joint fit between adjoining covers. Finish shall match enclosure fronts along entire male and female sides.
e. Enclosure accessories shall fit tight to wall at sides, in back plate at top and extend back and mechanically screw to wall at bottom.
2. Support channel partial backplate with top wall gasket and supports:
a. 20 gauge securely fasten to wall.
b. Enclosure front braced by internal channel braces. Minimum on either side of joint seam.
c. No sheet metal screws or other fastening devices shall be visible.
d. Provide wall brackets or stiffening supports adjacent to each joint and at least every 16 inch., maximum 24 inch. O.C.
3. Top of cover rest on backplate only and not between wall and backplate.
4. Accessories:
a. Pedestal brackets or bottom panel when required for style.
b. With worm gear driven damper control and knurled aluminum knob, where automatic control is not specified.

D. Design Equipment: Sterling.

E. Make: Rosemex, Sterling, Rittling, Vulcan.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Each unit isolated with shut-off ball valves to permit servicing. Provide flow balancer for each unit as detailed. Provide trap for each unit as detailed. Contractor responsible for correct end connections and arrangements. Arrange piping accessories and valving fully accessible for servicing. Enclosures fastened to structure with screws or bolts, no nailing allowed. Fasten at 6 inch. O.C. Provide air collecting chamber and manual vent on return end of each heating unit on all upfeed hot water installation.

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SECTION 238239 - UNIT HEATERS AND CABINET UNIT HEATERS (HYDRONIC AND ELECTRIC)

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation and related work as shown on the Contract Documents.

1.2 SUBMITTALS

A. Submit product data for unit heaters and cabinet unit heaters.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Free from expansion and contraction noises and strains. Fan speed shown on Schedule shall not be exceeded. Each piece of equipment shall be factory-boxed and tagged by room number. Cabinet unit heaters and unit heaters shall have baked enamel finish with color selected by the Architect from manufacturer's standard colors. Rating in accordance with standard test codes adopted jointly by IUGA and ASHRAE.

2.2 UNIT HEATERS

A. General:
   1. Wall hung or ceiling suspended.
   2. Access for servicing the heating element, motors, and controls.
   3. Horizontal discharge units with adjustable horizontal and/or vertical outlet vanes.
   4. Vertical units with adjustable outlet louvers or diffusers.

B. Fan and Motor:
   1. Statically and dynamically balanced.
   2. Motor shall be totally enclosed and designed for continuous operation. Lubrication shall be sealed-in, permanent type.

C. Heating Element (Hydronic):
   1. Serpentine coil, copper tube, aluminum fins, back or side connections to fit headroom requirements.

D. Hydronic:
   1. Design Equipment: Sterling.

2. Acceptable Makes: Daikin Applied, Airtherm, Dunham-Bush, Sterling, Trane, Vulcan.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Provide equipment in accordance with manufacturer's printed instructions. Report untrue walls before installation. Report cases where clearance below suspended heaters is less than 7-1/2 feet Provide clearance for piping or conduit. Support units independent of piping or conduit. Support units from building structure, with screws or bolts; no nailing allowed.

3.2 INSTALLATION - HYDRONIC

A. Provide valves and accessories and arrange to permit servicing. Coordinate correct end connections and coil arrangements.

B. Vertical cabinet heaters that are mounted on an existing wall shall be provided with continuous wood blocking that is painted to match the wall to infill any gaps created by the baseboard.

END OF SECTION 238239

SECTION 260500 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

B. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.2 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. All materials and equipment shall be installed in accordance with the manufacturer's recommendations.

1.3 LICENSING

A. The Contractor shall hold a license to perform the work as issued by the authority having jurisdiction.

B. Plumbing contract work shall be performed by, or under, the direct supervision of a licensed master plumber.

C. Electrical contract work shall be performed by, or under, the direct supervision of a licensed electrician.

1.4 PERMITS

A. Apply for and obtain all required permits and inspections, pay all fees and charges including all service charges. Provide certificate of approval from the Authorities Having Jurisdiction prior to request for final payment.

B. Provide electrical inspection certificate of approval from Middle Department Inspection Agency, Commonwealth Inspection Agency, or an Engineer approved Inspection Agency prior to request for final payment.

1.5 CODE COMPLIANCE

A. Provide work in compliance with the following Codes and Standards based on the current edition in effect at project location:
   1. Building, Code of New York State.
   2. Existing Building Code of New York State.
   3. Fire Code of New York State.
   4. Plumbing Code of New York State.
   5. Mechanical Code of New York State.
   6. Fuel Gas Code of New York State.
   7. Property Maintenance Code of New York State.
   8. Energy Conservation Code of New York State
   9. Accessible and Usable Buildings and Facilities, ICC A117.1.
   10. New York State Department of Labor Rules and Regulations.
   11. New York State Department of Health.
   12. National Electrical Code (NEC).
   13. Occupational Safety and Health Administration (OSHA).
   14. Local Codes and Ordinances.
   15. Life Safety Code, NFPA 101.
   16. Local Plumbing Department.
   17. New York State Education Department Manual of Planning Standards.

1.6 GLOSSARY

ACI	American Concrete Institute
AGA	American Gas Association
AGCA	Associated General Contractors of America, Inc.
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AFBMA	Anti-Friction Bearing Manufacturer's Association
AMCA	Air Moving and Conditioning Association, Inc.
ANSI	American National Standards Institute
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing Materials
AWSC	American Welding Society Code
AWWA	American Water Works Association
FM	Factory Mutual Insurance Company
IBR	Institute of Boiler & Radiation Manufacturers

IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Insurers
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NYS/DEC	New York State Department of Environmental Conservation
SBI	Steel Boiler Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
UFPO	Underground Facilities Protective Organization
UL	Underwriter's Laboratories, Inc.
OSHA	Occupational Safety and Health Administration
XL - GAP	XL Global Asset Protection Services

1.7 DEFINITIONS

Acceptance	Owner acceptance of the project from Contractor upon certification by Owner's Representative.
As Specified	Materials, equipment including the execution specified/shown in the contract documents.
Basis of Design	Equipment, materials, installation, etc. on which the design is based. (Refer to the article, Equipment Arrangements, and the article, Substitutions.)
Code Requirements	Minimum requirements.
Concealed	Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
Coordination Drawings	Show the relationship and integration of different construction elements and trades that require careful coordination during fabrication or installation, to fit in the space provided or to function as intended.
Delegated-Design Services	Performance and Design criteria for Contractor provided professional services. Where professional design services or certifications by a design professional are specifically required of a Contractor, by the Contract Documents. Provide products and systems with the specific design criteria indicated. If criteria indicated is insufficient to perform services or

	certification required, submit a written request for additional information to the Engineer. Submit wet signed and sealed certification by the licensed design professional for each product and system specifically assigned to the Contractor to be designed or certified by a design professional. Examples: structural maintenance ladders, stairs and platforms, pipe anchors, seismic compliant system, wind, structural supports for material equipment, sprinkler hydraulic calculations.
Equal, Equivalent, Equal To, Equivalent To, As Directed and As Required	Shall all be interpreted and should be taken to mean "to the satisfaction of the Engineer".
Exposed	Work not identified as concealed.
Extract	Carefully dismantle and store where directed by Owner's Representative and/or reinstall as indicated on drawings or as described in specifications.
Furnish	Purchase and deliver to job site, location as directed by the Owner's Representative.
Inspection	Visual observations by Owner's site Representative.
Install	Store at job site if required, proper placement within building construction including miscellaneous items needed to affect placement as required and protect during construction. Take responsibility to mount, connect, start-up and make fully functional.
Labeled	Refers to classification by a standards agency.
Manufacturers	Refer to the article, Equipment Arrangements, and the article, Substitutions.
Prime Professional	Architect or Engineer having a contract directly with the Owner for professional services.
Product Data	Illustrations, standard schedules, performance charts, instructions, brochures, wiring diagrams, finishes, or other information furnished by the Contractor to illustrate materials or equipment for some portion of the work.

Provide (Furnish and Install)	Contractor shall furnish all labor, materials, equipment and supplies necessary to install and place in operating condition, unless otherwise specifically stated.
Relocate	Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
Remove	Dismantle and take away from premises without added cost to Owner, and dispose of in a legal manner.
Review and Reviewed	Should be taken to mean to be followed by "for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents".
Roughing	Pipe, duct, conduit, equipment layout and installation.
Samples	Physical full scale examples which illustrate materials, finishes, coatings, equipment or workmanship, and establishes standards by which work will be judged.
Satisfactory	As specified in contract documents.
Shop Drawings	Fabrication drawings, diagrams, schedules and other instruments, specifically prepared for the work by the Contractor or a Sub-contractor, manufacturer, supplier or distributor to illustrate some portion of the work.
Site Representative	Owner's Inspector or "Clerk of Works" at the work site.
Submittals Defined (Technical)	Any item required to be delivered to the Engineer for review as requirement of the Contract Documents. The purpose of technical submittals is to demonstrate for those portions of the work for which a submittal is required, the manner in which the Contractor proposes to conform to the information given and design concepts expressed and required by the Contract Documents.

1.8 EXISTING CONDITIONS

A. Contractor shall review all available record documents of existing construction or other existing conditions and hazardous material information. Owner does not guarantee that existing conditions are the same as those indicated in these documents. Contractor shall record existing conditions via measured drawings and preconstruction photographs or video. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage, removal or construction operations.

B. Owner will occupy portions of the building immediately adjacent to the area(s) of removals. Conduct removals so Owner's operations are not disrupted. Contractor shall locate, identify, disconnect and seal or cap mechanical, plumbing, fire protection and/or electrical systems serving areas of removals, unless noted otherwise in the contract documents. Contractor shall arrange shut-down of systems with the Owner/Construction Manager. Piping and ductwork indicated to be removed shall be removed and capped or plugged with compatible materials. If services/systems are required to be removed, relocated or abandoned, provide temporary services/systems the bypass area(s) of removals to maintain continuity of services/systems to other parts of the building, as required.

1.9 SHOP DRAWINGS/PRODUCT DATA/SAMPLES

A. Provide submittals on all items of equipment and materials to be furnished and installed. Submittals shall be accompanied by a transmittal letter, stating name of project and contractor, name of vendor supplying equipment, number of drawings, titles, specification sections (name and number) and other pertinent data called for in individual sections. Submittals shall have individual cover sheets that 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 under one cover sheet per specification section (e.g. lighting fixtures, valves, plumbing fixtures, etc.). Submittals shall include all required documentation for each product listed in the specification section at the same time as a complete package. Number each submittal by trade. Indicate deviations from contract requirements on Letter of Transmittal. Submittals will be given a general review only. Corrections or comments made on the Submittals 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. If submitting hard copies, submit four (4) copies for review.

B. The Engineer will review up to two (2) submissions of any single submittal. The Contractor will be invoiced on an hourly rate basis for the time spent reviewing the same shop drawing in excess of twice.

C. If submittals are to be submitted electronically, all requirements in Item A apply. Submittals shall be emailed in PDF format to specific email address provided by the Construction Manager, General Contractor, Architect or Project Manager. Name of project shall be in subject line of email. Send emails to mealbasubmittalclerk@meengineering.com

D. Refer to Division 01 for additional requirements.

1.10 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.

1.11 EQUIPMENT ARRANGEMENTS

A. The contract documents are prepared using one manufacturer as the Basis of Design, even though other manufacturers' names are listed. If Contractor elects to use one of the listed manufacturers other than Basis of Design or if the physical size, performance or electrical characteristics for the Basis of Design equipment differs from what is indicated in the contract documents, submit detailed drawings, indicating proposed installation of equipment. Show maintenance clearances, service removal space required, and other pertinent revisions to the design 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 doorframes, access doors, walls, ceilings, or floors required to install. If revised arrangement submittal is rejected, revise and resubmit specified Basis of Design item which conforms to Contract Documents.

1.12 SUBSTITUTIONS

A. If Contractor desires to bid on any other kind, type, brand, or manufacture of material or equipment than those named in specifications, secure prior approval. To request such approval, Contractor shall submit complete information comparing (item-for-item) material or equipment offered with design material or equipment. Include sufficient information to permit quick and thorough comparison, and include performance curves on same basis, capacities, power requirements, controls, materials, metal gauges, finishes, dimensions, weights, etc., of major parts. If accepted, an addendum will be issued to this effect ahead of bid date. Unless such addendum is issued, substitution offered may not be used.

1.13 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 electrical connections and relocations as required to accomplish the above. Obtain approval in writing as to date, time, and location for shutdown of existing mechanical/electrical facilities or services.

1.14 ROUGHING

A. The Contract Drawings have been prepared in order to convey design intent and are diagrammatic only. Drawings shall not be interpreted to be fully coordinated for construction.

B. 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 avoid 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.

C. 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. Provide new materials, including new piping and insulation for relocated work.

D. Coordinate work with other trades and determine exact route or location of each duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Obtain from Owner's Representative exact location of all equipment in finished areas, such as thermostat, fixture, and switch mounting heights, and equipment mounting heights. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers, and other items. Do not rough-in contract work without reflected ceiling location plans.

E. Before roughing for equipment furnished by Owner or in other Divisions, obtain from Owner and other Divisions, 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.

1.15 COORDINATION DRAWINGS

A. Before construction work commences, Divisions for all trades shall submit coordination drawings in the form of CAD drawing files, drawn at not less than 1/4 inch. scale. Such drawings will be required throughout all areas, for all Contracts. 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. Division 23 shall prepare the base plan CAD coordination drawings showing all ductwork, all pertinent heating piping, and equipment. These drawings may be CAD files of the required Ductwork Shop Drawings. The drawings shall be coordinated with lighting fixtures, sprinklers, 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 redrawn.
   2. Division 23 shall provide CAD files and submit the base plan CAD Coordination Drawings to all Divisions.
   3. Divisions 21 and 22 shall draw the location of piping and equipment on the base plan CAD Coordination Drawings, indicating areas of conflict and suggested resolutions.
   4. Divisions 26, 27 and 28 shall draw the location of lighting fixtures, cable trays, and feeders over 1-1/2 inch. on the base plan CAD Coordination Drawings, indicating areas of conflict and suggested resolution.
   5. The General Construction Trade shall indicate areas of architectural/structural conflicts or obstacles on the CAD Coordination Drawings, and coordinate to suit the overall construction schedule.

6. The Construction Manager shall expedite all Coordination Drawing work and coordinate to suit the overall construction schedule. In the case of unresolved interferences, he shall notify the Owner's Representative. The Owner's Representative will then direct the various trades as to how to revise their drawings as required to eliminate installation interferences.
7. If a given trade proceeds prior 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 Divisions.

B. The purpose of the coordination drawing process is to identify and resolve potential conflicts between trades, and between trades and existing or new building construction, before they occur in construction. Coordination drawings are intended for the respective trade's use during construction and shall not replace any Shop Drawings, or record drawings required elsewhere in these contract documents.

1.16 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, lead paint, mercury and PCB's shall be in accordance with Federal, State and Local law requirements. Where equipment is called for to be relocated, contractor shall carefully remove, clean and recondition, then reinstall. Remove all abandoned piping, wiring, equipment, lighting, ductwork, tubing, 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.

B. For materials indicated to contain lead, that are being affected by demolition or construction, the contractor shall comply with all Federal, State and Local law requirements regarding worker exposure to lead disturbance and abatement procedures.

C. Refer to the Owner's Lead Paint Survey. The Survey identifies the surfaces within the buildings that were tested for lead by collecting paint samples and performing laboratory analysis. If any unidentified surfaces are to be impacted the lead content shall be tested by analytical determinations conducted by a qualified laboratory approved by the Owner. The contractor shall review the current owner's lead paint reports on file before starting any work which may disturb existing surfaces.

D. Refer to Division 02 for additional information regarding hazardous materials.

1.17 REFRIGERANT RECOVERY

A. Existing equipment to be removed, as shown on the plans may contain refrigerant and refrigerant oils. This refrigerant and refrigerant oil must be handled in accordance with Federal, State and Local law requirements.

B. Removal and recovery of refrigerant shall be in accordance with the current edition of Section 608 of the Clean Air Act of 1990, including all final regulations.

C. Refrigerant recovery must be performed by a technician, certified by an EPA-approved certification program, using refrigerant recovery and recycling equipment certified by an EPA-approved testing organization.

D. Owner "reserves the right of first refusal" on ownership of recovered refrigerant. Should Owner choose to maintain ownership of refrigerant, refrigerant shall be reclaimed, cleaned by this Contractor to ARI 700-1993 Standard of Purity, by an EPA certified refrigerant reclaimer. Refrigerant shall be turned over to the Owner in suitable marked containers to be stored on site, at a place of the Owner's choosing.

1.18 EQUIPMENT AND MATERIAL REQUIREMENTS

A. 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. 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. All electrical equipment and systems, as a whole, shall be tested and listed by an OSHA approved Nationally Recognized Testing Laboratory (NRTL) for the intended use in accordance with the applicable standards and have a physical label indicating such.
   6. Fire protection equipment shall be UL listed and FM approved.

B. Exterior and wet locations shall utilize materials, equipment supports, mounting, etc. suitable for the intended locations. Metals shall be stainless steel, galvanized or with baked enamel finish as a minimum. Finishes and coatings shall be continuous and any surface damaged or cut ends shall be field corrected in accordance with the manufacturer's recommendations. Hardware (screws, bolts, nuts, washers, supports, fasteners, etc.) shall be:
   1. Stainless steel where the associated system or equipment material is stainless steel or aluminum.
   2. Hot dipped galvanized or stainless steel where the associated system or equipment is steel, galvanized steel or other.

1.19 CUTTING AND PATCHING

A. Each trade shall include their required cutting and patching work unless shown as part of the General Construction Contract. 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 cut or abandoned holes left by removals of equipment or fixtures. 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.

1.20 PAINTING

A. Paint all insulated and bare piping, pipe hangers and supports exposed to view in mechanical equipment rooms, penthouse, boiler rooms and similar spaces. Paint all bare piping, ductwork and supports exposed to the out-of-doors with rust inhibiting coatings. Paint all equipment that is not factory finish painted (i.e. expansion tanks, etc.).

B. All painting shall consist of one (1) prime coat and two (2) finish coats of non-lead oil base paint, unless otherwise indicated herein. Provide galvanized iron primer for all galvanized surfaces. All surfaces must be thoroughly cleaned before painting. Review system color coding prior to painting with the Owner's Representative or Architect.

C. All items installed after finished painting is completed and any damaged factory finish paint on equipment furnished under this contract must be touched up by the Contractor responsible for same.

D. 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 Specifications.

E. All primers and paint used in the interior of the building shall comply with the maximum Volatile Organic Compound (VOC) limits called for in the current version of U.S. Green Building Council LEED Credits EQ 4.1 and EQ 4.2.

F. Refer to Division 9 - Finishes, for additional information.

1.21 EXISTING CEILING REMOVAL AND RE-INSTALLATION

A. In a renovation project, any existing ceiling removal and re-installation work required for the completion of a Contractors or Subcontractors work, shall be removed and re-installed by that Contractor or Subcontractor. This applies in any areas not called for to have a new ceiling installed.

B. The ceiling removal and re-installation shall include lay-in ceiling tile and grid, to the extent necessary to accomplish the work. Removed ceiling tile and grid shall be safely stored during the course of the work, and it shall be re-installed to the original existing condition.

C. The ceiling removal and re-installation shall include gypsum board or plaster ceilings and the associated suspension systems. Removed ceiling areas shall be patched with materials to match the existing ceiling, and painted to match. If paint cannot be matched exactly, paint the entire ceiling a similar color.

1.22 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 their review.
In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

1.23 CHASES

A. New Construction:
1. Certain chases, recesses, openings, shafts, and wall pockets will be provided as part of General Construction Trade. Mechanical and Electrical trades 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 Construction trade.

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 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 inch. 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.

1.24 PENETRATION FIRESTOPPING

A. Refer to Division 07 for project-wide fire stopping information.

1.25 NON-RATED WALL PENETRATIONS

A. Each trade shall be responsible for sealing wall penetrations related to their installed work, including but not limited to ductwork, piping, conduits, etc. See individual specification sections for requirements.

1.26 SUPPORTS

A. Provide required supports, beams, angles, hangers, rods, bases, braces, and other items to properly support contract work. 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.

B. For precast panels/planks and metal decks, support mechanical/electrical work as determined by manufacturer and the Engineer. Provide heavy gauge steel mounting plates for mounting contract work. Mounting plates shall span two or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

C. For finished areas without a finished ceiling system such as classrooms, offices, conference rooms, etc., where decking and structure is exposed, and ductwork/piping/conduit is exposed: All mounting brackets, channel support systems and mounting hardware for ductwork, piping, lighting, etc. shall be concealed and approved by the Architect/Engineer prior to the installation. AirCraft cable style hanging for ductwork is required. It is recommended that room mockups be done and receive Architect/Engineer approval prior to proceeding with installation.

D. Equipment, piping, conduit, raceway, etc. supports shall be installed to minimize the generation and transmission of vibration.

E. Materials and equipment shall be solely supported by the building structure and connected framing. Gypboard, ceilings, other finishes, etc. shall not be used for support of materials and equipment.

1.27 APPLIED FIREPROOFING

A. Scope: Provide encapsulation of surfaces where applied fireproofing materials have been disturbed, removed, or left missing by the removal of hangers or upper attachments, or when new hangers or upper attachment are installed.

B. Fire Resistance Rating: Fireproofing shall meet the original hourly rating when applied to the construction assembly where materials have been removed or disturbed, or is missing.

C. Fire Hazard Classification: Fireproofing shall be listed in the Underwriters Laboratories Building Materials Directory with the following performance properties:
1. Flame Spread: 10 or less.
2. Smoke Developed: 5 or less.

D. Product Data: Provide manufacturer's product descriptions for each required fireproofing material. Include application instructions, including primer/adhesive requirements and recommended minimum thickness and density for each required hourly rating.

E. Fire Proofing Manufacturer:
1. Retro-Guard cementitious replacement fireproofing by Grace Construction Products, or equivalent Cafco Blaze Shield, and Cafco 300 by Isolatek.
2. Physical Properties:
a. Dry Field Density (ASTM E 605): 15 lb/cu ft minimum average.
b. Cohesion/Adhesion (Bond Strength) (ASTM E 736): 200 lb/sq ft minimum average.
c. Compressive Strength (ASTM E 761): 500 lb/sq ft minimum.
d. Impact (Bond Impact) Resistance (ASTM E 760): Shall not crack or delaminate.
e. Effect of Deflection (ASTM E 759): Shall not crack or delaminate.

f. Corrosion Resistance (ASTM E 937): No evidence of corrosion.
g. Air Erosion (ASTM E 859): Maximum 0.025 g/sq ft weight loss.
h. Provide primer or adhesive recommended by the fireproofing manufacturer to obtain required bond strength for the specific fireproofing and substrate.

F. Apply fireproofing prior to installation of ductwork, piping, conduits, and other suspended items. Hangers, clips and other supports for these items shall be installed before application of fireproofing.

G. Examine the substrate and conditions under which fireproofing is to be applied. Do not proceed with the fireproofing work until unsatisfactory conditions have been corrected. Verify that hangers, clips, sleeves, and other items that will penetrate the fireproofing are in place. Check paint on substrate for compatibility with primer/fireproofing and adequacy of bond strength in accordance with fireproofing manufacturer's instructions.

H. Surface Preparation: Remove dirt, dust, oil, grease, loose paint and rust, mill scale, and other foreign matter that may impair the bonding of the fireproofing to the substrate. Clean substrate free of contamination from chemicals and solvents. Apply primer/adhesive where necessary to obtain bond strength of fireproofing to steel shop paint and where recommended by the fireproofing manufacturer.

I. Apply the fireproofing in accordance with UL fire test report and the manufacturer's application instructions. Thickness and density of fireproofing shall be in accordance with the approved product data and as required to produce the hourly fire resistance rating required.

1.28 ACCESS PANELS

A. Provide access panels for required access to respective trade's work. Location and size shall be the responsibility of each trade. Access panels provided for equipment shall provide an opening not smaller than 22 inch. by 22 in. Panels shall be capable of opening a minimum of 90 degrees. 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 cam locks. 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 Construction trade with a set of architectural plans with size and locations of access panels.

1.29 CONCRETE BASES

A. Provide concrete bases for all floor mounted equipment. Provide 3,000 lb. concrete, chamfer edges, trowel finish, and securely bond to floor by roughening slab and coating with cement grout. Bases 4 inch. high (unless otherwise indicated); shape and size to accommodate equipment. Provide anchor bolts in equipment bases for all equipment provided for the project, whether mounted on new concrete bases or existing concrete bases.

1.30 HVAC 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 final hot water, drain, vent, and gas connections to all equipment as required by the equipment. Provide final connections, including domestic water piping, wiring, controls, and devices from equipment to outlets left by other trades. Provide equipment waste, drip, overflow and drain 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.

1.31 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, gas connections to all equipment. Provide loose key stops, sanitary "P" traps, tailpiece, adapters, gas or air cocks, and all necessary piping and fittings from roughing point to equipment. Provide installation of sinks, faucets, traps, tailpiece furnished by others. Provide cold water line with gate valve and backflow prevention device at locations called for. Provide continuation of piping and connection to equipment that is furnished by others. Provide relief valve discharge piping from equipment relief valves.

C. Provide 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 and 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, as required.

1.32 ELECTRICAL EQUIPMENT CONNECTIONS

A. Provide complete power connections to all electrical equipment. Provide control connections to equipment. Heavy duty NEC rated disconnect ahead of each piece of equipment. Ground all equipment in accordance with NEC.

B. Provide for Owner furnished and Contractor furnished equipment all power wiring, electric equipment, control wiring, switches, lights, receptacles, and connections as required.

1.33 STORAGE AND PROTECTION OF MATERIALS AND EQUIPMENT

A. Store Materials on dry base, at least 6 inch. 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.

B. Refer to Division 01 for additional information.

1.34 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 change in contract, any such damage to equipment, systems, and building. Perform first seasons winterizing in presence of Owner's operating staff.

1.35 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. Divisions 22 and 26 shall add contract items to the chart provided by Division 23 or provide separate charts.

1.36 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.

1.37 OPERATION AND MAINTENANCE MANUALS

A. Submit by email (preferred) or digital media, thru the normal project submittal process. Include a copy of each final approved Shop Drawing, wiring diagrams, piping diagrams, spare parts lists, final testing and balancing report, 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 installing contractor and of supplier manufacturer Representative and service agency for all major equipment items. Provide a table of contents page and dividers based upon specification section numbers. Submit in a compiled and bookmarked PDF format as outlined below. Each item listed in the table of contents shall include a hyperlink to the associated section of the O&M Manual, in addition to the bookmarking.

B. Provide content for Operation and Maintenance Manuals as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
   1. Engineer will comment on whether content of operation and maintenance submittals is acceptable.
   2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

C. Submit Operation and Maintenance Manuals in the following format:
   1. Submit by uploading to web-based project software site, or by email to Architect, as a formal project submittal in conformance with the project specific submittal procedures. Enable reviewer comments on draft submittals.
   2. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.

3. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in the table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

D. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing Owner training. Engineer will comment on whether general scope and content of manual are acceptable.

E. Final Manual Submittal: Submit O&M manual in final form prior to requesting inspection for Substantial Completion and at least 2 weeks before commencing Owner training. Engineer will return copy with review comments.
1. Correct or revise O&M manual to comply with Engineer's comments. Submit copies of each corrected manual within 2 weeks of receipt of Engineer's comments.

F. Refer to Division 01 for additional requirements.

1.38 RECORD DRAWINGS

A. The Contractor shall obtain at his expense one (1) set of construction Contract Drawings, (including non-reproduction black and white prints or electronic files) for the purpose of recording as-built 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 contract documents in red 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, the complete set of red marked contract documents, plus all approved field sketches and diagrams shall be submitted to the engineer and used in preparation of the record drawings.

D. A complete set of red marked contract drawings shall be submitted, at one time, as the "Record" set. If there are no changes to a specific drawing, the contractor shall indicate "NO CHANGES" on that drawing. ALL drawings shall be included in the "Record" set.

E. The complete set of red marked Contract Documents or electronic files shall be certified by the Contractor as reflecting record conditions and submitted to the engineer for review.

F. The Contractor shall have the marked up set scanned, if they are not already electronic files, and then submit them to the Engineer as the "Record Set".

G. Refer to Division 01 for additional requirements.

1.39 FINAL INSPECTION

A. Upon completion of all Engineering Site Observation list items, the Contractor shall provide a copy of the Engineering Site Observation Report back to the Engineer with each items noted as completed or the current status of the item.

1.40 COMMISSIONING

A. Refer to General Commissioning Requirements in Division 01 for additional requirements.

1.41 TEMPORARY HEATING AND COOLING

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

B. Systems and equipment installed as part of this project shall not be used for temporary heating or cooling.

1.42 MAINTENANCE OF HVAC SYSTEMS DURING TEMPORARY USE PERIODS

A. Provide each air handling system with a set of prefilters in addition to the permanent filters. Furnish four 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 MERV-8 filters in all open ended ducts, return grilles and registers to keep dust out of ductwork. Change as often as necessary. Remove all such temporary filters upon completion. Use supply fans 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 and install new set. 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.

1.43 TEMPORARY FACILITIES

A. Refer to the Division 01 Sections, General Conditions and Supplemental General Conditions.

1.44 TEMPORARY LIGHT AND POWER

A. Refer to the Division 01 Sections, General Conditions and Supplemental General Conditions.

1.45 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:
   1. Thoroughly clean entire installation, both exposed surfaces and interiors.
   2. Remove all debris caused by work.
   3. Remove tools, surplus, materials, when work is finally accepted.

1.46 SYSTEM START-UP AND TESTING

A. All new heating and ventilating systems 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% outside air during the bake-off for an additional eight hours to purge the building. This work shall be completed prior to fall school occupancy or 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 one week prior to and one week after the commencement of school except upon written approval by the Owner.

C. Prior to commencement of work, the Division(s) effecting such system shall survey all building mechanical, plumbing, fire protection and electrical systems and components and make written notice to the Owner's Representative regarding any damage, missing items and/or incomplete systems. Prior to the conclusion of this project, the Contractor shall verify with the Owner's Representative that all building systems have been returned to their original conditions.

D. Start-up and testing of HVAC systems shall occur while the building is not occupied by students and only after notice to the Owner's Representative is made at least 24 hours in advance. Division 23 shall be responsible for providing temporary filter media over all supply air registers and diffusers during the HVAC system start-up procedure. Division 23 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 Owner's Representative.

1.47 TRANSFER OF ELECTRONIC FILES

A. Salas O'Brien Consulting and Engineering Group of New York, Inc. (FKA M/E Engineering) will provide electronic files for the Contractor's use in the preparation of sheet metal shop drawings, coordination drawings, or record drawings related to the project, subject to the following terms and conditions:
   1. The Contractor shall submit a formal request for electronic drawing files on the M/E Engineering, P.C. website, by utilizing the following website link: http://www.meengineering.com/contact-pages/contractor-request
   2. M/E Engineering, P.C. makes no representation as to the compatibility of these files with the Contractor's hardware or the Contractor's software beyond the specific release of the referenced specifications.
   3. M/E Engineering can only provide CAD files of M/E/P/FP drawing levels for which we are the Engineer of Record. CAD files of Architectural backgrounds, reflected ceiling plans, structural plans, etc. must be obtained separately from the Architect of Record.
   4. Data contained on these electronic files is part of M/E Engineering, P.C.'s instruments of service shall not be used by the Contractor or anyone else receiving data through or from the Contractor for any purpose other than as convenience in the preparation of shop drawings for the referenced project. Any other use or reuse by the Contractor or by others will be at the Contractor's sole risk and without liability or legal exposure to M/E Engineering, P.C. The Contractor agrees to make no claim and hereby waive, to the fullest extent permitted by law, any claim or cause of action of any nature against M/E Engineering, P.C., its officers, directors, employees, agents or sub-consultants which may arise out of or in connection with the Contractor's use of the electronic files.

5. Furthermore, the Contractor shall, to the fullest extent permitted by law, indemnify and hold harmless, M/E Engineering, P.C. from all claims, damages, losses and expenses, including attorney's fees arising out of or resulting from the Contractor's use of these electronic files.
6. These electronic files are not contract documents. Significant difference may arise between these electronic files and corresponding hard copy contract documents due to addenda, change orders or other revisions. M/E Engineering, P.C. makes no representation regarding the accuracy or completeness of the electronic files the Contractor receives. In the event that a conflict arises between the signed contract documents prepared by M/E Engineering, P.C. and electronic files, the signed contract documents shall govern. The Contractor is responsible for determining if any conflicts exist. By the Contractor's use of these electronic files the Contractor is not relieved of the Contractor's duty to comply with the contract documents, including and without limitation, the need to check, confirm and coordinate all dimensions and details, take field measurements, field verify conditions and coordinate the Contractor's work with that of other contractors for the project.

1.48 VIDEO RECORDING OF TRAINING SESSIONS

A. The contractor shall video record all training sessions required by their discipline. Video shall be in Windows Media Player video format saved on flash drives. Two (2) copies on flash drives are to be provided as a formal submittal. . Flash drives are to be tagged with project name, training session name(s), installing Contractor and date of training. The flash drive shall include a scanned version of the training session sign in list(s), including the presenter and the owner's participants.

1.49 ENERGY INCENTIVES

A. The Contractor, his Subcontractors and Suppliers shall provide to the Owner all paperwork necessary to support the Owners pursuit of incentives related to energy conservation as offered by the utility company or state sponsored incentive programs. This shall include at a minimum, receipts, and quantities and data sheets for energy efficient equipment such as: lighting, motors, variable frequency drives, etc.

1.50 INFECTION CONTROL

A. Construction procedures, temporary partitions, negative air systems, cleaning procedures, HVAC system isolation, dust control, etc. shall be in accordance with the infection control standards set forth by the Facility. A copy of the facilities standards are available from the Owner upon request.

END OF SECTION 260500

SECTION 260501 - BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a (Reapproved 2017).

B. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2020.

C. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.

D. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2021.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.

G. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

H. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.2 DESCRIPTION

A. The drawings are diagrammatic, unless detailed dimensioned drawings are included, and show only approximate locations of equipment, fixtures, panelboards, conduits, and wiring devices. Exact locations are subject to the approval of the Owner's Representative. The general run of electrical feeders, branch circuits, and conduits, indicated on the drawings, is not intended to be the exact routing. Exact routings of conduit shall suit the job conditions.

B. Circuit designations, in the form of "Home Runs" on branches, indicate the designation of the branch circuit, the size and the quantity of branch circuit conductors, and the panel board or interconnection box from which the branch circuit is served.

C. Make measurements at the site and in the building during construction for all systems installed as the work progresses in such a manner that the equipment, piping, vents, ducts, conduit, and boxes will fit in the space available. Maintain headroom and if in unfinished areas, be as neatly installed, as obscure and "out-of-the-way" as physically possible. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and /or furnish other equipment as required for ample maintenance space.

D. Any changes in the size or location of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.

1.3 QUALITY ASSURANCE

A. Electric equipment shall be installed in a neat and workmanlike manner. All methods of construction, details of workmanship, that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative.

B. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the specifications. The equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions, etc., correspond to the nomenclature dictated by those manufacturers. Where "or equal" is stated, equipment shall be equal in every way to that of the equipment specified and subject to approval. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

1.4 SUBMITTALS

A. Submit product data and information for the following equipment, materials and products, including all fittings and accessories:
   1. Conduit
   2. Surface Raceway
   3. Expansion Fittings
   4. Wireway and Wire Trough
   5. Channel Support Systems
   6. Conductors
   7. Cables

8. Cable Termination and Splice Kits
9. Poke-Through Service Fittings
10. Terminal and Equipment Cabinets
11. Wiring Devices Including Dimmers
12. Telephone/Data Communication Outlets
13. Water Proofing Seals
14. Flashing, Sealing, Firestopping Materials
15. Salvageable Materials
16. Testing reports prior to energizing equipment and materials.

1.5 SALVAGEABLE MATERIALS

A. Salvageable materials will be reviewed and identified by the Owner. Items selected by the Owner shall be delivered to a selected location on the Owner's property by this contract in an equal condition to prior this work.

B. Items normally accepted as salvage by the Owner:
1. Transformers
2. Meters, meter sockets and test switches
3. Deadfront switchgear
4. Panelboards and covers
5. Circuit breakers
6. Disconnects (100 AMP and up)
7. Adjustable speed drives
8. Motor starters
9. Luminaires
10. Fire alarm equipment
11. Motors above 1/2 HP and up
12. Environmental and automation control equipment
13. Telephones

PART 2 - PRODUCTS

2.1 MATERIALS

A. Conduit, Raceway and Tubing:
1. Rigid Metal Conduit (RMC) shall be hot-dipped galvanized or electro-galvanized steel, UL listed "rigid metal conduit."
a. Acceptable Manufacturers:
1) Nucor Tubular Products
2) Allied Tube and Conduit
3) Wheatland Tube
4) Approved equal

2. Electrical Metallic Tubing (EMT) shall be electro-galvanized steel with corrosion resistant zinc coating; UL listed.
    a. Acceptable Manufacturers:
        1) Nucor Tubular Products
        2) Allied Tube and Conduit
        3) Wheatland Tube
        4) Approved equal
3. Flexible Metal Conduit (FMC) shall be constructed of one continuous length of electro-galvanized, spirally wound steel strip with interlocking convolutions and interior surfaces free from burrs and sharp edges; UL listed.
    a. Acceptable Manufacturers:
        1) AFC (American Flexible Conduit) Cable Systems
        2) Anaconda Sealtite by ANAMET Electrical, Inc.
        3) Southwire
4. Liquidtight Flexible Metal Conduit (LFMC) shall be constructed of one continuous length of electro-galvanized, spirally wound steel strip with interlocking convolutions, interior surfaces free from burrs and sharp edges, and an outer liquidtight, nonmetallic, sunlight-resistant jacket; UL listed.
    a. Acceptable Manufacturers:
        1) AFC (American Flexible Conduit) Cable Systems
        2) Anaconda Sealtite by ANAMET Electrical, Inc.
        3) Southwire
5. Electrical Nonmetallic Tubing (ENT) shall be a nonmetallic, pliable, corrugated raceway of circular cross section with integral or associated couplings, connectors, and fittings, and made of materials that is resistant to moisture and flame retardant; UL listed. ENT shall me the requirements of NEMA TC-13 and shall be recognized by a CABO National Evaluation Report for use in one (1) hour and two (2) hour rated construction. Only cement recommended specifically for use with the brand of ENT used shall be used. Unless indicated differently on drawings, ENT systems shall be color coded BLUE for branch and feeder circuit wiring, YELLOW for communications, and RED for fire alarm and emergency systems.
    a. Acceptable Manufacturers:
        1) Carlon
        2) Heritage Plastics
        3) Approved equal
6. Rigid Polyvinyl Chloride Conduit (PVC) shall be made from polyvinyl chloride compound and be homogenous plastic material free from visible cracks, holes, or foreign inclusions. Conduit bore shall be smooth and free of blisters, nicks, or other imperfections. Conduit shall be rated for use with 90ºC conductors and UL listed. Conduit and fittings shall be tested in accordance with the testing requirements defined in NEMA TC 2, NEMA TC 3, UL 651 and UL-514. Schedule 40 shall be white in color; Schedule 80 shall be gray in color.

a. Acceptable Manufacturers:
   1) Carlon
   2) Heritage Plastics
   3) JM Eagle
   4) Cantex

7. Reinforced Thermosetting Resin Conduit (RTRC) shall be made of a single-circuit filament winding, with strands of fiberglass impregnated with resin; UL listed.
   a. Acceptable Manufacturers:
      1) Champion Fiberglass
      2) United Fiberglass
      3) NASCO

8. Surface Metal Raceway shall be .040 inch. steel UL listed "Surface Metal Raceway". Use manufacturer's standard fittings designed to be used with the specific raceway.
   a. One-Piece Raceway:
      1) Buff or ivory finish.
      2) Acceptable Manufacturers:
         a) Wiremold "700" Series (Design Make)
         b) Mono Systems
         c) Approved equal

B. Conduit Fittings:
   1. Fittings for rigid metal conduit shall be fully threaded and shall be of the same material as the respective raceway system. Fittings for electrical metallic tubing shall be single screw indenter fittings for conduits up to 2 inch. and double screw indenter fittings for conduits 2 in. and larger. Connectors shall also have insulated throat or plastic insulating bushing up to and including 1 inch. size. For sizes 1-1/4 inch. and larger, provide plastic insulating bushing. Die-cast, pressure cast fittings shall not be used. Fittings for rigid non-metallic conduit shall be solvent cemented in accordance with the manufacturer's instructions.
      a. Acceptable Manufacturers:
         1) O.Z. Gedney
         2) Steel City
         3) Thomas & Betts
         4) Crouse-Hinds
         5) Carlon
   2. Expansion Fittings shall be watertight, combination expansion and deflection type designed to compensate for movement in any direction. Fittings shall have flexible copper braid bonding jumpers, neoprene sleeve and stainless steel bands, use aluminum body fittings for rigid aluminum conduit.
      a. Acceptable Manufacturers:
         1) Crouse-Hinds, Type "XD"
         2) O.Z./Gedney, Type "DX"

3) Approved equal

C. Wireway, Wire Trough, and Auxiliary Gutters:
1. Wireway and Wire Trough shall be hinged cover type wireway with provisions for full lay-in along the entire length of run. Wireway shall be steel, enclosed with gray enamel finish. Provide NEMA 1 units for interior/dry/clean locations and NEMA 12 for interior dry maintenance/shop/utility locations. Size to meet NEC fill requirements or larger as noted on Contract Documents. Provide knockouts along runs. Recess in wall where required for flush mounted equipment. Hinge shall be on the bottom of front face for horizontal mounting. Provide all covers, couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, tees, pullboxes, hangers, reducers, supports, and other fittings to match and mate with wireways as required for complete system.
a. Acceptable Manufacturers:
1) Square D "Square Duct"
2) General Electric
3) Hoffman
4) Meco

D. Strut-Type Channel Raceways and Fittings:
1. Strut-Type Channel Raceways and Fittings shall be provided for racking of conduit, trapeze suspensions, equipment support, cable racks and panel racks. Channel shall be steel with electroplated zinc finish for interior dry locations. Provide necessary accessories such as bolts, screws, anchors, connection plates, and straps as required to perform the necessary functions. Wet location and exterior channel support systems shall be steel with hot dipped galvanized finish and stainless steel hardware as a minimum. Cut ends shall be touched up with suitable matching finish.
a. Acceptable Manufacturers:
1) Unistrut
2) Globe
3) Kindorf
4) B-Line

E. Low Voltage (600V or less) Conductors and Cables:

1. Conductors shall be insulated for 600 volts, unless otherwise noted, and shall be standard AWG and kcmil sizes. Conductors shall be 98%, thermal plastic or cross-linked polymer insulated, heat and moisture resistant Conductor sizes No. 18 AWG and smaller shall be a solid single strand; No. 16 AWG and larger shall be multiple stranded. Minimum conductor size shall be #12 AWG except smaller sizes may be used for communications and special systems. Conductor sizes shall be as called for. Conductors shall be labeled with UL seal and be permanently marked with the manufacturer's name, wire size and insulation type. Insulation for all 600 volt conductors shall be Type THHN/THWN-2 or Type XHHW-2, unless otherwise noted. All exterior and underground conductors shall be XHHW-2. Luminaire fixture wire shall conform to the latest Underwriters Laboratories requirements. Flexible cords and cables for general portable use shall be Type SO or SOOW or as noted. Cables for special use shall be of the type specified for the application.
   a. Color Coding:
      1) All circuits shall be color coded according to the following schedule.

	Three Phase 120/208V 240V	Three Phase 277/480V	Single Phase 120/240V
Ground	Green	Green	Green
Neutral	White	Gray	White
A or L1	Black	Brown	Black
B or L2	Red	Orange	Red
C or L3	Blue	Yellow	---

   b. Acceptable Manufacturers:
      1) General Cable (Brand of Prysmian Group)
      2) Southwire
      3) The Okonite Company
      4) Service Wire Co.
      5) Encore Wire
2. Metal Clad, Type "MC" Cable shall consist of thermal plastic insulated copper conductors of size and quantity indicated, protected by a positive interlocked armor of galvanized steel. The conductors shall be twisted together and shall have an overall moisture and fire resistant fibrous covering. The cable shall have an integral green insulated full size equipment grounding conductor running its entire length. Where dimming is called for the cable is allowed to include dimming control wiring with a voltage rating to match the power. The cable shall meet the requirements of the NEC for "Type MC" Metal Clad Cable and shall bear the UL Label.
   a. Acceptable Manufacturers:
      1) Southwire
      2) AFC Cable

3) Service Wire Co.
4) Encore Wire

3. Terminal Lugs and Connectors:
   a. The lug shall be capable of continuous operation at the current rating of the cable it is used on. The lug shall be UL listed per UL 486A, using industry standard crimping tools and dies. Terminal lugs shall be solderless, pressure type with UL label for "CU/AL" conductor terminations. The lug shall be a closed-end compression (crimp) type, constructed of seamless, alloy suitable for copper and/or aluminum conductors to match the conductor. The lug shall be made with a chamfered inside end, for ease of conductor insertion. Both one and two hole lugs shall be NEMA sized for standard stud sizes and spacing. The lug shall be designed for use at the system voltage.
      1) Acceptable Manufacturers:
         a) 3M Scotchlok 30,000 and 31,000 Series
         b) Burndy
         c) O.Z./Gedney
         d) Thomas and Betts
   b. The conductor connection shall be capable of continuous operation at the current rating of the cables it is used on. The connection shall be UL listed per UL 486A, using industry standard crimping tools and ides. The connector shall be an inline compression (crimp) type, constructed of seamless, tin-plated copper. The connector shall be constructed with chamfered inside-ends and with center cable stops. The connector shall be designed for use at the system voltage.
      1) Acceptable Manufacturers:
         a) 3M Scotchlok 10,000 and 11,000 Series
         b) Burndy
         c) O.Z./Gedney
         d) Thomas and Betts
   c. "Split-bolt" Connectors shall be solderless type.
      1) Acceptable Manufacturers:
         a) Burndy
         b) Kearney
         c) O.Z./Gedney
         d) Thomas and Betts
         e) Anderson
   d. "TWIST ON" Connectors shall be spiral steel spring type and insulated with vinyl cap and skirt.
      1) Acceptable Manufacturers:
         a) 3-M Company "Scotch-Lok"
         b) Ideal "Wing-Nuts"
         c) Approved equal

F. Outlet Boxes, Device Boxes, Rings, and Covers:
   1. Outlet Boxes having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit or cable fittings, or cables, with provisions for mounting outlet box cover. Outlet boxes shall be galvanized steel, not less than 2-1/2 inch. deep, unless restricted by the surroundings, 4 inch. square or octagonal. Boxes and associated fittings, plates and devices shall be mechanically fastened (screwed), friction fitting is not acceptable. Outlet boxes exposed to moisture, surface mounted, exterior, wet or damp locations shall be cadmium cast alloy complete with external threaded hubs and gasketed screw fastened covers. Minimum box size shall be as indicated in the NEC for the conductors and devices installed. Boxes shall be approved for the environmental condition where they will be installed.
   2. Conduit bodies providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point and listed in accordance with outlet box requirements.
   3. Extension ring intended to extend sides of outlet box or device box to increase box, volume, or both
      a. Acceptable Manufacturers:
         1) Steel City
         2) Raco
         3) Appleton
         4) Crouse Hinds
   4. Telephone/Data Communications Outlet Boxes:
      a. 4 inch. x 4 in. outlet box with single gang plaster ring with cover plate suitable for indicated communications outlet and conduit routed to accessible ceiling space . Cover plate shall match the receptacle cover type.
   5. Pull and junction boxes shall be constructed of not less than 14 gauge galvanized steel with trim for flush or surface mounting in accordance with the location to be installed. Provide screw-on type covers. Boxes installed in damp or wet locations shall be of raintight construction with gasketed cover and threaded conduit hubs. In no case shall boxes be sized smaller than as indicated NEC for conduit and conductor sizes installed. Boxes shall be approved for the environmental condition of the location where they will be installed.
      a. Acceptable Manufacturers:
         1) Hoffman
         2) Keystone
         3) Approved equal
   6. Flush floor junction boxes shall be recessed cover boxes designed for flush mounting in masonry. Provide checkered plate gasketed cover suitable for foot traffic. Make: O.Z. Gedney Type YR or approved equal.

G. Terminal and Equipment Cabinets:

1. Terminal and equipment cabinets shall be code gauge galvanized steel with removable endwalls. Fronts shall be of code gauge steel, flush or surface type (as indicated) with concealed trim clamps, concealed hinges, flush lock, and grey baked enamel finish. Boxes and front shall be UL listed and shall be minimum 35 inch. H x 24 inch. W x 6 inch. D. Provide removable insulated plywood terminal board mounted on inside back wall of cabinet.
    a. Acceptable Manufacturer:
        1) Square D "Mono-Flat"
        2) Approved equal

H. Wiring Devices:
1. Wiring Devices (toggle switches, key switches, receptacles, dimmers, occupancy sensors, etc.) shall be specification grade as a minimum. Switch handle and receptacle face shall be as directed by the Owner's Representative. Provide device cover plates of rounded nylon colored to match the device in finished areas and rounded raised (Steel City 450/460 series) only for surface mounted locations in unfinished areas. Provide neoprene gasketed cast aluminum/zinc box with hinged (for receptacle) rain tight cast aluminum/zinc lockable while in use cover with stainless steel hardware for devices designated "WP".
    a. Acceptable Manufacturers:
        1) Pass and Seymour
        2) Hubbell
        3) Leviton
2. Toggle/Snap Switches:
    a. Units shall be quiet operation, quick make/quick break, rated for 20A/120-277V/1hp at 120/277V, side/back wired, , with nylon/polycarbonate toggle, self grounding mounting screw clip plate (not staple), ground terminal and silver alloy contacts. Units shall meet latest Federal Specification WS-896, NEMA WD-1 and UL Test 20. Single pole units shall be Hubbell 1221, P&S 20AC1 or Leviton 1221-2. Provide two pole, three way, four way, illuminated handle, keyed, etc. type of the same quality and model.
    b. Momentary Contact: Units shall be as indicated above (20A, 277V, nylon handle, side/back wired), three position, two circuit/three wire with spring return to center position, provide where indicated and as needed for proper system operation. Hubbell HBL1557, P&S 1250, Leviton 1256 or approved equal. Provide keyed operation or pilot light where indicated. When used for lighting controls for vacancy sensor control, provide jumper across the circuit terminals.
3. Receptacles:
    a. Provide receptacles where indicated on the drawings and where called for. Provide type receptacle as indicated and if not indicated then utilize general receptacle.

b. General Receptacle: Units shall be NEMA 5-20R, duplex, 20A, 125V, side/back wired, #14 to 10AWG screw terminals with nylon face, indented brass contacts for three point connection, self grounding stainless steel mounting screw clip plate and green ground terminal. Shall meet requirements of Federal Specification W-C-596, NEMA WD 6 and UL 498.
   1) Units shall have 0.032" thick brass contacts, 0.031" brass mounting strap and be: Hubbell HBL5352, P&S PS5362 or Leviton 5362.

c. Ground Fault Interrupting Receptacles: Units shall be as specified above for General Receptacle and have 5mA interrupting ground fault level, test/reset front buttons, full through feed capability, power off on reverse wired sensing, 10kA short circuit current rating, be tamper/weather resistant and in compliance with UL 943. Unit shall self-test function to periodically test the components automatically and indicate a failure condition utilizing an LED. Receptacles indicated as "WP" shall be a ground fault interrupting receptacle. Shall be Hubbell GFR5362, P&S 2097TRWR or Leviton GFWR2.

d. Tamper Resistant Receptacles: Units shall be as specified above for General Receptacle and have protective shutters to prevent entry into the line or grounded front openings unless all plug prongs are present.

e. USB Power Receptacle: Units shall be as specified above for General Receptacle but have 0.040" zinc plated mounting strap, two 20A 125V outlets and two USB charging (5A minimum total, 5VDC, USB 2.0/3.0 one Type A and one Type C) outlets. Overall depth shall not exceed 1.7 inch. Shall be Hubbell USB20 or approved equal.

f. Special Receptacles: provide other type receptacles as indicated herein or on the drawings. Such receptacles shall be Hubbell, P&S or Leviton highest grade available.

I. Waterproofing Seals:
   1. Provide expanding link type seal, for installation between duct/conduit, and sleeve or core-drilled hole in concrete.
   2. Make: Link Seal, manufactured by Thunderline Corp., or approved equal.

J. Flashing, Sealing, Fire-stopping:
   1. Fire-Stopping for Openings Through Fire and Smoke Rated Wall and Floor Assemblies:
      a. Provide materials and products listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems". The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.
      b. Provide fire-stop system seals at all locations where piping, tubing, conduit, electrical busways/cables/wires, ductwork and similar utilities pass through or penetrate fire rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for drywall construction.

c. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.

d. The methods used shall incorporate qualities, which permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating.

2. Acceptable Manufacturers:
   a. Dow Corning Fire-Stop System Foams and Sealants
   b. Nelson Electric Fire-Stop System Putty, CLK and WRP
   c. S-100 FS500/600, Thomas & Betts
   d. Carborundum Fyre Putty
   e. 3-M Fire Products

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA NEIS (National Electrical Installation Standard) latest edition.

B. Unless otherwise noted, wiring for all systems indicated in the contract documents shall consist of insulated conductors installed in raceways. Raceways shall be continuous from outlet box to outlet box and from outlet box to cabinet, junction or pull box. Secure and bond raceways to all boxes and cabinets so that each system of raceways is electrically continuous throughout. Unless otherwise indicated on the drawings, install all wiring in the following raceway system:
   1. Wiring 600 Volts or Less in Dry Interior Locations: EMT.
   2. Wiring 600 Volts or Less in Dry Locations and Subject to Physical Damage: RMC.
   3. Wiring 600 Volts or Less in Outdoors, Above Grade Locations: RMC.
   4. Wiring 600 Volts or Less in Outdoors, Below Grade Locations: PVC-80 unless concrete encasement is indicated.
   5. Wiring Installed in Corrosive Locations: PVC-80.
   6. Flexible metal conduit shall be used for final connection to all motors, final connection to rotating or vibrating equipment, final connections to dry type transformers and final connections to recessed lighting fixtures. Liquidtight flexible conduit shall be used in all wet or damp locations. Maximum length of flexible conduit shall be 36 inch., except that from outlet boxes to lighting fixture maximum length shall be 6 feet Provide green insulated equipment grounding conductor in all flexible metal conduit.
   7. Surface metal raceway shall be used for surface runs in finished area where concealed conduit cannot be run or where specifically indicated on drawings.

8. Where allowed, branch circuits may be type MC cable between homerun junction box and equipment/device connection in drywall partitions only. Homerun junction box to be a maximum of 20 feet from equipment/device.

C. Raceways:
1. Sized as indicated on the drawings. Where sizes are not indicated, raceways shall be sized as required by the National Electrical Code in accordance with the quantity, size, and type of the insulation conductors to be installed. Raceways shall be minimum 3/4 inch. trade size for branch circuit wiring and minimum 1 inch. trade size for all telephone, data, intercommunications, instrumentation, fire alarm, television and computer systems and for all branch circuit "Home Runs" to panelboards. Installed to provide adequate grounding between all outlets and the established electrical system ground.
2. Arranged in a neat manner for access and allow for access to work installed by other trades.
3. Install raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts handtight, plus one-quarter turn more.
4. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4 inch trade size and insulated throat metal ground bushings on 1-1/2 inch trade size and larger conduits terminated with locknuts. Install throat metal grounding bushings on service conduit.
5. Complete raceway installation before starting conductor installation.
6. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 feet above finished floor. Wherever a cluster of four (4) or more raceways rise out of floor exposed, provide neatly formed 6 inch. high concrete envelop, with chamfered edges, around raceways.
7. Installed with a minimum of bends and offsets. All bends shall be made without kinking or destroying the cross section contour of the raceway. Factory made bends are acceptable and should be considered for raceways larger than 2 inch.
8. Make bends in raceway using large-radius performed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
9. Conceal conduit within finished walls, ceilings, and floors unless otherwise noted, or where permitted by the Owner's Representative. All exposed raceways shall be painted to match existing adjacent surface as directed by the Architect. Install conduit parallel or perpendicular to building lines.
10. Support conduit within 12 inches of enclosure to which attached.

11. Install raceway sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings in accordance with NFPA 70.
12. Seal raceway opening that penetrate rooms or walls with acoustical requirements on both sides of rooms or walls with acoustically rated putty or firestopping.
13. Differing Temperatures: For raceways routed between areas with differing temperatures (interior to exterior, walk in coolers/freezers, environmental chambers, etc.) install raceway as follows:
    a. Provide a thermal break, 4 inch. minimum of stainless steel or Schedule 40 PVC conduit within space wall/separation.
    b. Seal raceway penetration through the wall/separation.
    c. Provide a box on each side of the space wall/separation.
    d. Provide raceway interior sealant (duct seal or suitable foam) to provide a complete air barrier after conductors are installed.
    e. Mounting of raceway and boxes on equipment shall be coordinated and approved by the equipment manufacturer.
    f. Installed with exterior surfaces not less than 6 inch. from any surface with normal operating temperature of 200°F or higher.
14. Expansion-Joint Fittings:
    a. Install in runs of aboveground PVC that are located where environmental temperature change may exceed 30 deg. F and that have straight-run length that exceeds 25 feet. Install in runs of aboveground RMC and EMT conduit that are located where environmental temperature change may exceed 100 deg. F and that have straight-run length that exceeds 100 feet.
    b. Install expansion fittings at locations where conduits cross building or structure expansion joints.
    c. Install with position, mounting, and piston setting selected in accordance with manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
    d. Installed such that no undue stress is placed on any electrical raceway due to the proper functioning of expansion joints.
15. Raceway installed in wet/damp locations or on exterior walls shall have a spacer manufactured for this purpose provided to maintain a space/void between the mounting surface and the raceway.
16. Do not install conduits within 2 inches of the bottom side of a metal deck roof.
17. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
18. Cut conduit perpendicular to the length. For conduits 2 inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs. Bush where necessary.

19. Install pull wires in empty raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inch of slack at both ends of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
20. Plugged at the ends of each roughed-in raceway with an approved cap or disc to prevent the entrance of foreign materials during construction.
21. Installed with UL approved rain-tight and concrete-tight couplings and connectors.
22. Raceways shall not be attached to or supported by wooden plug anchors or supported from mechanical work such as ductwork, piping, etc.
23. Raceways installed in concrete slabs shall be located so as not to affect structural integrity of slab, and such that conduit shall have a minimum of 1 inch. of concrete cover on all sides. Obtain approval from the Owner's Representative prior to installing conduit in concrete slabs. Raceways in slabs shall be for floor box use only, or routing vertically through.
24. If it is necessary to burn holes through webs of beams or girders, call such points to the attention of the Owner's Representative and receive written approval both as to location and size of hole before proceeding with work. All holes shall be burned no larger than absolutely necessary.
25. Become familiar with the general construction of the building and place sleeves, inserts, etc., as required. All penetrations through existing floors shall be core drilled and sleeved.
26. All raceways shall be supported adequately by malleable iron pipe clamps or other approved methods. In exterior or wet locations, supports shall allow not less than 1/4 inch. air space between raceway and wall. Firmly fasten raceway within 3 feet of each outlet box, junction box, cabinet or fitting. The following table lists maximum spacing between conditions, strength of supporting members, etc.
27. Furnish and install such supports at no additional cost to owner.

Conduit Trade Size	Type of Run	Horizontal Spacing in Feet	Vertical Spacing in Feet
1/2 inch., 3/4 inch.	Concealed	7	10
1 inch., 1-1/4 inch.	Concealed	8	10
1-1/2 inch. and larger	Concealed	10	10
1/2 in., 3/4 in.	Exposed	5	7
1 in., 1-1/4 inch.	Exposed	7	8
1-1/2 inch. and larger	Exposed	10	10

28. Where raceways puncture roof, install "witches hat" unit suitable with the roofing material with 50 year caulk/stainless steel clamp as required in order that the roof warranty is maintained. Coordinate with representative of roofing material manufacturer.
29. At each flush mounted panelboard, terminal cabinet, control cabinet, etc., provide four (4) spare 3/4 inch. raceways from panelboard, etc., to an area above the nearest accessible ceiling space. Make 90° turn above the ceiling, arranged for further continuation of raceway, and cap.

D. Outlet Boxes:
1. Consider location of outlets shown on drawings as approximate only. Study architectural, process piping, mechanical, plumbing, structural, roughing-in, etc., drawings and note surrounding areas in which each outlet is to be located. Locate outlet so that when fixtures, motors, cabinets, equipment, etc., are placed in position, outlet will serve its desired purpose. Where conflicts are noted between drawings, contact Owner's Representative for decision prior to installation. Comply with the NEC relative to position of outlet boxes in finished ceilings and walls.
2. Prior to installation, relocate any outlet location a distance of 5 feet in any direction from location indicated on drawings if so directed by the Owner's Representative. Prior to completion of wall construction, adjust vertical height of any outlet from height indicated if so directed by Owner's Representative. The above modifications shall be made at no additional cost to the Owner.
3. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Outlet boxes shall be sized to accommodate the wiring, splices and device(s) to be installed in accordance with the NEC.
4. Saw-cut opening for boxes recessed in masonry walls in center of cell of masonry block, and install box flush with surface of wall. Box shall have extra-deep type raised tile covers or shall be 3-1/2 inch. deep boxes with square corners and dimensions to accommodate conductors installed. Prepare block surfaces to provide a flat surface for a raintight connection between box and coverplate or supported equipment and box, whether installed indoors or outdoors.
5. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
6. Locate boxes so that cover or plate will not span different building finishes. Install a device cover plate over each and every outlet indicated on drawings. Do not install plates until painting, cleaning and finishing of surfaces surrounding the outlet are complete. Install single one-piece multi-gang covers over multi-gang devices.
7. Where outlets at different mounting heights are indicated on drawings adjacent to each other (due to lack of physical space to show symbol on drawings), install outlets on a common vertical line.

8. Where switch outlets are shown adjacent to strike side of door, locate edge of outlet box approximately 3 inch. from door frame.
9. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
10. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
11. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
12. Floor outlet boxes shall be installed flush with finished floor, adjust level and tile as required. Where finished floor is terrazzo, provide boxes specifically designed for installation in terrazzo. Where floors are to receive carpet or flooring material, coordinate with appropriate trade and provide insert. Rectangular covers shall be parallel and perpendicular with the building or, if used, floor tile/floor joints/pattern. Coordinate cover type with the flooring and device type.
13. Outlet boxes installed in plaster, gypsum board or wood paneled hollow cavity walls shall be installed flush with raised plaster covers or raised tile covers. Boxes shall be mechanically fastened and supported by two (2) adjacent structural members (studs) with cross brackets (Garvin Industries Model BMB or approved equal).
14. Surface ceiling mounted outlet boxes shall be minimum 4 inch. square, 1-1/2 inch. deep, galvanized sheet metal.
15. Surface wall mounted outlet boxes shall be cast type boxes.
16. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
17. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
18. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty for boxes and enclosures in areas of walls with acoustical requirements. Provide gaskets for wallplates and covers.
19. Seal openings and knockouts in back and sides of boxes and enclosures in areas of walls with lead shielding requirements.

E. Wiring Methods:
1. Conductors shall not be installed until raceway system, including all outlets, cabinets, bushings and fittings, is completed. Verify that all work of other trades which may cause conductor damage is completed. Use only U.L. approved cable lubricants when necessary. Do not use mechanical means to pull conductors No. 8 or smaller.
2. In general, conductors shall be the same size from the last protective device to the load.

3. Wiring systems shall be properly grounded and continuously polarized throughout, following the color-coding specified. Connect branch circuit wiring at panelboards, as required, in order to provide a "balanced" three-phase load on feeders.
4. Provide insulated green ground conductor in each branch circuit.
5. All feeder connections shall be made to bus and other equipment using solderless, pressure type terminal lugs.
6. Branch circuits connected to a 20A circuit breaker shall be sized as indicated except for lengths exceeding 75 feet For circuits longer than 75 ft. to 100 feet utilize No. 10 AWG conductors (line, neutral and ground) and for circuits from 100 ft. to 150 feet utilize No. 8 AWG (line, neutral and ground) unless otherwise indicated. Conduit size shall be modified in accordance with the NEC.
7. For splices and taps, No. 10 AWG and smaller, use solderless "twist on" connectors having spiral steel spring and insulated with a vinyl cap and skirt.
8. For splices and taps, No. 8 and larger, use insulated solderless set screw AL/CU or hydraulically compressed sleeve fittings suitable for the intended use.
9. Use cast connections for ground conductors.
10. Provide minimum 6 inch. of spare/slack of each conductor in each junction or pull box and termination.
11. Make all splices and connections in accessible boxes and cabinets only.
12. Cover uninsulated splices, joints, and free ends of conductor with rubber and friction tape of PVC electrical tape. Plastic insulating caps may serve as insulation. Heat shrink sleeves shall be acceptable for crimp type splices.
13. On termination at branch circuit outlets, leave a minimum of 8 inch. free conductor for installation of devices and fixtures.
14. Feeder conductors shall be continuous from point of origin to load termination without splice. If this is not practical, contact the Owner's Representative and receive written approval for splicing prior to installation of feeder(s). Where feeder conductors pass through junction and pull boxes, bind and lace conductors of each feeder together. For parallel sets of conductors, match lengths of conductors as near equal as possible.
15. Branch circuit conductors installed in panelboards, and control conductors installed in control cabinets and panels shall be neatly bound together using "Ty-Raps" or equal.
16. Provide conduit seals and explosion proof devices as indicated on the plans and as dictated by the NEC for all hazardous locations indicated on the drawings.
17. Lighting fixtures, detectors, etc., in mechanical equipment, boiler and pump rooms shall be installed with exposed raceway after equipment, ductwork, piping, etc., are in place. In general, lighting shall be as located on the drawings; where conflicts exist, locate lights for best distribution.
18. Fire proof tape all medium voltage cables in handholes, man holes, building entrance and junction/pull boxes.
19. Provide cable/conductor vertical support in accordance with the NEC.

F. Receptacles:
1. Provide hospital grade receptacle for all hospital construction.
2. Ground opening shall be up for vertical installation and on the left for horizontal installation.

G. Toggle Switches:
1. Switches shall be installed in accessible locations near room/space entryway(s).
2. Provide lighted handle switches in mechanical rooms, elevator pits, electric rooms, etc.
3. Switches shall have neutral pulled through the box even if not used.

H. Junction and Pull Boxes:
1. Install junction and pull boxes in readily accessible locations. Access to boxes shall not be blocked by equipment, piping, ducts and the like. Provide all necessary junction or pull boxes required due to field conditions and size as require by the National Electrical Code.
2. Boxes shall be clearly labeled indicating the associated circuit. Where the conduit is colored the box cover shall match this color.

I. Equipment Mounting Heights:
1. Unless otherwise noted, mount devices and equipment at heights measured from finished floor to device/equipment centerline as follows:

a.	Toggle switches (up position "on")	46 inch.
b.	Wall lighting controls (dimmer, digital switch, etc.	46 in.
c.	Receptacle outlets (long dimension vertical, ground" pole farthest from floor)	18 inch.
d.	Receptacle outlets above counters	8 inch. above counters
e.	Receptacle outlets, above hot water or steam baseboard heaters. Do not install receptacle outlets above electric baseboard heaters	30 inch.
f.	Receptacle outlets, hazardous areas; also for refrigerators	48 in.
g.	Receptacle outlets, weatherproof, above-grade	24 inch.
h.	Clock outlets (104 inch. AFF or 10 inch. below ceiling, whichever is lower)	104 in.
i.	Telephone outlets	18 in.
j.	Telephone outlets, wall mounted	46 in.
k.	T.V. outlet	18 in.

l.	Fire alarm manual stations	46 in.
m.	Fire alarm combination audio/visual and standalone visual device (entire strobe lens at heights indicated)	80 inch. to bottom of the notification device
n.	Standalone fire alarm horn	90 inch. (min) to 96 inch. (max)
o.	Standalone fire alarm speaker	80 in. to bottom
p.	Distribution panelboards, to top of backbox	72 inch.
q.	Terminal cabinets, control cabinets, to top of backbox	72 in.
r.	Disconnect switches, motor starters, enclosed circuit breakers.	48 in.

2. Where structural or other interferences prevent compliance with mounting heights listed above, consult Owner's Representative for approval to change location before installation.

J. Hangers and Supports:
1. Provide steel angles, channels and other materials necessary for the proper support and erection of motor starters, distribution panelboards, large disconnect switches, large circuit breakers, pendant mounted lighting fixtures, etc.
2. Panelboards, disconnect switches, circuit breakers, cabinets, large pull boxes, adjustable speed drives, cable support boxes and starters shall be secured to the building structure and not supported from conduits. Small panelboards, etc., as approved by Owner's Representative, may be supported on walls. Racks for support of conduits and heavy electrical equipment shall be secured to building construction by substantial structural supports.

K. Identification:
1. Provide engraved lamicoid identification nameplates on switchboards, main service disconnects, transfer switches, motor control centers and on all panelboards using designation shown in panelboard schedule. Include voltage, phase, equipment served, voltage source to panel or equipment.
2. Provide engraved lamicoid identification nameplates for each circuit breaker in the main distribution panel listing the panelboard or equipment connected to each device.
3. Provide engraved lamicoid identification nameplates on all items of equipment including individual circuit breaker enclosures and disconnect switches, listing the equipment connected to the particular device provided under Specification Sections 262000 and 262913, including, but not limited to: starters, disconnect switches, adjustable speed drives, circuit breakers, etc. Include voltage, phase, equipment served, voltage source to panel or equipment.

4. Provide complete type written directory for each panelboard listing room number, function, etc., for each circuit breaker. Directory shall be placed in a plastic clear sleeve in the interior of the panelboard door. Provide type written updated panelboard directories for existing panelboards affected by this work.
5. Nameplates shall be engraved black, with white core, with Helvetica medium 3/16 inch. lettering. 1/8 inch. lettering is acceptable where space of 3/16 in. is not available.
6. Identify junction and pullboxes for particular service and circuit such as power, emergency power, lighting, fire alarm, telephone, interphone, public address, nurse call, etc. using stencil lettering on cover. Colored to match the conduit system.
7. Using adhesive backed printed tape label (clear background, black lettering) all receptacle and switch coverplates, power poles, etc. listing panel designation and circuit number. Tape shall be attached to inside of receptacle or switch coverplates.

L. Spare Parts:
1. Deliver to Owner and obtain receipt for spare parts including key switches, fuses, etc.

3.2 TESTS

A. 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 and exterior branch circuit 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. Document test results and submit for approval prior to energizing conductors.

END OF SECTION 260501

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SECTION 260526 - GROUNDING

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.2 DESCRIPTION

A. Provide grounding system equal to or exceeding the requirements of NEC and as indicated in the contract documents. Raceway system which includes metal conduit, wireways, pullboxes, junction boxes, busway, wire ways, cable trays, enclosures, motor frames, etc., shall be made to form a continuous, conducting permanent ground circuit of the lowest practical impedance to enhance the safe conduction of ground fault currents and to prevent objectionable differences in voltage between metal nonload current carrying parts of the electrical system.

B. Provide solid grounding of building structures and electrical and communications systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits and systems. Types of grounding systems include the following:
   1. Electrical Service and Transformer Grounding
   2. Building Grounding
   3. Equipment Room Ground Terminal Bar
   4. Electrical Equipment Grounding
   5. Surge Protection Device (SPD) Grounding
   6. Telecommunications Grounding
   7. Equipotential Grounding Systems
   8. Underground Distribution Grounding
   9. Common Ground Bonding with Lightning Protection System.

1.3 QUALITY ASSURANCE

A. All methods of construction, details of workmanship, that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the specifications. The equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions. etc., correspond to the nomenclature dictated by those manufacturers. Where "or equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

B. Electrical Components, Devices and Accessories: Listed and labeled as defined in the NEC by Nationally Recognized Testing Laboratory (NRTL) and marked for intended use.

C. Comply with UL 467 for grounding and bonding materials and equipment.

1.4 REQUIREMENTS

A. Grounding conductors, bonding conductors, jumpers, grounded conductors, etc. shall be sized in accordance with the NEC.

B. Equipment and materials shall be installed in accordance with the manufacturer's recommendations.

C. Provide ground system coordinated with and in accordance with the utility company requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Conductors:
   1. Exposed grounding components such as bars, straps, cables, flexible jumpers, braids, shunts, etc., shall be bare copper unless otherwise indicated.
   2. Grounding conductors in raceway with 600V circuiting shall be insulated to match the circuit conductors with green color.
   3. Grounding conductors used with system voltage greater than 1000V shall be bare unless otherwise indicated.
   4. Grounding conductor size shall be as indicated or as required by the NEC whichever is larger, stranded, soft drawn or soft annealed copper, unless otherwise indicated. Sizing shall take into account circuit voltage drop.
   5. Acceptable Manufacturers:
      a. Same make as for 600 volt conductors.

B. Connectors, Clamps and Terminals:

1. Mechanical connectors and clamps shall be made of copper alloy or silicon bronze. Solderless compression terminals shall be copper, long-barrel, NEMA two bolt. Bolts and washers (Belleville) shall be of comparable material or stainless steel.
    a. Acceptable Manufacturers:
        1) Burndy
        2) Hubbell Anderson Corp.
        3) Thomas & Betts
        4) Approved equal
2. Exothermic Welds:
    a. Provide exothermic welds designed for size and type of intended cable, rods, structure, etc. Solder prohibited for connections, except for medium and high voltage cable metallic tape shields (utilize mechanical and solder).
    b. Acceptable Manufacturers:
        1) Erico "Cadweld"
        2) Burndy "ThermOweld"
        3) Approved equal
3. Pipe Clamp:
    a. Pipe clamp for bonding to pipe type electrode (water pipe, etc.) shall be a suitably sized copper alloy clamp.
    b. Acceptable Manufacturers:
        1) Burndy GAR-BU
        2) O-Z Gedney Type CG
        3) Burndy "Durium"
        4) AFL Global "Everdur"
        5) Approved equal
4. Flexible Strap:
    a. Flexible grounding straps shall be of braided high conductivity copper with two hole connector. Strap shall have equal to or greater than ampacity of the system it is bonding to. Strap shall provide flexibility in all directions when installed properly.
    b. Acceptable Manufacturers:
        1) Burndy
        2) OZ Gedney
        3) Approved equal
5. Electrostatic Floor Bonding:
    a. Listed grounding kit for bonding ESD carpet, vinyl, rubber and epoxy floor coverings and coatings to ground with the following components:
        1) 1 inch. wide copper grounding tape.
        2) Heavy gauge stainless steel ground termination plates with double sided conductive tape and 20 inch. long lead wire with a #10 terminal ring at the end.

3) Acceptable Manufacturers:
   a) Ground Zero Electrostatics Inc. "Zerostat" Floor Termination and Grounding Kits.

C. Ground Bars:
1. Provide ground bars where indicated. Ground bars shall be:
   a. 98% conductive copper, minimum.
   b. 4 inch. x 1/4 in. thick minimum with length as indicated with minimum 36 inch. for electric room/MDF and all other minimum of 24 in.
   c. Standard NEMA bolt hole patterns with maximum quantity of lug locations. Spacing of 1-1/8 inch. apart.
2. Bar shall be mounted to an accessible wall location with galvanized steel hardware and 2000V rated insulators. Mounting shall be suitable for full complement of cabling.
3. Unit shall conform to EIA/TIA standards.
4. Acceptable Manufacturers:
   a. Erico
   b. Newton Instrument
   c. Burndy
   d. Harger

PART 3 - EXECUTION

3.1 INSTALLATION

A. Grounding Conductors:
1. Provide grounding conductor(s) with all power circuits. Conductor shall be sized as indicated or as required by the NEC as a minimum and shall be terminated on the equipment, device, enclosure, etc. grounding terminal. Conductor size shall be for the entire length unless approved by the Engineer where oversized for voltage drop.
2. Conductors above grade to ground electrodes (water piping, structural column, etc.) and to equipment (service entrance, ground bars, ground halos, etc.) shall be installed in metallic conduit with ends bonded to the conduit
3. Grounding conductors shall be installed to have a minimum radius of 3 inch.
4. Grounding conductors in a raceway system shall be terminated/bonded to each box, cabinet, enclosure, etc. through which it passes or terminates.
5. Grounding conductors routed with underground circuits shall be bonded to each ground electrode and metallic cable support system within the raceway system including pull and access locations.

6. Stranded conductors penetrating vapor barriers, foundations, slab on grade and water stop membranes shall have the interstitial spaces between strands filled with solder 4 inch. beyond the membrane each side. The conductor shall be sealed to the membrane with a manufacturer approved method.

B. Raceway Systems:
1. All metal supports, cable trays, messenger cables, frames, sleeves, brackets, braces, etc. for the raceway system, panels, switches, boxes, starters controls, etc., which are not rigidly secured to and in contact with the raceway system, or which are subject to vibration and loosening, shall be bonded to the raceway system.
2. Termination of rigid conduit at all boxes, cabinets, and enclosures shall be made up tightly with a double locknut arrangement and a bushing, bushings being of the insulated type. Utilize grounding bushings as specified elsewhere in these specifications.
3. Conduit which runs to or from boxes, cabinets, or enclosures having concentric or eccentric knockouts which partially perforate the metal around the conduit and hence impair the continuity of system ground circuits shall be provided with bonding jumpers connected between a grounding type bushing/locknut on the conduit and a ground bus or stud inside the box, cabinet, or enclosure and attached thereto.
4. Conduit expansion joints and telescoping sections of metal raceways shall be provided with bonding jumpers sized in accordance with the NEC.

C. Connectors Clamps and Terminals:
1. Connectors utilized above grade in dry accessible locations shall be mechanical or exothermic type.
2. Connectors in damp locations, below grade or if not indicated shall be exothermic type.
3. Clean the area near the connecting surfaces prior to any connection to ensure effective contact. Cleaning shall be to the bare metal. Wire brush area if needed to remove rust scale paint, dirt, etc. to expose bare metal.
4. Exothermic connections shall be installed in accordance with the manufacturer's recommendations and tested with heavy blow of a five pound sledge.

D. Flexible Strap:
1. Flexible straps shall be used when bonding vibrating/moveable equipment, with expansion fittings and where recommended by the manufacturer.
2. Sufficient slack shall be provided to compensate for the anticipated vibration, movement and expansion.

E. Secondary Electrical Systems:

1. The neutral (grounded) conductor of each low voltage, single and/or polyphase system or distribution system, except special isolated double insulated systems, shall be solidly connected to ground at the transformer neutral bushing, or at the main secondary switchgear to the system ground, and shall be sized for current carrying capacity, not to be less than as required by the NEC. Ground connection shall be to the building grounding system, building steel, building water service, building concrete reinforcement and as indicated.
2. Provide equipment grounding conductor, green colored insulation, with phase conductors, to primary side of all transformers rated 600 volts or less circuited to the enclosure and secondary neutral bushing, to all electrical utilization and distribution equipment; insulation shall be same type as phase conductors. Transformer enclosures shall be bonded to the primary and secondary circuit grounding conductor.
3. Equipment grounding conductors shall extend from the point of termination back to the ground bus of the source panelboard, switchboard, transformer, or switchgear.

F. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors in conduit from building's main service equipment or grounding bus to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes 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 or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

END OF SECTION 260526

SECTION 262000 - ELECTRIC DISTRIBUTION

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.2 DESCRIPTION

A. Provide electric distribution equipment as indicated on the Contract Documents and as specified herein.

1.3 QUALITY ASSURANCE

A. All methods of construction, details of workmanship, that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the specifications. The equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions, etc., correspond to the nomenclature dictated by those manufacturers. Where "or equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

B. Installation shall be in accordance with NFPA 70 (National Electrical Code), National Electrical Safety Code (NESC), state codes, local codes, and requirements of authority having jurisdiction.

C. Equipment shall be designed, manufactured, assembled, and tested in accordance with the latest revisions of applicable published ANSI, NEMA, UL and IEEE Standards.

1.4 SUBMITTALS

A. Submit the following product data/information:
   1. Manufacturer and equipment type.
   2. Standard catalog information sheet.

3. Detailed shop drawings indicating plan, elevation, end and isometric views. Top and bottom conduit areas shall be clearly shown and dimensioned on the drawings.
4. Single-line diagram.
5. Complete Bill of Materials.
6. All relevant ratings, including, but not limited to, voltage, current, interrupting and withstand.
7. Overcurrent Device Information. Model number, available settings, setting ranges, capabilities, etc.
8. Submit available and final settings, programming and adjustments.

B. Submit product data and information for the following equipment, materials, products, etc.:
1. Transformers
2. Distribution Switchboards
3. Distribution and Branch Circuit Panelboards
4. Circuit Breakers
5. Power Meters
6. Switches.
7. Fuses

C. Test Reports:
1. Submit type written test report for all testing indicated herein.

1.5 WARRANTY

A. Provide full system warranty (labor, travel, equipment, etc.) in accordance with Division 1 and a minimum of one (1) year from acceptance.

PART 2 – PRODUCTS

2.1 TRANSFORMERS

A. Dry-Type Transformers:

1. Transformers to be factory-assembled and tested, air-cooled ventilated units for 60 Hz service. Transformers that require internal or external fan assisted forced air cooling to obtain ambient air (AA) rated kVA are not acceptable. Transformers 15 kVA and less shall have 185□C insulation system and shall be designed not-to-exceed 115□C rise above 40□C ambient. Transformers 30 kVA and higher shall have 220□C insulation system and shall be designed not-to-exceed 150□C rise above 40□C ambient. Insulation systems shall be U.L. listed. Cores shall be manufactured from a high-grade, non-aging, silicon steel with high magnetic permeability, low hysteresis and eddy current losses, one leg per phase, and grounded to enclosure. Cores shall be clamped with structural angles and bolted to the enclosure to prevent damage during shipment or rough handling. Remove clamping after installation. Coils shall be continuous winding except for taps, copper, vacuum impregnated with non-hydroscopic thermosetting varnish and shall have a final wrap of electrical insulating material designed to prevent injury to the magnet wire. Transformers having coils with magnet wire visible will not be acceptable. 30 KVA, and larger, floor mounted. Under 30 KVA, wall mounted. Provide Mason type ND, Korfund or Vibrex vibration isolation devices for each transformer. Provide ground bar kit or a ground bar installed on the inside of the transformer enclosure.
2. Ratings: Shall be as indicated on the "Transformer Schedule" or as noted on the drawings. IEEE #C57, NEMA and US Government requirements shall apply. The transformer efficiencies shall meet or exceed the requirements of New York State and the US Department of Energy.
3. For transformers up to 300 kVA, provide with 6-2-1/2% full capacity taps, 2-FCAN (for connections above nameplate) and 4-FCBN (for connections below nameplate). For transformers above 300 kVA, provide 4-2-1/2% fully rated taps, 2-FCAN and 2-FCBN.
4. Manufacturers: Subject to compliance with contract documents, the following manufacturers are acceptable:
    a. Square D
    b. Eaton Corporation
    c. ABB
    d. Acme
    e. Sola/Hevi-Duty
    f. Howard

2.2 DISTRIBUTION SWITCHBOARD

A. Provide distribution switchboard as specified and scheduled herein and shown on the associated drawings. The switchboard shall meet Underwriter's Laboratories enclosure requirements and be furnished with an Underwriter's Laboratory label for service entrance equipment.

B. The switchboard shall be dead front with front accessibility only required. The switchboard framework shall consist of steel channels welded or bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting. The framework is to be formed, code gauge steel, rigidly welded and bolted together to support all cover plates, bussing and component devices during shipment and installation. Each switchboard section shall have as open bottom and an individual removable top plate for installation and termination of conduit. Top and bottom conduit areas are to be clearly shown and dimensioned on the shop drawings. The wireway front covers are to be hinged to permit access to the branch circuit breaker load side terminals without removing the covers. All front plates used for mounting meters, selector switches or other front mounted devices shall be hinged with all wiring installed and laced with flexibility at the hinged side. All closure plates shall be screw removable and small enough for easy handling by one man. The paint finish shall be grey ANSI Standard No., 61 enamel over a rust-inhibiting phosphate primer.

C. The switchboard bussing shall be silver plated copper and of sufficient cross-sectional area to continuously conduct rated full load current with a maximum average temperature rise of 50□C above an ambient temperature of 25□C Provide grounding bus. The main horizontal or through-bus shall be rated as indicated on the drawings. The bus bars shall be rigidly braced to comply with the withstand rating of the switchboard. The main horizontal bus bars between sections shall be located at the back of the switchboard to permit a maximum of available conduit area. The end section shall have bus bar provisions for the addition of a future section. The provisions shall include the bus bars installed and extended to the extreme side of the section and fabricated in such a fashion that the addition of a future section would require only the installation of a single splice bus connection per phase and neutral. The horizontal main bus bar supports, connections, and joints shall be bolted with carriage bolts and Belleville washers. The vertical bus shall be the same rating as the horizontal bus.

D. Each switchboard, as a complete unit, shall be given a single withstand short circuit current rating by the manufacturer. The withstand short circuit current rating shall certify that all equipment is capable of withstanding the stresses of a fault equal to the interrupting capacity rating of the smallest overcurrent protective device contained therein. Such rating shall be established by actual tests by the manufacturer on equipment constructed similarly to the subject switchboard. This test data shall be available and shall be furnished to the Architect/Engineer with the shop drawings submittal.

E. Main disconnect device shall be a molded case circuit breaker, , totally front accessible and front connectable.

F. Distribution molded case circuit breakers shall be group mounted and shall be totally front accessible and front connectable. The circuit breakers shall be mounted in the switchboard to permit installation, maintenance and testing without reaching over any line side bussing. The circuit breakers shall be removable without disturbing either the line side or load side cable terminations and all line and load side connections are to be individual to each circuit breaker. No common mounting brackets or electrical bus connectors will be acceptable. Line side circuit breaker connections shall be bolt-on type. Provide an externally operable mechanical means to trip the circuit breaker, enabling maintenance personnel to verify the ability of the circuit breaker trip mechanism to operate as well as exercise the breaker latch and operating mechanisms. Each type of circuit breaker assembly shall have undergone and passed heat tests according to UL test procedures and be UL Listed.

G. Ratings shall be as indicated in the Contract Documents. Circuit breakers within the switchboard shall be fully rated for the scheduled interrupting rating. Reducing breaker ratings on the basis of "series rating" is not acceptable.

H. Provide utility customer current transformer compartment located in the service entrance section of the switchboard, connected for cold sequence metering. The compartment shall be barriered and covered with a single-hinged door with sealing provisions. All front plates used for mounting meters, instrument transfer switches or other front mounted devices shall be hinged with all wiring installed and laced with flexibility at the hinged side.

I. Manufacturers: Subject to compliance with contract documents, the following manufacturers are acceptable:
   1. Square D "QED Power-Style"
   2. Eaton Corporation "Pow-R-Line"
   3. ABB ReliaGear "SB"
   4. Siemens "SB Series"

2.3 DISTRIBUTION PANELBOARD

A. Provide distribution panelboards as indicated in the "Panelboard Schedule" and as located on the drawings. Panelboards shall be equipped with quick make/quick break thermal magnetic, molded case circuit breakers as scheduled.

B. Panelboard bussing and lugs shall be copper. Provide full sized neutral equipped with full capacity bonding strap for service entrance applications and mount electrically isolated from enclosure. Provide neutral bus rated 200 percent of phase bus where indicated on drawings, connectors shall be sized for double sized or parallel conductors. Provide grounding bus in each panelboard, securely bonded to the box. Panelboard bus structure, main lugs, and main breaker shall have current ratings as indicated. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50□C rise above ambient.

C. Circuit breakers shall be equipped with individually insulated, braced and protected connectors. Large permanent, individual circuit numbers shall be affixed to each breaker in a uniform position. Tripped indication shall be clearly shown by the breaker handle taking a position between "ON" and "OFF". Provisions for additional breakers shall be such that no additional connectors will be required to add breakers.

D. Each panelboard, as a complete unit shall have a short circuit rating equal to or greater than the rating shown on the Panelboard Schedule. All panelboards shall be fully rated. "Series Ratings" are NOT acceptable. The use of series rating of panelboards for short circuit rating is not acceptable.

E. Panelboard assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel to be as specified in UL Standard 50 for cabinets. The size of wiring gutters shall be in accordance with UL Standard 67. Cabinets shall be equipped with locks and all locks shall be keyed alike. End walls shall be removable. Fronts shall be of code gauge, full-finished steel with rust-inhibiting primer and baked enamel finish.

F. The panelboard interior assembly shall be dead front with panelboard front removed. Panelboard front shall be door in door construction with full length piano-hinge. Main lugs or main breakers shall be barriered on five (5) sides. The end of the bus structure opposite the mains shall be barriered.

G. Panelboards shall be UL listed for use intended.

H. Ratings shall be as indicated in the contract documents.

I. Manufacturers: Subject to compliance with contract documents, the following manufacturers are acceptable:
   1. Square D "I-Line"
   2. Eaton Corporation "PRL3"
   3. ABB ReliaGear "10ext"
   4. Siemens

2.4 BRANCH CIRCUIT PANELBOARD (480Y/277 volt, 208Y/120 volt, 240/120 volts):

A. Provide branch circuit panelboard as indicated in the "Panelboard Schedule" and as located on the drawings. Panelboards shall be equipped with quick make/quick break thermal-magnetic, molded case circuit breakers as scheduled.

B. Panelboard bussing and lugs shall be copper. Provide full sized neutral equipped with full capacity bonding strap for service entrance applications and mount electrically isolated from enclosure. Provide neutral bus rated 200 percent of phase bus where indicated on drawings with connectors shall be sized for double sized or parallel conductors. Provide grounding bus in each panelboard, securely bonded to the box. Panelboard bus structure and main lugs or main circuit breaker shall have current ratings as indicated. Such ratings shall be established by heat rise tests, conducted in accordance with UL Standard 67.

C. Provisions for additional circuit breakers shall be such that field addition of connectors or mounting hardware will not be required to add circuit breakers to the panelboard. Bus connections shall be bolt-on.

D. Each panelboard, as a complete unit, shall have a short circuit current rating equal to or greater than the rating shown on the Panelboard Schedule or on the plans. All panelboards shall be fully rated. "Series Ratings" are NOT acceptable. Reducing breaker ratings on the basis of series rating is not acceptable.

E. The panelboard bus assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel to be specified in UL Standard 50 cabinets. Wiring gutter space shall be in accordance with UL Standard 67 for panelboards. Each front shall include a door and have a flush, stainless steel, cylinder type lock with catch and spring-loaded door pull. All panelboard locks shall be keyed alike. Doors shall be mounted by completely concealed steel hinges. A circuit directory frame and card with a clear plastic covering shall be provided on the inside of the door. Fronts shall be of code gauge, full-finished steel with rust inhibiting iron phosphate sealer and baked enamel finish. Minimum box width shall be 20 inch.

F. Panelboards with main circuit breaker shall have inherent and listed coordination of the main and branch circuit breakers.

G. Ratings shall be as indicated on the Panelboard Schedule.

H. Manufacturers: Subject to compliance with Contract Documents, the following manufacturers are acceptable:
   1. 480Y/277 Volt:
      a. Square D "NF"
      b. Eaton Corporation "PRL2"
      c. ABB ReliaGear "RE" or "RS"
      d. Siemens
   2. 208Y/120 Volt and 240/120 Volt:
      a. Square D "NQ"
      b. Eaton Corporation "PRL1"
      c. ABB ReliaGear "RQ"
      d. Siemens

2.5 CIRCUIT BREAKERS

A. Circuit breakers shall be molded case constructed using glass reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

B. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes. Single pole 15 and 20 ampere circuit breakers shall be UL listed as "Switching Breakers" at 120V ac or 277 V ac and carry the SWD marking. Lugs shall be mechanical, rated for 60/75° AL/Cu.

C. Thermal Magnetic Circuit Breakers: Inverse time current element for low level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit breaker frame sizes 250A and larger.

D. Adjustable, Instantaneous Trip Circuit Breakers – Magnetic trip element with front mounted, field adjustable trip setting.

E. Electronic Trip Circuit Breakers (400A frame and above): , RMS sensing, field replaceable rating plug or electronic trip and front field adjustable settings for long-time, long-time delay, short time, short time delay, as indicated.
   1. Square D Micrologic trip unit.
   2. Eaton Corporation Optim 550 trip units for circuit breakers 400 – 1600 amp frame or RMS 610 trip units for 2000 amp frame to 6000 amp frame.
   3. ABB Spectra RMS or MicroVersa trip unit.
   4. Siemens Sentron Sensitrip III trip unit.

F. Shunt Trip: 120V trip coil energized from separate circuit, with coil-clearing contact.

G. Ground-Fault Circuit Interrupter (GFCI) circuit breakers shall be quick-make, quick-break, thermal-magnetic, Class A, 6 milliampere ground fault sensing and trip indicating, and multipole breakers shall have common trip. The ground fault circuit breakers shall not occupy any more space than a standard breaker of the same number of poles.

H. Arc Flash Energy Mitigation: Provide the following arc flash energy mitigation system for all circuit breakers 1200A and larger.

1. Arc Energy Reduction Maintenance Switch: Equipment main circuit breaker shall have a selector switch in the front of the unit enclosure for maintenance periods. The switch shall be 30mm metal Square D type K and labeled "Normal" and "Maintenance". The normal position shall utilize the standard trip settings of the breaker. The maintenance position shall utilize a quicker series of trip settings to reduce the potential arcing energy. The selector switch shall have a protective flip up cover. LED warning light on the face of the unit enclosure shall indicate when in the maintenance mode and have appropriate signage. The system shall be fully wired and tested by a factory authorized/trained technician.

I. Listed combination of coordinated circuit breakers shall be verified by the equipment manufacturer utilizing published data sheets. Confirmation listings shall be submitted.

J. Ratings shall be as indicated in the Contract Documents.

K. Enclosed circuit breakers shall be molded case, thermal-magnetic type, ratings as noted, with overcenter, trip-free, toggle-type operating mechanism, quick make/quick break action and positive handle indication. Multiple pole breakers shall be common trip type. Each circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each phase. Provide provisions for padlocking in the "off" position. Breakers shall be calibrated for operation in an ambient temperature of 40□C and shall be suitable for mounting and operating in any position. Breakers shall have removable lugs, UL listed for copper and aluminum conductors. Breakers shall be installed in NEMA 1 general purpose, surface enclosures, unless otherwise noted.
   1. Manufacturers: Subject to compliance with Contract Documents, the following manufacturers are acceptable:
      a. Square D
      b. Eaton Corporation
      c. ABB
      d. Siemens

2.6 POWER METER

A. Where indicated on the drawings, provide a power meter with the following parameters:
   1. LCD or LED display.
   2. Line voltage control power.
   3. Voltage input with overcurrent protection and disconnecting means.
   4. True RMS voltage and current measurement.

5. Metered parameters: Phase current, line voltage, phase voltage, frequency, power factor per phase and three phase total, real power per phase and total, reactive power per phase and total, apparent power per phase and total, total real energy, total reactive energy, total apparent energy, user configured sliding window for real, reactive and apparent power peak demand. Sampling rate shall be 512 sample points per cycle minimum
6. Accuracy: Energy, and demand power: 0.2% in accordance with ANSI C12.20Instrument current transformers shall be factory wired to shorting blocks to prevent open-circuiting the current transformers under energized conditions. The meter shall also be user programmable for current to any CT ratio.
7. Capable of metering up to 480 volts without external potential transformers. The meter shall also be user programmable for voltage range to any PT ratio.
8. Communications: Modbus RTU, TC/IP, etc.
9. Acceptable Manufacturers:
    a. Equipment (Unit Manufacturer)
    b. Square D
    c. Eaton Corporation
    d. Shark

2.7 SWITCHES

A. Disconnect (Safety) Switches
1. Shall be heavy-duty type three-pole, with “Quick Make/Quick Break” operating handle mechanically interlocked with the cover, horsepower and voltage rated to match equipment served. Where indicated switches shall be provided with dual-element, time delay, rejection type fuses. Switches shall be installed in NEMA 1 for indoor use, NEMA 3R for outdoor use. Provide provisions for padlocking in the “off” position. Provide neutral bar in single phase or three phase, four wire circuits, and ground bar in all switches. Provide auxiliary contacts where called for.
2. All disconnects connected downstream of ASD’s shall have a normally open and normally closed auxiliary contacts which shall be wired to the ASD to indicate disconnect is open.
3. Manufacturers: Subject to compliance with Contract Documents, the following manufacturers are acceptable:
    a. Square D
    b. Eaton Corporation
    c. ABB
    d. Siemens

2.8 FUSES

A. All fuses rated 600 volts and below shall be rejection type dual-element, time-delay type. Provide two (2) complete sets of fuses for all fusible devices. Deliver spare fuses to the Owner and obtain receipt.

B. Manufacturers:
   1. Fuses 600 Amperes and Below: Type RK5, Bussman Type FRS-R (600 volts), Bussman Type FRN-R (300 volts) or equivalent.
   2. Fuses Rated Above 600 Amperes: Type L, Bussman Type KRP-C or equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Receive, inspect, handle, store, and install equipment as per NEMA published bulletins.

B. Visually inspect physical and mechanical conditions, anchorage, alignment, and grounding. Verify the equipment is clean and perform specific inspections and tests recommended by the manufacturer.

C. Secure covers to enclosures and tighten all bolts to manufacturer recommended torques to reduce noise generation. Remove shipping bolts, blocking and wedges.

D. Construct concrete bases and anchor floor mounted equipment according to manufacturer's written instructions. Concrete base shall be 4 inch nominal thickness and extend 3 inches on all sides, with 6" x 6", #6 reinforcing wire mesh centered and doweled into floor. Coordinate size and location of concrete bases with actual equipment provided. Cast anchor bolts inserts into bases. Concrete, reinforcement, and framework requirements are specified with concrete. Locate base to provide adequate clearances for proper ventilation.

E. Tighten electrical connectors and terminals according to manufacturer's published torque tightening values.

F. Ground equipment per the NEC and Section 260526.

G. Dry-Type Transformers:
   1. Install wall mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer. Coordinate installation of supports with actual transformer provided.
   2. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmissions to the building structure.

H. Switchboards:

1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded. Install anchor bolts to elevations required for proper attachment to switchboards. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.
2. Frame and mount the printed basic operating instructions, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboard.
3. Install filler plates in unused spaces of panel mounted sections.
4. Install overcurrent protective devices, surge protection devices, and instrumentation. Set field-adjustable switches and circuit breaker trip ranges.

I. Panelboards:
1. Mount top of trim 90 inches above finished floor unless otherwise noted. In ADA accessible locations, mount top of trim 48 inches above finished floor.
2. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box. Securely mount to the building structure (not wall surface material, finishes, etc.) utilizing 3/8" minimum bolts/washers/nuts with quantity suitable for the building structure and in accordance with the manufacturer's recommendations. Distribution panelboards if not mounted to a concrete wall shall additionally have a galvanized steel channel base to support it from the floor with horizontal members around the perimeter and vertical a minimum of 18" on center.
3. Install overcurrent protective devices, surge protection devices, and instrumentation. Set field-adjustable switches and circuit breaker trip settings.
4. Install filler plates in unused spaces.
5. For recessed panelboards, stub four (4) 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four (1) 1-inch empty conduits into raised floor space or below slab to floor below not on grade.
6. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
7. Provide insulated protective cover over threaded bolts/studs within the panelboard.

8. Provide lugs/terminations suitable for the indicated conductor size. Where conductors have been oversized for voltage drop and where approved by the Engineer it shall be allowed to reduce the conductor size using hydraulically crimped splice in a box next to the distribution equipment to allow for standard lug termination.

J. Molded Case Circuit Breakers:
1. Visually inspect that equipment nameplate data are as described in the specifications and shown on the drawings. Inspect physical and mechanical condition, and anchorage, alignment, grounding, and clearances.
2. Verify that the unit is clean and operate the breaker to ensure smooth operation. Inspect bolted connections for high resistance using a low resistance ohmmeter or by calibrated torque-wrench method in accordance with manufacturer's published data.
3. Inspect operating mechanism, contacts, and chutes in unsealed units.
4. Provide pad lockable branch circuit breaker device to hold circuit breaker in the closed position, but not prevent overcurrent protection, for all branch circuits serving fire alarm controls panels, emergency lighting and life safety branch circuits.

K. Disconnect (Safety) Switches:
1. Provide wiring, conduit and connections between ASD and disconnect auxiliary switch to ASD.

L. Fuses:
1. Examine fuses before installation. Reject fuses that are moisture or physically damaged. Examine holders to received fuses for compliance with installation tolerances and other conditions affecting performance. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment. Arrange fuses so rating information is readable without removing fuse.

M. Electric Metering:
1. Install meters furnished by utility company. Install raceways and equipment according to the utility company's written instructions. Provide empty conduits for metering leads and extend ground connections as required by utility company.

3.2 FIELD QUALITY CONTROL

A. Dry-Type Transformers:
1. Measure resistance at each winding, tap, and bolted connection.

2. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
3. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
4. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
5. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions and secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Switchboards and Panelboards:
1. Test insulation resistance for each bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test. Test continuity of each circuit.
2. Test ground-fault protection of equipment for service equipment per NFPA 70.
3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
4. Correct multifunctioning units on site where possible, and retest to demonstrate compliance; otherwise replace with new units and retest.
5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Molded Case Circuit Breakers (Electronic Trip):
1. Breakers shall be tested with secondary current injection utilizing a minimum of three (3) different points on each of the phase and one for ground fault overcurrent curves. Phase test points shall be at instantaneous, short time and long time portions of the curve. The tested points shall be plotted on the TCC curves utilizing the final settings with the coordination study. Each breaker shall be tested to prove proper operation at the specific settings.

3.3 IDENTIFICATION

A. Identify all items of equipment as described in Section 260501. Identification shall be provided for switchboards, panelboards, transformers, motor starters, disconnect switches, enclosed circuit breakers, switchboard main/distribution breakers, surge suppression devices, control panels, etc.

B. Switchboards and panelboards shall have a label indicating name/tag ID, feeder source, conductor color convention and for service entrance locations the available short circuit current.

C. Provide a permanent label on service equipment containing the following information:
   1. Nominal system voltage.
   2. Available fault current at the service overcurrent protective device.
   3. The clearing time of service overcurrent protective device based on the available fault current at the service equipment.
   4. The date the label was applied.

3.4 ELECTRICAL LOAD TEST

A. Conduct a load test prior to request for final payment and comply with the following:
   1. Energize maximum normal light and power load for a period of two hours when scheduled.
   2. Record voltage at service and at each panel.
   3. Measure current in each phase of all feeders.
   4. Adjust transformer taps as directed by engineer after review of report.
   5. Provide and install all necessary metering equipment.
   6. Owner's Representative or Site Representative shall witness the test.
   7. Before final acceptance specified test shall be completed to the satisfaction of the Owner's Representative who shall be sole judge of the acceptability of such tests and who may direct the performance of such additional tests as deemed necessary in order to determine the acceptability of the systems, equipment, material and workmanship. Additional tests required by the Owner's Representative shall be provided at no additional cost. Protective equipment shall be actuated in a manner that clearly demonstrated their workability and operation.

3.5 CLEANING

A. At the completion of the project, while equipment is de-energized, it shall be thoroughly cleaned to a shipped condition using methods in accordance with the manufacturer's recommendations. Utilize vacuum for cleaning and not compressed gas.

3.6 SPARE PARTS

A. Deliver loose equipment to the Owner and obtain receipt for fuses, keys to panelboards, etc.

END OF SECTION 262000

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SECTION 265000 - LIGHTING

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2022.

B. ASTM D648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position; 2018.

C. ASTM D1929 - Standard Test Method for Determining Ignition Temperature of Plastics; 2020.

D. ASTM D2843 - Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics; 2022.

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023c.

F. IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products; 2019.

G. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources; 2021.

H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

J. UL 1598 - Luminaires; Current Edition, Including All Revisions.

K. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.2 RELATED DOCUMENTS

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

1.3 DESCRIPTION

A. Provide interior and exterior lighting systems, including luminaires, hangers, supports, fittings, wiring, connections and controls, as indicated in the Contract Documents for complete and operational systems. Luminaires, in general, have been specified for the particular type of ceiling in which they are to be installed. Verify the ceiling construction details and provide luminaires suitable for the respective ceiling types and room finish schedule.

1.4 REFERENCES

A. The following standards, criteria, codes, etc. shall be followed in the manufacture and installation of the lighting systems.
   1. NFPA
   2. NEC
   3. IESNA
   4. NEMA
   5. ANSI
   6. UL

1.5 QUALITY ASSURANCE

A. Luminaires shall be as specified in the "Luminaire Schedule". Luminaire types, appearance, characteristics, photometrics, finishes, etc., correspond to the specified manufacturer and associated series or catalog number listed in the "Luminaire Schedule". Products of other listed acceptable manufacturers shall be equivalent in every way to that of the luminaire specified. The Engineer reserves the right to disapprove any luminaire type submitted which they feel is not equal in quality, appearance or performance to the luminaire specified.

B. Manufacturer's luminaire series or catalog numbers listed in the "Luminaire Schedule" indicate quality, type, and style, but may not cover required special design details. Provide luminaires having such special details as noted in the "Luminaire Schedule", as indicated by the specified luminaire model number and as required for proper installation.

C. All luminaires shall be new and bear a Nationally Recognized Testing Laboratories (NRTL) label for the service intended.

D. Luminaires shall be products of manufacturers regularly engaged in the manufacture of the type of luminaires specified and shall be the manufacturer's latest standard design that complies with specification requirements.

E. Verify the availability of all luminaires proposed to be used in the execution of the work prior to submitting same for approval. The discontinuance of production of any luminaire after such approval has been granted shall not relieve the Contractor from furnishing an approved luminaire of comparable quality and design at no additional cost.

F. Photometric and operational data shall be provided only by qualified and certified organizations. Certification documentation shall be submitted with the luminaire information.

G. Should there be any difference between drawings and schedules, secure from Architect/Engineer such information as necessary prior to providing proposal. When finishes are not definitely specified, they shall be as selected by the Architect and not be limited to standard finishes.

H. Locations indicated for luminaires are approximate. Field coordinate exact locations as near as possible to the location indicated. Coordinate with the Engineer for any major location changes.

1.6 SUBMITTALS

A. Product Data: For each luminaire type, include in a single submittal, in order of luminaire designation, the catalog "cut" sheet with complete manufacturer and model number. Product data should include the following:
   1. Manufacturer and Catalog Number.
   2. Features, accessories, materials and finishes.
   3. Physical description and dimensions of luminaires.
   4. Life, power input, output (lumens, distribution, CCT, and CRI) and energy-efficiency data.
   5. Photometric data and adjustment factors based on laboratory tests (space to mounting height ratio, coefficient of utilization complete values, IES distribution, candlepower distribution by angle and luminaire efficiency). Format shall be in accordance with IES TM-27.
   6. Power, signal, and control wiring diagrams between luminaires and controllers.
   7. Lens/Louver Type.
   8. Driver with each type luminaire as applicable (type, sound rating, overload protection, voltage, input/fixture wattage, ballast factor, power factor, etc.).
   9. Integral battery inverters.
   10. Emergency lighting units, including batteries and chargers.
   11. Certification of IES LM-79, IES LM-80 and TM-21 testing for LED luminaires. Luminaires shall be tested in accordance with IES LM and TM standards.
   12. Warranty.

B. Coordination Drawings: Provide coordination drawings in accordance with Section 260500. Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Luminaires.
   2. Suspended ceiling components.
   3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
   4. Structure members to which equipment and or luminaires will be attached.
   5. Initial access modules for acoustical tile, including size and locations.
   6. Items penetrating finished ceiling, including other luminaires, air outlets and inlets, speakers, sprinklers, access panels, ceiling mounted projectors, etc.
   7. Coordination of ceiling types and ceiling grids/structure to account for luminaire mounting and space requirements and luminaire lengths.

C. Color Chips: Provide color chips of available finishes for luminaires upon request of Architect/Engineer.

1.7 DELIVERY, STORAGE AND HANDLING

A. Luminaires and equipment shall be delivered with NRTL and manufacturer's labels intact and legible. Broken, cracked and damaged materials and equipment shall be removed from the site immediately and be replaced with new materials and equipment. Luminaires and accessories shall be stored in protected dry locations in their original unbroken package or container. Luminaires shall be protected from dust and dampness both before and after installation. Luminaires shall be protected from paint and cleaning solvents during all phases of construction.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

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

B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division hazard by a NRTL.

C. UL Compliance: Comply with UL 1598 and UL 8750.

D. Recessed Luminaires: Comply with NEMA LE 4.

2.2 LIGHT-EMITTING DIODE (LED) LUMINAIRES

A. Luminaires shall be identical in construction features, options and appearance to the luminaries specified in the Luminaire Schedule. LED luminaires include white and RGBW systems as indicated on the luminaire schedule.

B. Luminaires shall be provided with all cables, controllers, power supplies, drivers, connectors, terminators and accessories required for a complete installation. LED system shall utilize pulse width modulation, non-linear scaling techniques and reverse polarity protection.

C. Provide dimming down to 10% as a minimum, or to percentage indicated or called for on the drawings. Unless otherwise indicated, the dimming control shall be a 0-10VDC signal

D. LED luminaires shall be high brightness and binned for forward voltage, luminous flux and wavelength.

E. LED luminaires shall be tested in accordance with IESNA LM-79 (luminous output, power input, luminaire efficacy (lumens/watt), color temperature and color rendering index), IESNA LM-80 (L70, output luminous maintenance, 10,000 hour minimum test, calculation method is not acceptable) and IESNA TM-21/28. Luminaire output shall be a minimum of 100 lumens/watt. Rated life shall be a minimum of 50,000 hours at 70% output. Testing shall be performed by a US Department of Energy (DOE) accredited laboratory.

F. Drivers shall be solid state Class 1 power supply/driver with universal input (120-277V). The system shall have a minimum 90% power factor, 3.5 maximum crest factor, minimum efficiency of 90%, a maximum of 20% THD and overload protection. Adequate heat sink capability shall be provided to ensure the rated life. Unit shall meet FCC rules and regulations.

G. Where indicated luminaires shall have color tuning capability and control. System to have separate dimming (5-100%) and color (3000K to 5000K, or as indicated on drawings) adjustability. Control shall be Dali or DMX512 for controllability as indicated. The system shall utilize the most recent settings when energized.

H. The luminaire (to include LED sources and drivers) shall have a full five (5) year minimum warranty for replacement and labor.
   1. Acceptable LED Manufacturers:
      a. Philips
      b. Osram
      c. Cree
      d. Nichea
      e. Lumiled

I. LED Emergency Drivers:
   1. LED emergency drivers shall have the following minimum requirements:

a. Operate indicated fixtures at full illumination for 90 minutes minimum.
b. Universal voltage input (120 to 277V).
c. Upon loss of normal power, fixtures shall automatically switch to battery power.
d. Upon restoration of normal power, fixture shall return to normal mode and charge battery.
e. Battery shall be maintenance free, nickel cadmium type with a minimum life expectancy of seven (7) years.
f. Driver shall be suitable for the environment installed.
g. Driver shall be Class 2 and enclosed entirely in the fixture (except for down lights and exterior locations).
h. Units shall be listed for UL 924 -Emergency Lighting and Power Equipment.
i. Minimum five (5) year non-prorated full warranty.
j. Design Make: Iota, ILB-CP series or approved equal.

2.3 LUMINAIRE CONSTRUCTION

A. Metal Parts:
1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during maintenance and when secured in operating position.

C. Lenses:
1. Shall be listed materials tested in accordance with ASTM D635, "Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position" and burns less than 2/5 inches per minute.
2. The products shall have a smoke density of less than 75 when tested in accordance with ASTM D2843, standard test method for "Density of Smoke from the Burning or Decomposition of Plastics".
3. The flame spread rating shall not exceed 0-25 and smoke developed rating shall not exceed 450 inch accordance with ASTM E84, standard test method for "Surface Burning Characteristics of Building Materials".
4. Self-ignition shall not occur below 600°F, in accordance with ASTM D1929, standard test method for "Ignition Properties of Plastics".
5. Materials shall remain in place 15 minutes at 175°F and fall from frame at 200° below ignition temperature in accordance with ASTM D648, "Deflection Temperature of Plastics Under Flexural Load".

2.4 LUMINAIRE SCHEDULE

A. Luminaire schedule is found on the contract drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL INSTALLATION

A. Comply with NECA NEIS (National Electrical Installation Standard) latest edition.

B. All luminaires shall be installed as per manufacturer furnished installation instructions.

C. Provide for every luminaire as shown on the plans, or as scheduled on the drawings.

D. Location of all ceiling and wall mounted luminaires shall be as indicated on the Architectural and Electrical drawings. The contractor shall verify ceiling type, construction, and material prior to ordering.

E. Provide luminaires with an IC rating for luminaires installed in direct contact with insulation.

F. Provide plaster frames for plaster ceilings and flanged frames for drywall ceilings.

G. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

H. Luminaires shall be suitable and as recommended by the manufacturer for the actual intended mounting method and materials.

I. Supports:
   1. Sized and rated for luminaire weight.
   2. Able to maintain luminaire position after cleaning and maintenance.
   3. Provide support for luminaire without causing deflection of ceiling or wall.
   4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

J. Flush-Mounted Luminaires:
   1. Secured to outlet box.

2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

K. Wall-Mounted Luminaires:
1. Attached to structural members in walls, to a minimum 20 gauge backing plate attached to wall structural members, or using through bolts and backing plates on either side of wall.
2. Do not attach luminaires directly to gypsum board.

L. Suspended Luminaires:
1. Pendant and Rods:
a. Pendant mount luminaires from 1/4 inch. threaded rods of required length.
b. Brace pendants and rods longer than 48 inches to limit swinging.
2. Aircraft Cable:
a. Cables shall be 1/16 inch. aircraft cable with end safety fittings. Cable shall be provided with 2 inch. diameter mini-canopy and threaded coupler for attachment to a 1/4 inch.-20 threaded stud extending 3/4 inch. below ceiling.
b. Cable assembly shall include a spring-loaded adjustment device mounted in the fixture.
c. The Contractor shall be responsible for providing required supports for cable attachment.
d. For cord feed to the luminaire provide continuous cord clip of matching color to attach the cord to the cable.
e. Support per manufacturer's recommendations.
3. Support stem mounted, single unit luminaires with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
4. Use tubing or stem for wiring at one point of continuous rows of luminaires and tubing, rod, or wire support for suspension for each unit of length of luminaire chassis, including one at each end.

M. Ceiling-Grid-Mounted Luminaires:
1. Secure to any required outlet box.
2. Use approved devices and support components to connect luminaire to building structure in a minimum of four locations, spaced near corners of luminaire. Utilize #10 steel wire; similar to that used to support the ceiling grid.
3. Provide UL listed seismic hold-down clips and fasten to luminaires and to ceiling grid members at or near each luminaire corner.
4. Install luminaires of sizes less than ceiling grid as indicated on reflected ceiling plans or center in acoustical panel and support luminaire independently with at least two metal channels spanning and secured to ceiling tees.

5. Contractor to verify luminaire mounting and supports are compatible with the ceiling grid type and mounting/support requirements.
6. Contractor to coordinate recessed linear luminaire run lengths with the ceiling grid layout and required mains supports. All continuous run lengths to be verified and coordinated prior to determining the final housing lengths.

N. Provide all necessary accessories for "end-to-end" mounting where continuous rows of luminaires are indicated. All luminaire assemblies shall be grounded.

O. Luminaires installed in continuous rows may be fed by a single outlet if luminaires are UL approved and suitable for through wiring in luminaire raceway.

P. New luminaires may be provided to replace existing luminaires indicated to remain or be reused, subject to shop drawing approval.

3.3 GROUNDING

A. Ground all non-current carrying parts of all lighting luminaires.

B. All grounding shall be accomplished with NRTL tested grounding connectors suitable for this purpose.

3.4 FINAL CLEANING

A. Immediately prior to acceptance, damp clean diffusers, luminaire trim, reflectors, louvers, lens, and similar objects of all luminaires. Remove all dirt, corrosion, foreign material, finger marks, and blemishes. Replace all burned out LEDs and failed components.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test of Emergency Lighting: Under supervision of Engineer, interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

D. Replace luminaires damaged during shipment, construction, or installation.

3.6 STARTUP SERVICE

A. Comply with requirements for startup specified in Section 260936 "Lighting Controls."

3.7 ADJUSTING

A. Provide adjusting the direction of aim of luminaires to suit occupied conditions. Adjustment may be required during hours of darkness.

B. Final distribution shall be acceptable to the Owner and may take several attempts.

3.8 REMOVAL OF BALLASTS IN EXISTING LUMINAIRES

A. Assume ballasts contain PCB material unless labeled otherwise or test samples show materials are not PCB; submit a test report. Remove all ballasts from existing luminaires indicated on contract documents. Dispose of all ballasts which do not have non PCB labels in PCB containers and pay all costs to have containers taken to EPA approved incinerators and disposed of all EPA regulations. Follow all EPA regulations for transporting material. If ballast has leaked in existing luminaires, remove material deposited in luminaire and dispose of those materials as indicated above. Provide documentation verifying disposal of PCB contaminated ballasts.

3.9 REMOVAL OF LAMPS IN EXISTING LUMINAIRES

A. 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.

END OF SECTION 265000

SECTION 265500 - LIGHTING CONTROL

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.2 DESCRIPTION

A. Provide a complete lighting control system as indicated on the Contract Documents and as specified herein.

1.3 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.4 QUALITY ASSURANCE

A. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the specifications. The equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions, etc. correspond to the nomenclature dictated by those manufacturers.

B. Installation shall be accordance with NFPA 70 (National Electrical Code), energy conservation codes, state codes, local codes, and requirements of authority having jurisdiction.

C. Equipment shall be designed, manufactured, assembled, and tested in accordance with the latest revisions of applicable published ANSI, NEMA and IEEE Standards.

D. All equipment shall NRTL tested.

E. All components and assemblies are to be factory pretested.

F. The controls provider must:
   1. Provide equipment from manufacturers for which they maintain a contract, distributorship, are an agent, or other formal arrangement for which documentation can be produced showing authority to sell and service the equipment in this territory.
   2. Demonstrate that they have successfully installed similar systems, utilizing their standard products, for a minimum period of five (5) years.

3. Employ service technicians who are trained in accordance with the systems manufacturer's recommendations.
4. Own and demonstrate proficiency in the use of the required test equipment, tools, etc. for the proper installation, set-up, testing and maintenance of the system. If requested, must provide a listing of tools and/or equipment and where appropriate, certifications in the proper training and use of the tools and/or equipment.

1.5 SUBMITTALS

A. Submit the following equipment, materials, and products including all components and accessories:
1. General Equipment
2. Vacancy/occupancy Sensors
3. Digital Lighting Control System
4. Wiring diagrams
5. Commissioning Plan

B. Submit the shop drawings and the product data specified below at the same time as a single submittal package.

C. Product Data: Provide equipment data sheets, specifications, wiring diagrams and installation instructions for all required system components.

D. Shop drawings shall include the following at a minimum:
1. Composite custom wiring and/or schematic diagram of each control circuit as proposed to be installed (standard diagrams will not be accepted). Wiring diagrams shall include all system components, including but not limited to: room controllers, digital switches, vacancy/occupancy sensors, photocells, isolated relays, digital I/O interfaces to conference room A/V systems, network interfaces, lighting control panels, and associated components.
2. All system devices shall be located per the system manufacturers recommendations. All devices shall be suitable for the building configuration and intended operation.

1.6 SYSTEM DESCRIPTION

A. The lighting control system and/or components, as specified and indicated on the drawings to provide the intended and required control of the lighting systems.

PART 2 - PRODUCTS

2.1 GENERAL EQUIPMENT

A. Switches:

1. Toggle/Snap:
    a. Unit shall be quiet operation, quick make/quick break, rated for 20A/120-277V/1hp at 120/277V, side/back wired, , with nylon/polycarbonate toggle, self grounding mounting screw clip plate (not staple), ground terminal and silver alloy contacts. Units shall meet latest Federal Specification WS-896, NEMA WD-1 and UL Test 20.
    b. Acceptable Manufacturers (for single pole units, provide two pole, three way, four way, illuminated handle, keyed, etc. type of the same quality and model).
        1) Hubbell HBL1221
        2) P&S 20AC1
        3) Leviton 1221-2
2. Low Voltage:
    a. Unit shall be button type switch that is configurable from one button to eight buttons using point-to-point low voltage wiring for control of single or multiple loads. Each button shall provide a momentary contact and all share a common return. The switch shall be totally passive and contain no active electronics or power supply. Operation is dependent upon a Class 2 connection to a compatible relay panel or other device that can react to a momentary contact signal.
    b. Each button shall have an LED indicator light that can serve as a status indicator or as a locator light. The LED indicators shall be powered by a 24VDC source originating from the lighting control panel or other device. The button quantities shall be as indicated on the plan views.
    c. Acceptable Manufacturer:
        1) Wattstopper LVSW series (Design Make)
        2) Acuity Brands
        3) Hubbell
        4) Approved Equal.
3. All device colors shall match the surrounding devices and shall be selected by the Owners Representative.

B. Lighting Dimmers:
1. Provide lighting dimmer where indicated suitable for the type of luminaire for even continuous control. Unit shall be rated for the indicated connected load plus 25% minimum (even when ganged). Review luminaire schedule and plans for type and loading. Provide for three-way control as indicated.
2. Low voltage dimming shall be as recommended by the luminaire manufacturer for magnetic or solid state.
3. LED dimmers shall be as recommended by the luminaire manufacturer and be listed for use with the associated driver.
4. Device color shall match the other project devices.
5. Acceptable Manufacturers:

a. Lutron (Design Make)
b. Crestron
c. Acuity Brands
d. Leviton
e. Approved equal

2.2 VACANCY/OCCUPANCY SENSORS

A. Vacancy/occupancy Sensors:
1. Vacancy/occupancy sensors shall comply with the following as a minimum:
a. Zero crossing switching operation (switch on/off only where sine wave is at zero volts) suitable for linear, non-linear and electronic/magnetic fluorescent ballasts for the loads indicated. Where the load to be controlled exceeds the sensor load rating provide a separate relay of adequate rating.
b. Failure of the unit shall be to the on/closed position or manual operation.
c. Motion sensitivity adjustment (dip switch or dial) and time delay adjustment (5 to 30 minutes minimum, dip switch or dial).
d. Line voltage input and switching. Field selectable for 120 or 277 VAC, 60 Hz.
e. UL listed and have a five (5) year manufacturer full replacement warranty.
f. Test mode feature to override the set time delay to allow adjusting of the sensitivity.
g. Sensor locations shall be adjusted during construction and at occupancy as recommended by the manufacturer for optimal sensing and operation.
h. Operation shall be field selectable with vacancy sensor being manual "on" with close switch/contact upon motion sensing and open after the set amount of time delay without motion or occupancy sensor being automatic on upon motion sensing.
i. Adjustable controls/settings shall only be accessible when the front cover is removed or from the back of the unit.
j. Unit color shall match the project devices except for the ceiling-mounted units which shall match the ceiling color. All color selections shall be by the Architect.
k. Ultrasonic sensing shall not be affected by air movement and shall operate at 32 kHz minimum (shall not interfere with hearing aids or other equipment).
l. Provide components as needed for the indicated control.
m. A factory-authorized representative shall coordinate and instruct the startup services of the sensors providing placement recommendations, connection guidance and startup supervision and adjustment.
2. Wall Mounted - Dual Technology:

a. Unit shall fit into a standard single gang electrical box, have an On/Off button, and utilize PIR and ultrasonic technology motion sensing. Both types of sensing are needed for contact closure but only one (1) is needed to keep it closed.
b. Minimum Switching Capacity: 120 V - 800 W, 277 V - 1200 W.
c. The sensing shall be 180 degrees and the sensitivity area to be a minimum of:
    1) Major Motion (Walking/Arm Wave): 35 feet x 30 feet
    2) Minor Motion (Small Motion at Desk): 20 feet x 15 feet
d. Ambient light level sensing (adjustable 20-300 fc) to prevent "On" operation when the ambient light level is greater than the setpoint level.
e. High impact resistant sensor lens.
f. Acceptable Manufacturers:
    1) Wattstopper DW-100 (Design Make)
    2) Hubbell
    3) Eaton
    4) Acuity Brands

3. Wall Mounted - Dual Technology - Dual Switching:
    a. Unit shall fit into a standard single gang electrical box, have two (2) On/Off buttons, and utilize PIR and ultrasonic technology motion sensing. Both types of sensing are needed for contact closure but only one (1) is needed to keep it closed. To have two (2) contacts each fully rated, electrically separate and be commonly controlled.
    b. Minimum Switching Capacity: 120 V - 800 W, 277 V - 1200 W.
    c. The sensing shall be 180 degrees and the sensitivity area to be a minimum of:
        1) Major Motion (Walking/Arm Wave): 35 feet x 30 feet
        2) Minor Motion (Small Motion at Desk): 20 feet x 15 feet
    d. Ambient light level sensing (adjustable 20-300fc) to prevent "On" operation when the ambient light level is greater than the setpoint level.
    e. High impact resistant sensor lens.
    f. Acceptable Manufacturers:
        1) Wattstopper DW-200 (Design Make)
        2) Hubbell
        3) Eaton
        4) Acuity Brands
4. Wall Mounted - Dual Technology - Dimmer Switch:
    a. Unit shall fit into a standard single gang electrical box, have an on/off button and utilize dual technology (PIR and Ultrasonic) motion sensing. Both types of sensing are needed for contact closure, but only one is needed to keep it closed. Selectable manual or automatic on mode. Provide with 0-10 VDC dimming control with raise and lower buttons.

b. Minimum Switching Capacity: 120 V - 1000 W, 277 V - 1200 W.
c. The sensing shall be 180° and the sensitivity area to be a minimum of:
   1) Major Motion (Walking/Arm Wave): 35ft. x 30 feet
   2) Minor Motion (Small Motion at Desk): 20 feet x 15 feet
d. Ambient light level sensing (adjustable 20-300 fc) to prevent "on" operation when the ambient light level is greater than the set point level.
e. High impact resistant sensor lens.
f. Dimming Control Signal: 0-10 VDC, with minimum sink current of 50mA. Raise/lower buttons to allow manual dimming of the space luminaires.
g. Acceptable Manufacturers:
   1) Wattstopper DW-311 (Design Make)
   2) Hubbell
   3) Eaton
   4) Acuity Brands

5. Ceiling Mounted - Dual Technology (No Subscript):
   a. Unit shall mount to standard octagonal box, have auxiliary contact (Form C, 0.5A at 24 VDC), and utilize PIR and ultrasonic technology motion sensing. Both types of sensing are needed for contact closure but only one (1) is needed to keep it closed.
   b. Shall have self-contained rated contacts or control a separate switch pack. If a self-contained unit, then the ratings and function shall meet or exceed the switch pack specifications.
   c. Sensing shall be 360 degrees with a minimum operating area of:
      1) Major Motion (Walking/Arm Wave): 50 feet x 30 feet
      2) Minor Motion (Small Motion at Desk): 40 feet x 20 feet
   d. Units shall be suitable for overlap of motion detection areas without reduction in spacing and false operation.
   e. Sensing shall be suitable for a ceiling/mounting height of up to 12 feet minimum.
   f. Ambient light level sensing (adjustable 20-300 fc) to prevent "On" operation when the ambient light level is greater than the setpoint level.
   g. The maximum depth shall be 1.5 inch. below the ceiling/box.
   h. Acceptable Manufacturers:
      1) Wattstopper DT-300 (Design Make)
      2) Hubbell
      3) Eaton
      4) Acuity Brands

B. Switch Pack:
   1. Provide a minimum of one (1) switch pack for each ceiling-mounted vacancy/occupancy sensor. Provide additional units for multiple circuits (quantity to match the quantity of circuits).
   2. Unit shall be plenum rated with line voltage side into a metallic box.

3. Low voltage power shall be suitable for a minimum of three (3) sensors. Multiple sensors shall be able to control a single switch pack.
4. Minimum switching capacity shall be 20A (all types of loads) at 120/277 VAC.

2.3 DIGITAL LIGHTING CONTROL SYSTEM

A. General:
1. All associated system components shall be supplied from a single manufacturer and shall be compatible for communication as part of the digital lighting control network. Combining multiple manufactures system components to achieve the required system operation is not acceptable.

B. Vacancy/Occupancy Sensors:
1. Wall or ceiling mounted (to suit installation) dual technology digital (passive infrared and ultrasonic) occupancy sensor. Provide unit to accommodate the square-foot coverage requirements for each area controlled.
2. Sensors shall have adjustable settings and features as noted below. Sensor shall be adjusted through one of the following: graphic LCD display, push button or via software from handheld device.
   a. Sensitivity: 0-100% in 10% increments.
   b. Time Delay: 1-30 minutes in 1 minute increment. Time delay shall be set 20 minutes.
   c. Detection Technology: Dual technology activation and or re-activation. The sensor shall be capable of being set to either PIR & Ultrasonic, PIR Only or Ultrasonic Only as required by the space being controlled as recommended by the manufacturer.
   d. Test mode – Five second time delay
   e. Walk-through mode
   f. Selectable operating parameters shall include as a minimum Auto (Occupancy) / Manual (Vacancy) - ON, blink warning, and daylight enable/disable when photosenors/day-light sensors are included in the digital network.
3. Sensing shall be 360 degrees with a minimum operating area of:
   a. Ultrasonic: 25 feet x 25 ft.
   b. Passive Infrared: 32 ft radial.
4. RJ-45 port(s) for connection to digital lighting control network.
5. Two-way infrared (IR) transceiver to allow remote programming through handheld configuration device and control by remote personal controls.
6. Assignment of occupancy/vacancy sensor to a specific load within the room without wiring or special tools.
7. Manual override of controlled loads.

8. Multiple occupancy sensors shall be installed in a room if required by the size/configuration by connecting them to the open topology digital lighting control network. No additional configuration shall be required.
9. Provide wall or ceiling mounted sensors as indicated on the drawings. Final locations of all sensors shall be in accordance with the manufacturer's recommendations.

C. Acceptable Manufacturers:
1. Wattstopper: Digital Lighting Management - DLM, (Design make).
2. Acuity Controls: nLight
3. Crestron Controls: GLPAC
4. Hubbell NX

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide all required system components, interconnection wiring and branch circuit power connections as required by the lighting control system manufacturer to meet the intended sequence of operation and system performance requirements. All system wiring shall be in accordance with the system manufacturer's requirements at a minimum.

B. When using wire for connections other than the digital lighting control network (Category 5e with RJ-45 connectors), provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contractor termination requirements. All Category 5e cabling and connectors shall be terminated and tested to meet the system manufacturer’s requirements. Category 5e cabling shall have a thermoplastic jacket to easily identify from other building network cabling, building management system, or other low voltage systems cabling.

C. All line voltage wiring shall be installed in conduit. Terminations shall be done above accessible ceilings or within utility rooms and within a 4"x4" back box and have a suitable cover provided. Digital network devices (room controllers, isolated relays, plug load controllers, etc.) shall be mounted to a junction box and connected as recommended by the system manufacturer.

D. All low voltage control cabling shall be plenum rated. Cabling shall be installed in minimum 3/4" conduit in vertical runs in walls/partitions and inside mechanical/utility rooms. Provide suitable back box as required by the system manufacturer for the device being installed. Above accessible ceilings all control cabling shall be installed within separate J-hook supports located at 3' on center with the cabling neatly bundled. All cabling inside utility rooms without ceilings shall be installed in conduit.

3.2 SYSTEM PROGRAMMING

A. Upon completion of the installation, the system shall be programmed by the manufacturer's factory authorized representative who shall verify a complete fully functional system.

B. The system manufacturer shall include separate individual site visits scheduled to complete the system programming and perform the following functions:
   1. Initial system startup/programming (time shall be suitable to setup all system devices).
   2. Coordination with the owner to develop preferred lighting control scenes, scene illumination levels, button operation and coordinate day lighting requirements prior to final system programming. Once verified with the owner all system components shall be fully programmed and setup.
   3. Verification of the system operation (time shall be suitable to test and verify day lighting functions are operating properly). The manufacturer shall provide light meters for verification; time shall be as required for proper testing of the system.
   4. The lighting control system manufacturer shall coordinate all room names and scheduling with the owner prior to final setup.
   5. The presence of the system manufacturer's service technicians to assist the installing electrician in all of the above is a requirement of this project and proof of time expended shall be provided to the Owner's Representative.

3.3 SYSTEM COMMISSIONING

A. The electrical contractor shall provide both the Owner and the electrical engineer with a minimum of ten working days written notice of the system startup and configuration date.

B. Refer to the lighting control details that are part of the Construction Drawings for sequence of operation and commissioning requirements of the project lighting control scenarios.

C. All lighting control systems and components shall be commissioned to verify sensor location, time delay/sensitivity is properly set, auto-on/manual-on, override times, controls, day-lighting control, communications between control panels, and timeclock controls are operating as intended.

D. Calibrate all sensor time delays, sensitivity settings and properly aim to guarantee proper detection of occupants and energy savings.
   1. Adjust time delay so that controlled area remains lighted for 20 minutes after occupant leaves area.

E. Exterior photocells shall be aimed per the manufacturer's installation instructions. Locate and aim to be facing to the north and avoid being blocked by the building architectural features.

F. Provide written or computer-generated documentation on the commissioning of the system including room by room description including:
   1. Sensor parameters, time delays, sensitivities, and daylighting set points.
   2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
   3. Load Parameters (e.g. blink warning, etc.)

3.4 SYSTEM TRAINING

A. The Contractor shall provide instruction to the Owner's Representative with regard to use and operation of the system. Obtain signed receipt from Owner's Representative that instruction has been given.

B. The lighting control system's manufacturer shall supply at least one (1) service technician after all systems have been tested and in full operation as described above to assist the installing electrician to demonstrate and instruct the Owner's Representative on the operation, programming and any uniqueness of the control system. Provide additional instruction and training to the owner to as required to verify the owner is comfortable with the system operation. Time of demonstration and instruction to be at Owner's convenience during normal working hours and shall be scheduled a minimum of ten working days prior.

3.5 WARRANTY

A. Provide a five-year complete manufacturer’s warranty on all products to be free of manufacturers’ defects.

3.6 MAINTENANCE

A. Spare Parts:
   1. Provide the following spare parts/components to be used for the owner’s maintenance. The spare parts shall be fully tested for proper operation and turned over to the owner in the original boxes:

END OF SECTION 265500

SECTION 283103 - FIRE ALARM SYSTEM - EXISTING HARDWIRED SYSTEM

PART 1 GENERAL

1.1 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.

C. UL 268 - Standard for Smoke Detectors for Fire Alarm Systems; Current Edition, Including All Revisions.

D. UL 2075 - Standard for Gas and Vapor Detectors and Sensors; Current Edition, Including All Revisions.

1.2 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the expansion of the existing fire alarm systems and related Work required in these Contract Documents.

B. The work described in this section shall apply to the Middle/High School, Elementary School and Bus Maintenance Facility.

1.3 QUALITY ASSURANCE

A. All methods of construction, details of workmanship that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the specifications. The equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions, etc. correspond to the nomenclature dictated by those manufacturers. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

B. Installation shall be in accordance with NFPA 70, NFPA 72, (National Fire Alarm Code), state codes, local codes, and requirements of the authority having jurisdiction.

C. Equipment shall be designed, manufactured, assembled, and tested in accordance with the latest revisions of applicable published ANSI, NEMA, NFPA, UL and IEEE Standards.

D. Contractor shall be a licensed fire alarm installer in the State of New York.

E. Items specified for the fire alarm are to match the existing system and to maintain one fire alarm system in the facility. No other makes will be specified.

1.4 GENERAL DESCRIPTION

A. The existing High School fire alarm panel is a Edwards EST3

B. The existing Middle School fire alarm panel is a Edwards EST3

C. The existing addressable fire alarm panels shall have their capabilities extended to provide coverage for the renovated spaces as shown on the contract drawings.

D. The following work is proposed:
1. Provide initiation devices including, but not limited to, smoke detectors, heat detectors, manual stations, and magnetic door holders in the building. Provide the additional modules required to the existing fire alarm control panel.
2. Provide audio-visual and visual only devices in the existing buildings and in the additions. Provide an extender power panel to support the additional devices.
3. Provide carbon monoxide detection and notification where indicated.
4. Provide control modules for magnetic door holders.
5. Provide for all devices shown on the contract drawings.
6. Refer to Appendix A for operation/sequence of matrix.

E. Before any work is accomplished on the existing system, a thorough testing shall be done on the system to conform to NFPA 72. A test report shall be completed and submitted to the engineers for review. Once the preliminary testing is found to be acceptable, work can proceed on the existing system. An additional test will be performed after the work is complete.

1.4 SUBMITTALS

A. Complete equipment list including quantities. Catalog descriptive literature for all equipment. Riser Wiring Diagram showing all devices, wire quantities and sizes. Typical Terminal Wiring Diagram for each type of device. Terminal Wiring Diagram for the Fire Alarm Control Panel. Calculations, including actual equipment loads used to derive battery backup ampere-hour rating. Submittals that fail to comply with the requirements described will be rejected.

PART 2 PRODUCTS

A. MODIFICATIONS TO THE EXISTING FIRE ALARM CONTROL PANELS

1. Provide the necessary initiation modules for the additional devices required. Each individual function shall be provided by solid state plug-in panels or modules. Removal of any plug-in module shall cause a trouble signal to sound. New end of line resistors shall be located per the existing system. Provide supplementary control modules as required and shown by riser diagram for control of magnetic door holders, duct smoke dampers, fan shutdown.
2. Provide separate visible and audible alarm, trouble and supervisory indication for each circuit.
3. Make: Modules and equipment shall match existing Simplex systems. No substitute, no equal.

2.2 REMOTE TRANSPONDER UNIT (RTU)

1. The RTU shall function as a subpanel to the FACP, and shall have all the initiation, notification, control, battery, display functions, etc. as the FACP. In the event of failure of the FACP the RTU shall continue to function as a standalone system. All remote notification shall be through the FACP. Provide power circuits to the RTU similar to the FACP. The spare capacity indicated for the FACP shall also be provided in the RTU's. All trouble and alarm conditions at the RTU shall be transmitted to the FACP for suitable operation.
2. RTU's shall contain their own processors and memory and function independently of the FACP but utilize the same base programming. Programming functions in the RTU shall be accessible through the FACP and RTU.
3. The RTU shall be capable of communication with addressable devices that are uniquely identified by an address. Wiring shall be shielded twisted pair cable. The system must allow up to 2,500 feet wire length to the furthest addressable device. T-tapping of the communications channel or multiple loop channels shall be supported.
4. Enclosures shall be of modular size to allow surface mounting of multiple boxes adjacent to each other, shall have hinged solid metal doors and contain a lock with a key common to all system devices.
5. The FACP shall communicate with RTU's through dual supervised data lines. Data lines shall be standard #18 AWG twisted shielded pair minimum or as recommended by the manufacturer. In normal operation, each line shall be used alternately on intervals to maintain line integrity. Should either data line fail, system shall automatically revert to alternate data line and data line trouble shall be reported to operator. The FACP shall automatically "re-boot" after data line is restored.
6. Design Make: To match FACP.

2.3 AUDIO EVACUATION SYSTEM

1. The High School fire alarm panel shall have its capabilities expanded to provide voice evacuation features. Provide the required audio controllers and amplifiers to accommodate new voice evacuation devices.
2. Notification speakers shall be located as shown on the drawings and shall be electrically supervised, and zoned as shown on the drawings. Minimum zoning shall be by floor. Provide zone selector switches, individual zone lamps, trouble lamp and test switch at the Emergency Communications Control Panel (ECCP). All-call capability shall be provided by operation of a single switch. Master microphone shall be located in the ECCP and shall have integral "press-talk" announcement. Signals shall automatically sound again upon lifting of "press-to-talk" switch at the end of the announcement.
3. Provide an audible amplifier unit and locate within the ECCP. All components shall be solid state. Preamplifier shall contain microphone input and necessary tone and volume controls. Power amplifier shall be rated 500 watts minimum for suitable power rating for the indicated system, locations and ambient sound level while having the system spare capacity factor indicated and have a frequency response of 125-12,000 Hz. System shall provide intelligible voice communication throughout the project.
4. Speakers shall be surface mounted, 4 inch. size, 8 ohms impedance, 11 watts rating. Provide integral matching transformer for 25 volt line and with 0.25, 0.5, 0.75, 1.0 and 2 watt taps. Speakers shall have a steel housing, water-sealed compression driver, and baked epoxy finish. Color shall be red. Provide bi-directional or weatherproof mounting where shown on drawings.
5. In the event of 120 VAC power failure, the entire audio evacuation system shall automatically transfer to the system standby power source.

2.4 VENTILATION FAN SHUTDOWN CONTROL

1. Provide additional normally closed relays, wiring and connection into the fan motor control circuits ahead of all automatic devices for the additional fans added as a part of this contract.
2. Sequence fan shutdown for every air distribution system over 1000 cfm. Provide duct detectors in return of systems over 2,000 cfm and in return at each floor of systems over 15,000 cfm.
3. Provide drill bypass feature, locate switch on Fire Alarm Control Panel and label "DRILL-FAN SHUTDOWN BYPASS." Buzzer shall sound continuously while in bypass mode.
4. Provide fan reset feature, locate switch on Fire Alarm Control Panel and label "FAN RESET."

2.5 NOTIFICATION APPLIANCE CIRCUIT POWER EXTENDER

A. Provide power extender for additional indicating devices as part of this contract. Power extender shall be compatible with the existing fire alarm control panel. The power extender shall include the following:
   1. Four additional general alarm notification circuits rated 2 amps @ 24 volts.
   2. UL listed to Standard 864.
   3. Ground fault detection.
   4. Internal 8 amp power supply/battery charger and 18 Ah batteries in external cabinet. Shall also contain brownout and power loss supervision.
   5. Individual circuit trouble LED's.
   6. Surface mount cabinet. Mount next to existing fire alarm control panel.

2.6 INITIATION DEVICES

A. General:
   1. Provide analog addressable smoke and thermal sensors as shown. All detectors, control modules, monitor modules and all other initiation devices shall communicate with twisted pair cable and have an individual address. Peripheral devices shall be of the some manufacturer as the FACP.
   2. Spot type detectors shall utilize the same interchangeable bases.
   3. If a device is removed or taken out of service a trouble signal shall be initiated.

B. Photo-Obscuration Type Smoke Detector:
   1. The photo-obscuration detector shall operate on the photo electronic principle and provide an analog signal to the system indicating the amount of smoke. Detector shall be an analog addressable type.
   2. The detector shall incorporate a built in type identification so the system can identify the type of detector. The sensor shall be continually monitored to measure any change in their sensitivity because of the environment (dirt, smoke, temperature, humidity, etc.). Unit shall not be affected by exterior light or EMF.
   3. The detector shall be designed and arranged to prevent interference from exterior electromagnetic fields and light.
   4. The detector shall provide advance indication of the analog value of the products of combustion to the FACP indicating that maintenance is required in order to insure normal operation. The detector sensitivity shall be adjustable per device (within UL limits) and be set at the FACP for continuous or variable based on time of day. There shall be a minimum of six (6) selectable sensitivity levels. The individual detector sensitivity setting shall be adjusted to meet the building/space characteristics and operation. The detector shall monitor the obscuration continuously and raise the obscuration level to compensate for a dirty sensor to maintain the set sensitivity.
   5. Detectors shall be designed for twistlock mounting to a separate base assembly. Provide manufacturer's recommended back box suitable for surface mounting where required.

6. The detector base shall have terminals for making all connections; no soldering shall be required. It shall be possible to secure the detector to the base with a concealed socket headscrew to prevent unauthorized tampering.
7. Smoke detectors shall be UL 268 listed and FM approved.
8. All smoke detectors shall be field checked and set to meet the prevailing conditions of the premise and any Owner requests. All such work shall be performed by an authorized representative of the manufacturer trained in such procedures.
9. Photo-obscuration type smoke detection shall be used for smoke detection unless indicated otherwise indicated.

C. Heat Detector:
1. The heat detector shall be a thermal sensor and shall constantly monitor the space temperature and constantly report this to the system. The unit shall be analog addressable.
2. The sensor shall use dual solid state thermistors and shall monitor the ambient temperature from 32 degrees Fahrenheit, to 155 degrees Fahrenheit and provide a fast response to rapid increase in temperature. The sensor shall send data to the FACP representing the analog value of the ambient temperature. The FACP shall be suitable to monitor for set temperature (selectable by detector for 135 or 155 degrees F) and rate of rise (selectable by detector for 15 or 20 degrees Fahrenheit per minute). Individual detector thermal settings shall be adjusted for the building/space characteristics and operation but shall initially be set to 135 degrees Fahrenheit set temperature and 15 degrees Fahrenheit per minute rate of rise.
3. Detectors shall be designed for twistlock mounting to a separate base assembly. Provide back box suitable for surface mounting where required.
4. The detector base shall have terminals for making all connections; no soldering shall be required. It shall be possible to secure the detector in the base with a concealed socket headscrew to prevent unauthorized tampering.
5. Smoke detectors shall be UL 268 listed and FM approved.
6. All thermal sensors shall be field checked and set to meet the prevailing conditions of the premise. All such work shall be performed by an authorized representative of the manufacturer trained in such procedures.

D. Addressable Initiation Module:
1. The addressable initiation module shall be used to connect supervised conventional initiating device or zone of supervised conventional initiating devices (water flow switches, tamper switches, manual pull stations, (4) wire smoke detectors, conventional (4) wire duct detectors, fire pump alarms, dry chemical fire extinguisher control panels, etc.) to one of the system's addressable circuits.

2. The module shall provide address setting means using rotary decimal switches and also store an internal identifying code which the control panel shall use to identify the type of device.
3. The module shall contain an integral LED that flashes each time the unit is polled.

E. Manual Pull Stations:
1. Noncoded pull-down type, double action (push then pull down) manual addressable units with front keyed test/reset. Units shall be semi-flush where installed in construction with hollow or block walls. Where construction does not allow semi-flush mounting then unit shall be surface mounted utilizing the manufacturers back box. Each unit shall have a distinct address. Units shall be key reset.
2. Units installed outdoors or in potentially wet locations shall be rated for such conditions.
3. Bright red finish with white lettering "FIRE ALARM".
4. Provide tamperproof clear lexan protective shield with horn and batteries to produce 85 Db minimum sound pressure level at 10 feet when shield is raised. Shield shall have activation/deactivation switch with lockout screw, and 400 lb. breaking strength retaining cable.

F. Carbon Monoxide (CO) Detector:
1. Detector shall sense the level of CO concentration within a space and provide analog addressable signal to the system and be UL 2075 listed. Unit shall have a minimum life span of 10 years without replacement/recalibration.
2. Provide with audible notification base unit for local unique notification. Alarm and notification initiation shall be from the control panel.
3. Detector shall connect to the system addressable circuiting.
4. Alarm level shall be adjusted at the control panel. Upon an alarm the local notification shall sound and a trouble alarm initiated.

G. Combustible Gas Detector:
1. Detector shall constantly monitor the space for methane (natural gas) and propane (LP) gas and constantly report this to the system.
2. Provide analog addressable modules for gas detectors, as required to connect to the system.
3. Detector shall be listed to UL Standard 2075.
4. Detector shall be wall mounted, 1'-0" below ceiling for natural gas detection, and 1'-0" above the finished floor for propane detection.
5. Acceptable manufacturers:
   a. Macurco GD-2A Combustible Gas Detector
   b. Approved equal.

2.7 NOTIFICATION APPLIANCES

A. Horns:
   1. 24 volts DC.
   2. Basic grille type with powder coated red finish paint.
   3. Horn shall be rated 94 dBA (anechoic chamber) at 10 feet. Output shall be selectable steady tone or coded. Provide dampening devices to reduce unit output by 5dBA for a minimum of 40% of the system horn units and install as needed to meet the Owner's needs.
   4. Units shall be semi-flush where installed in construction with hollow or block walls. Where construction does not allow semi-flush mounting then unit shall be surface mounted utilizing the manufacturers back box.
   5. Units installed outdoors or in potentially wet locations shall be rated for such conditions.
   6. Provide directional projector where noted on the Drawings.
   7. Provide backbox and grille for fully recessed installations; 4 inch. deep box maximum.
   8. Horn for carbon monoxide alarm notification shall meet the requirements above but have a white finish color, have the word "ALERT" imprinted on the device and have a temporal Code 4 alarm.

B. Strobe Unit:
   1. 24 volts DC with built-in Xenon Flasher; two watts maximum. Pulse duration shall be 0.2 seconds with maximum duty cycle of 40%. Illumination intensity shall be field selectable for 15/30/75/110 candela or 135/177/185 candela as applicable for the location. Output setting shall be 15 candela in corridors, 75 candela in general areas, 177 candela in sleeping areas or as indicated. Flash rate minimum 1 Hz, maximum 2 Hz. Units within building shall flash in synchronization.
   2. Protruding pyramid shaped lexan lens with reflector and the word "FIRE" imprinted on the lens.
   3. Rated life shall be a minimum of 500 hours of continuous operation.
   4. Units installed outdoors or in potentially wet locations shall be rated for such conditions.
   5. Units shall be semi-flush where installed in construction with hollow or block walls. Where construction does not allow semi-flush mounting then unit shall be surface mounted utilizing the manufacturers back box. Wall or ceiling mounted as noted on the Drawings.
   6. Provide surface backbox for surface installation; 4 inch. deep maximum.
   7. Strobe for carbon monoxide alarm notification shall meet the requirements above but have a white finish color and have the word "ALERT" imprinted on the device.

2.8 ADDRESSABLE CONTROL MODULE

A. The addressable control module shall have an individual system address, be supervised and control an output dry contact from indication from the FACP. This can be used to control or have an input to elevator controls, notification appliances, door holder circuits, fans systems, etc. as indicated. Modules shall be connected to the addressable loop(s).

B. The unit shall control an output relay (dry contact form C). The module shall mount in a 4 inch. square, 2-1/8 inch. deep electrical box.

C. The module shall contain an integral LED that shall flash each time the module is polled.

D. The module shall provide address setting means using rotary decimal switches and also store an internal identifying code which the control panel shall use to identify the type of device. Each unit shall have a separate address and be connected to the system addressable signaling circuit.

2.9 MAGNETIC DOOR HOLDERS

A. Holders shall be wall or floor mounted adjacent to the doors as dictated by the building conditions. Floor mounted units shall only be used where wall mounted are not possible.

B. Door holders shall be aluminum construction, have 25 pound holding force and shall have all necessary mounting hardware. Provide door plate for each and extender chain (chromed and 1 inch. links) where needed.

C. At each door holder location (or pair of door holders where two doors occupy the same opening), provide a flush mounted keyswitch to disable or enable the door holders. (Keyswitches not indicated on drawings). The keyswitch shall be maintained contact, with key removable in the vertical position. Keyswitch shall be tamper resistant, factory prewired brushed stainless steel finish. Provide all wiring to connect to local door holders. Make: DynaLock 2800 Series to meet the conditions or equivalent.

2.10 NOTIFICATION APPLIANCE CIRCUIT EXTENDER (NAC)

A. Unit shall provide additional notification appliance circuit capability for new or existing system and be utilized for horns and strobe units.

B. Connections to the unit shall include power, notification appliance circuit output circuits and addressable control input or notification circuit input. The power circuit shall be from an emergency source if available in the building.

C. Notification appliance circuit capability shall be four Class B or Class A, 2A, 24VDC minimum. Selectable for synchronized or not.

D. Power supply shall be rated for 8A minimum at 24VDC for circuit power use and battery charging. Battery and charger shall be as specified within this section.

E. Unit shall provide output circuit/operation/battery/power/status monitoring and trouble signal to FACP as needed.

F. Provide with battery and charger. Battery to be sized for backup as indicated for FACP.

G. Operation: upon a signal through the addressable control input or the notification appliance circuit indicating a system alarm.

H. Use: Units can be utilized where indicated or where building is greater than 60,000square feet. There shall be a minimum of one unit for each floor.

2.11 WIRE GUARDS

A. Where specified herein or shown on the drawings provided a suitable wire guard for protection of indicated devices/equipment. Units shall be custom as needed for the application.

B. Wire guard shall be a minimum #6 wire gage of zinc plated steel, overall clear coating and welded at joints. For any unit needing access it shall have an integral hinge and locking means.

C. As a minimum provide a wire guard for equipment where indicated and in gymnasiums.

D. Wires shall have 2 inch maximum spacing.

E. Acceptable Manufacturers:
1. Design Make: American Time and Signal.
2. Simplex.

F. Approved equal.

2.12 PULL STATION ALARM COVER

A. Provide a protective alarm cover over manual pull stations in public places. Unit shall allow easy access to the manual pull station and also provide an audible alarm when operated.

B. Unit shall provide a 95dB alarm at 1 foot and be powered from a 9VDC battery.

C. Unit shall be suitable for use in the intended location and pull station.

D. Acceptable manufacturer:
1. System manufacturer.

E. STI Stopper II.

PART 3 EXECUTION

3.1 INSTALLATION, EQUIPMENT

A. All installations shall be accomplished in a professional manner by qualified personnel regularly engaged in and experienced in this type of Work. Fire alarm installation shall be directed by a person who possesses a state license for installation of fire alarm systems. All equipment and components shall be installed in accordance with the manufacturer's recommendations.

B. System junction boxes and surface mounted device boxes shall be painted red.

C. Provide all wiring to the smoke dampers installed by others. Provide an addressable control module for each. Wire to the damper junction box with flexible conduit and wire; provide box or boxes as required. Install according to NEC. Smoke dampers shall close when its associated smoke duct detector is in alarm, upon direction from the FACP or if the associated fan unit is not operating.

D. Provide all power supplies and wiring to smoke relief hatches and fire barriers provided by others. Smoke relief hatch or fire barrier shall operate only when its associated smoke detector is in alarm.

E. Provide all wiring to duct smoke detectors. Duct smoke detectors shall be mounted on the ventilating ductwork by others. All mounting arrangements, holes cut into ductwork, sealing of openings along with ceiling and access doors for the duct type detectors shall be provided by others. Provide duct detectors along with sampling tubes with end caps. Sequence smoke damper operation thirty seconds after its associated fan has been shut down.

F. Provide all wiring required for fan shutdown. Wire from the addressable control module for each fan to be shut down and provide wiring from the module to the fan control unit (starter, adjustable speed drive, etc.) Dry contact shall be wired ahead of all control functions for starters. Provide intermediate relay for control circuits beyond the rating of the control module.

G. Install all door holders in accordance with installation detail on the drawings and coordinate with the General Construction trade. Connect door holders to nearest 120 volt corridor receptacle circuit.

H. Provide 120 volt AC supervisory relays in the Fire Alarm Control Panel enclosure for each magnetic door holder power circuit to insure their associated circuit breakers are in the "ON" position. In the event a circuit breaker is in the "OFF" position, its associated supervisory relay shall transmit a trouble signal.

I. Detection and initiating equipment shall be listed by NRTL and approved by FM.

J. All surface mounted devices shall be mounted on a special box furnished by fire alarm equipment manufacturer. Total assembly shall be secure, smooth contour and have no protrusions.

K. Where detectors are installed on wood or masonry surfaces, attach brackets directly to the surface with tamperproof fasteners. Where detectors are installed on suspended ceilings, provide additional supports in the ceiling, such as channel support system, angle iron or additional runner bars. Fasten the additional supports rigidly to the ceiling runner bar system. Attach bracket to the supports with tamperproof fasteners. Install metal spacers between the bracket and supports so that the ceiling tiles will not be a part of the support system.

L. Install wall mounted audio/visual signal devices at 80 inch. AFF to center line. Where ceiling types are called for, verify ceiling type and mounting height in the field. Provide pendant-mounted devices as required for specified mounting height.

M. An auxiliary fire alarm relay used to control an emergency control device that provides control functions described in this specification shall be located within 3 feet of the emergency control device and all wiring shall be supervised.

N. All smoke detectors shall be field checked and set to meet the prevailing conditions of the premise. All such work shall be performed by an authorized representative of the manufacturer trained in such procedures.

O. Provide circuiting from all indicated motor controls for indication if not operational and close any associated smoke dampers.

P. For existing systems under renovation provide heat detection throughout the space utilizing the manufacturer recommended spacing. At the end of construction remove the heat detectors and provide the indicated system.

3.2 SYSTEM CIRCUITING

A. All wiring shall conform to the NEC and to NFPA 72, National Fire Alarm Code.

B. Install all wiring in accordance with manufacturer's recommendations taking into account loading, intended location, circuit length, spare capacity and voltage drop.

C. All wiring shall be copper, plenum rated, and supported via J-Hooks where routed above an accessible ceiling and installed in a dedicated/segregated EMT conduit system where routed above an inaccessible ceiling.

D. Provide minimum #18 AWG twisted shielded pair for addressable signal line circuits. Notification appliance circuits shall be#14AWG minimum.

E. Provide minimum #18 AWG twisted pair for speakers. Speaker circuits shall be shielded.

F. Addressable signal line circuits shall be NFPA 72 - 2010 Class A (redundant, single open operation).

G. Notification appliance circuits shall be NFPA 72 - 2010 Class A (redundant, single open operation).

H. Notification circuits shall be segregated as indicated on the drawings and by individual floors as a minimum. Circuits shall also be dedicated to audible or visual appliances but not both.

3.3 PROGRAMMING

A. Include in bid the cost to cover all system programming, including items particular to this project (such as custom zone descriptions, time delay settings, sensitivity settings, etc.) such that entire system is 100% complete and operating to the Owner's satisfaction. Coordinate all system programming with the Owner. Also, provide programming of the system a minimum of once during the warranty period to provide changes requested by the Owner.

3.4 TESTING AND INSTRUCTION

A. Test the complete fire protection system and guarantee for a period of one (1) year after Owner's Representative written acceptance. Provide a minimum of four (4) hours of instruction to the operating personnel designated by the Owner's Representative with regard to use and operation of the system. Provide two (2) sets of keys to all panels, manual stations, etc., to the Owner's Representative.

B. Prior to request for final payment submit bound Operator Manuals as specified in other sections of these Specifications that shall include as a minimum:
   1. Bill of Material.
   2. Manufacturer's equipment description for each type of device and each Fire Alarm Control Panel initiation and control module type used.
   3. Record Drawings for fire alarm wiring diagrams showing typical connection diagrams for each type of device and a complete riser diagram showing all devices, zones, and wiring requirements. Record Drawings for fire alarm wiring diagram shall show all terminal connections at the Fire Alarm Control Panel.
   4. Instruction report stating when instruction was given and who was in attendance, signed by the Owner's Representative.
   5. Written test report from an authorized representative of the equipment manufacturer that each device and overall system operation has been 100% tested and approved by the manufacturers.

3.5 CERTIFICATE OF COMPLETION AS DESCRIBED IN NFPA 72.CO DETECTOR SIGNAGE

A. Coordinate with the Owner, install a permanent 8-1/2 inch. and 11 inch., two (2) color lamicoid sign at eye level in the vicinity of every CO alarm notification device indicating specific instructions to be followed, ex. "Do not enter room if an alarm is sounding".

3.6 CO DETECTOR SIGNAGE

A. Coordinate with the Owner, install a permanent 8-1/2 inch. and 11 inch., two (2) color lamicoid sign at eye level in the vicinity of every CO alarm notification device indicating specific instructions to be followed, ex. "Do not enter room if an alarm is sounding".

END OF SECTION 283103

SECTION 310000 - SITE CLEARING

PART 1 GENERAL

1.1 GENERAL

A. This Section includes:
   1. Protecting existing trees and vegetation to remain.
   2. Removal of trees, shrubs, designated plant life and vegetation.
   3. Removal of topsoil and subsoil, rough grading, and site contouring.
   4. Clearing and grubbing.
   5. Temporary erosion and sedimentation control measures.
   6. Removal of above and below grade improvements and surface debris.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   1. Section 312000: Excavation and Fill
   2. Section 312513: Erosion and Sediment Control

1.3 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other non-soil.

B. Clearing: Removal of trees, shrubs, bushes, and other organic matter found at or above original ground level.

C. Remove: Remove existing items from site and legally dispose of them off-site, unless indicated to be removed and reinstalled. Removal shall be completed daily.

D. Existing to Remain: Existing items that are not to be removed and that are not otherwise indicated to be removed or removed and reinstalled.

1.4 SUBMITTALS

A. Pre-Construction photographs sufficiently detailed, of existing conditions of trees, adjoining construction, and site improvements. Submit before work begins.

B. Submit schedule indicating proposed trees to be removed or trimmed to Owner and Owner's Representative for review prior to commencement of work.

1.5 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
   3. Provide clear and appropriate signage for alternate routes and proper notice to people.

B. Maintain access to existing adjacent areas of the building, walkways, roads, and other adjacent occupied or used facilities.
   1. This is an active facility and phasing of the work will be required and with agreement of Owner to minimize disruptions to the existing operations.
   2. Do not close or obstruct adjacent areas of the building, walkways, roads, or other occupied or used facilities without agreement with the Owner and written permission from authorities having jurisdiction.

C. Utility Locator Service: Notify utility locator service (Dig Safely New York – 811 or 800-962-7962) or retain services of a private utility locating firm for area where Project is located before site clearing.

D. Hazardous Materials:
   1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Owner's Representative and Owner. Hazardous materials shall be removed as per the characterization of hazard and disposed of in accordance with NYSDEC requirements.

E. Storage of removed items or materials on-site will not be permitted, unless indicated to be removed and stockpiled on site.

F. Utility Service: Maintain existing utilities in service and protect them against damage during selective demolition operations.

G. Do not commence site clearing and demolition operations until temporary erosion and sedimentation control measures are in place.

1.6 DELIVERY AND STORAGE

A. Deliver and store materials in a manner to prevent contamination or segregation.

1.7 QUALITY ASSURANCE

A. Comply with hauling and disposal regulations of authorities having jurisdiction.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PREPARATION AND PROTECTION

A. Protect and maintain benchmarks and survey control points from disturbance during construction. Damaged or lost benchmark, monuments and survey control points shall be replaced by a licensed New York State Registered Land Surveyor at the Contractor's expense.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner.

D. Identify trees to be removed and trimmed and confirm with Owner and Engineer prior to any demolition.

E. When unanticipated conflicts with intended function or design are encountered, investigate, and measure the nature and extent of conflict. Promptly submit a written report to Engineer.

F. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with adjacent areas of the building, roads, streets, walks, walkways, and other adjacent occupied and used facilities.
   1. Do not close or obstruct adjacent areas of the building, streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
   2. Erect temporary protection, such as walks, ramps, fences, and railings where required to permit safe passage of people and vehicles.
   3. Protect existing building elements, appurtenances, and items to remain.

G. Identify and protect existing utilities.

H. Tree Protection: Erect and maintain a temporary fence around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove fence when construction is complete.
   1. Do not store construction materials, debris, or excavated material within drip line of remaining trees.

2. Do not permit vehicles, equipment, or foot traffic within drip line of remaining trees.
3. Do not excavate within drip line of trees, unless otherwise indicated.

I. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people, damage to buildings and facilities to remain.
1. Provide protection to ensure safe passage of people around selective demolition area.

3.2 CLEARING AND GRUBBING

A. Install erosion control measures at the limits of clearing and grubbing or as indicated on the Contract Drawings prior to commencement of clearing and grubbing. Repair and or replace erosion control devices immediately if damaged during clearing and grubbing.

B. Remove obstructions, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.

C. Do not remove trees, shrubs, and other vegetation unless indicated to be removed.

D. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.

E. Carefully grub within drip line of remaining trees.

F. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
1. Place fill material in horizontal layers not exceeding 8-inch loose depth and compact each layer to a density equal to adjacent original ground.

3.3 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths is encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
1. Remove subsoil and non-soil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust. Provide temporary erosion and sediment control measures as indicated on the Contract Drawings.
1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within drip line of remaining trees.

3. Stockpile surplus topsoil and allow for respreading deeper topsoil
4. Dispose of unused topsoil at the end of the project as specified for waste material disposal.

3.4 TREE/STUMP REMOVAL

A. Removal:
   1. Remove tree, stump, and root system in entirety.
   2. Remove material from the site daily.
   3. Dispose at authorized facility.

B. Restoration
   1. Place fill, rough grade area and restore to existing conditions

3.5 REMOVAL AND DISPOSAL

A. Removal:
   1. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property.
   2. Remove material from the site daily.
   3. Dispose at authorized facility.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

D. Dumping: No dumping shall be allowed in any stream, corridor, wetlands, surface waters, or at unspecified locations or at locations not approved by the Engineer or regulatory agencies.

E. Leave Work area in a neat and uncluttered condition.

3.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction. The Contractor shall temporarily relocate existing mailboxes, road signs, fences, landscaping, etc. during construction and re-install them at their original location once the work is completed.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement, slabs, sidewalks, curbs, and gutters to remain before removing existing pavement. Saw-cut faces vertically.

3.7 ROUGH GRADING

A. Identify required lines, levels, contours, and datum.

B. Identify known underground, above ground, and aerial utilities. Stake and flag locations.

C. Notify utility companies to paint out utility locations.

D. Excavate topsoil and subsoil from areas to be further excavated, re-landscaped, or re-graded.

E. Stockpile topsoil and subsoil in designated area(s).

END OF SECTION 310000

SECTION 312000 - EXCAVATION AND FILL

PART 1 GENERAL

1.1 REFERENCE STANDARDS

A. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012 (Reapproved 2021).

B. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)); 2012 (Reapproved 2021).

C. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2017 (Reapproved 2025).

D. ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction; 2023.

E. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2025a.

1.2 SUMMARY

A. This Section includes:
   1. Preparing subgrades for structures, walks, pavements, grasses, and plants.
   2. Subbase course for concrete slabs, walks and asphalt pavement.
   3. Excavating and backfilling trenches for utilities and structures.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Plans and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   1. Section 310000: Site Clearing
   2. Section 329000: Topsoil & Seeding

1.4 DEFINITIONS

A. Earth Excavation: The removal of all surface and subsurface material not classified as rock as defined below.

B. Unsatisfactory Soil: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction. Soil that may contain rock or gravel larger than 3 inches in any dimension, frozen materials, organic matter vegetation, soft, nondurable particles, elongated particles, or other deleterious matters.

C. Contaminated Soil: Soil that may require specific disposal method/location as it may contain items such as but not limited to trace/detect chemical, oil or soft or loose bituminous asphalt tar.

D. Construction Debris Soil: Soil containing debris, waste, rubbish, slag, cinders, ashes, metals, or other manmade or foreign materials.

E. Rock: Limestone, sandstone, shale, granite, and similar material in solid beds or masses in its original or stratified position which can be removed only by blasting operations, drilling, wedging, or use of pneumatic tools, and boulders with a volume greater than 1.0 cu yd. Concrete building foundations and concrete slabs, not indicated, with a volume greater than 1.0 cu yd shall be classified as rock.
   1. Limestone, sandstone, shale, granite, and similar material in a broken or weathered condition which can be removed with an excavator or backhoe equipped with a bucket with ripping teeth or any other style bucket shall be classified as earth excavation.
   2. Masonry building foundations, whether indicated or not, shall be classified as earth excavation.

F. 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 will include:
   1. All soil deposits of any description both above and below groundwater levels. These may be naturally deposited or placed by previous construction operations.

G. Subgrade Surface: Surface upon which subbase or topsoil is placed.

H. Subbase: Select granular material or subbase course Type 2 which is placed immediately beneath pavement or concrete slabs.

I. Maximum Density: The dry unit weight in pounds per cubic foot of the soil at "Optimum Moisture Content" when determined by ASTM D698 (Standard Proctor), or ASTM D1557 (Modified Proctor).

J. 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.

K. Landscaped Areas: Areas not covered by structures, walks, roads, paving, or parking.

L. Unauthorized Excavation: The removal of material below required elevation indicated on the Plans or beyond lateral dimensions indicated or specified without specific written direction by the Owner's Representative.

M. Grading Limit Line (Shown on Plans): Limits of grading, excavations and filling required for the work of this contract. Unless specifically noted otherwise, the Grading Limit Line and Contract Limit Line will be considered the same.

1.5 SUBMITTALS

A. Product Data:
1. Filter Fabric: Manufacturer's catalog sheets, specifications, and installation instructions.
2. Geogrid: Manufacturer's catalog sheets, specifications, and installation instructions.

B. Quality Control Submittals:
1. Subbase Materials: Material Test Reports: Classification according to ASTM D2487, laboratory compaction curve according to ASTM D1557 and certified gradation analysis according to ASTM C136 for each soil material proposed for fill and backfill. Name and location of source and the DOT Source Number.
2. Other Aggregates: Name and location of source and soil laboratory test results.

1.6 PROJECT CONDITIONS/COORDINATION AND SCHEDULING

A. Existing Utilities:
1. Coordinate the work to determine the extent of the areas of subsurface investigation required to locate all underground utilities and service connections in the areas of excavation.
2. Coordinate the work with the Owner and Owner's Representative to minimize utility disruptions and facility operations. Provide a schedule for the Work required to the Owner and Owner's Representative for approval. Upon approval of the schedule, notify the Owner and Owner's Representative a minimum of three (3) working days prior to performing the Work.
3. Within the areas of excavation, all underground utilities and service connections shall be field located, and their locations marked at least two (2) weeks prior to the performance of the required excavation work.

B. Existing Conditions:
1. 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 steel 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.

2. Dewatering: Include the disposal of surface water and ground water, which may accumulate in open excavations, unfinished fills, or other low areas. Remove water by pumping, or other methods to prevent softening of exposed surfaces. Surface dewatering plan shall include the rerouting of any storm water runoff or natural drainage if necessary and shall comply with NYS DEC requirements.
3. Protection and Restoration of Surfaces: Protect newly graded areas from traffic, erosion, and settlements. Repair and reestablish damaged or eroded slopes, elevations or grades and restore surface construction prior to acceptance. Protect existing streams, ditches and storm drain inlets from water-borne soil by means of straw bale dikes. Conduct work in accordance with NYS DEC requirements.

C. Cold Weather Requirements:
1. Excavation: When freezing temperatures are anticipated, do not excavate to the final required elevations for concrete work unless concrete can be placed immediately.
2. Backfilling: Do not backfill with any frozen soil materials.

D. Thru-traffic or fill placement with heavy construction vehicles or equipment which causes rutting or weaving to occur within the perimeter of a building will not be permitted. If rutting or weaving occurs during placement of fill, place specified fill in a stable area outside building perimeter and spread with tracked equipment to specified layer thickness.

1.7 DELIVERY AND STORAGE

A. Deliver and store materials in a manner to prevent contamination or segregation.

B. Protect filter fabric from sunlight during transportation and storage.

1.8 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

B. Routine testing of existing soils and compacted material for compliance with these Specifications shall be performed by a testing agency acceptable to Engineer.

C. Compacted material that does not meet density requirements shall be removed and/or re-compacted and retested.

PART 2 PRODUCTS

2.1 MATERIALS

A. Select Granular Fill Material: Stockpiled, sound, durable, sand, gravel, stone, or blends of these materials, free from organic and other deleterious materials. Comply with the gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	**Size opening (mm)**	
2 inch	50.0	100
No. 40	0.425	0-70
No. 200	0.075	0-15

1. Magnesium Sulfate Soundness Test: 20 percent maximum loss by weight after four test cycles.
2. Plasticity Index: The plasticity index of the material passing the No. 40 mesh sieve will not exceed 5.0.
3. Elongated Particles: Not more than 30 percent, by weight, of the particles retained on a 1/2-inch sieve will consist of flat or elongated particles. A flat or elongated particle is defined as one which has its greatest dimension more than three times its least dimension.

B. NYSDOT Subbase Course Type 2: Stockpiled, crushed ledge rock or approved blast furnace slag. Comply with the gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	**Size opening (mm)**	
2 inch	50.0	100
1/4 inch	6.3	25-60
No. 40	0.425	5-40
No. 200	0.075	0-10

1. Magnesium Sulfate Soundness Test: 20 percent maximum loss by weight after four test cycles.
2. Plasticity Index: The plasticity index of the material passing the No. 40 mesh sieve will not exceed 5.0.
3. Elongated Particles: Not more than 30 percent, by weight, of the particles retained on a 1/2-inch sieve will consist of flat or elongated particles. A flat or elongated particle is defined as one which has its greatest dimension more than three times its least dimension.

C. NYSDOT #1 Crushed Stone: Clean, durable, sharp-angled fragments of rock of uniform quality. Comply with the gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	**Size opening (mm)**	
1 inch	25.0	100
1/2 inch	12.5	90 – 100

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
¼ inch	6.3	0-15

1. Magnesium Sulfate Soundness Test: 18 percent maximum loss by weight after ten test cycles.

D. NYSDOT #2 Crushed Stone: Clean, durable, sharp-angled fragments of rock of uniform quality. Comply with the gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
1-1/2 inch	37.5	100
1 inch	25.0	90 – 100
1/2 inch	12.5	0-15

1. Magnesium Sulfate Soundness Test: 18 percent maximum loss by weight after ten test cycles.

E. NYSDOT #1 Screened Gravel: Clean, durable gravel free from coatings. Comply with the gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
1 inch	25.0	100
1/2 inch	12.5	90 – 100
¼ inch	6.3	0-15

1. Magnesium Sulfate Soundness Test: 18 percent maximum loss by weight after ten test cycles.

F. NYSDOT #2 Screened Gravel: Clean, durable gravel free from coatings. Comply with the gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
1-1/2 inch	37.5	100
1 inch	25.0	90 – 100
1/2 inch	12.5	0-15

1. Magnesium Sulfate Soundness Test: 18 percent maximum loss by weight after ten test cycles.

G. Underdrain Filter Type 2 (NYSDOT 605.10, 733-2002): Material consisting of crushed stone, sand, gravel, or screened gravel. Comply with the gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
1/2 inch	12.5	100
1/4 inch	6.3	20 – 100
No. 10	2.0	0-15
No. 20	.85	0-5

1. Magnesium Sulfate Soundness Test: 20 percent maximum loss by weight after ten test cycles.

H. Selected Borrow/Fill: Sound, durable, sand, gravel, stone, or blends of these materials, free from organic and other deleterious materials. Comply with the gradation requirements specified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
4 inch	101.6	100
No. 40	0.425	0-70
No. 200	0.075	0-15

I. Suitable Material (Fill and Backfill for Landscaped Areas): Material consisting of mineral soil (inorganic), blasted or broken rock and similar materials of natural or man-made origin, including mixtures thereof. Maximum particle size will not exceed 2/3 of the specified layer thickness prior to compaction. NOTE: Material containing cinders, industrial waste, sludge, building rubble, land fill, muck, and peat will be considered unsuitable for fill and backfill, except topsoil and organic silt may be used as suitable material in landscaped areas provided it is placed in the top layer of the subgrade surface.

J. Flowable Fill: Shall consist of a mixture of Portland cement, sand, water and admixtures proportioned to provide a non-segregating, free-flowing, self-consolidating material that will result in a hardened, dense backfill.
1. Shall have a 28-day compressive strength between 40 and 100 psi.

K. Bioretention Soil: Material consisting of sand and organic material free of stones, stumps, roots, or other woody material over 1-inch diameter.
1. Shall be classified as a USDA sandy loam, loamy sand, loam, or a loan/sand mix (with 35%- 60% sand).
2. Less than 25% USDA clay.
3. Minimum permeability = 0.5 feet/day
4. pH range: 5.2 – 7.6
5. Organic content: 3-7%

2.2 GEOTEXTILE

A. Pavement Section Geogrid: Tensar TriAx Geogrid or approved equivalent.

B. Erosion Control: Filter X, Mirafi 100X, Stabilinka T140N or approved equivalent.

C. Separation: Amoco 2002 & 2004, Contech Construction Products Inc. C-180, Synthetic Industries Geotex 250ST & 315ST, Mirafi Geolon HP570 & HP1500 or approved equivalent.

PART 3 EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

3.2 CLEARING AND GRUBBING

A. Clear and grub the site within the grading limit line 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.

3.3 REMOVAL OF TOPSOIL

A. Remove existing topsoil from areas within the Work Limit Line where excavation or fill is required.

B. Stockpile approved topsoil where directed until required for use. Place, grade, and shape stockpiles for proper drainage.
   1. Topsoil will be tested prior to stockpiling. Stockpile only quantities of topsoil approved in writing for re-use.

3.4 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: Will be re-routed as shown on the Contract Plans.

D. Utilities abandoned beneath and five feet laterally beyond the structure's proposed footprint will be removed in their entirety. Excavations required for their removal will be backfilled and compacted as specified herein.

E. Utilities extending outside the five feet limit specified above 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.

3.5 EXCAVATION

A. Excavate earth as required for the Work.

B. Install and maintain all erosion and sedimentation controls during all earthwork operations as specified on the Contract Plans.

C. Maintain sides and slopes of excavations in a safe condition until completion of backfilling. Comply with Code of Federal Regulations Title 29 - Labor, Part 1926 (OSHA).
   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 fill. Place, grade, and shape stockpiles for proper drainage as approved by the Engineer.

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. Slabs and Floors: Excavate to the following depths below bottom of concrete for addition of select granular material:

1. Interior Floors: 6 inches unless otherwise indicated.
2. Exterior Slabs and Steps: 12 inches unless otherwise indicated.

G. Pipe Trenches: Open only enough trench length to facilitate laying pipe sections. Unless otherwise indicated on the Plans, excavate trenches approximately 24 inches wide plus the outside pipe diameter, equally divided on each side of pipe centerline. Cut trenches to cross section, elevation, profile, line, and grade indicated. Accurately grade and shape trench bottom for uniform bearing of pipe in undisturbed earth. Excavate at bell and coupling joints to allow ample room for proper pipe connections.
1. Trench in Rock: Excavate an additional 6 inches below bottom of pipe for bed of cushion material under the piping.

H. Open Ditches: Cut ditches to cross sections and grades indicated.

I. Pavement: Excavate to subgrade surface elevation.

J. Unauthorized Excavations: Unless otherwise directed, backfill unauthorized excavation under footings, foundation bases, and retaining walls with compacted select granular 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 Engineer.

K. Notify the Owner's Representative upon completion of excavation operations. Do not proceed with the work until the excavation is inspected and approved. Inspection of the excavation by the Engineer will be made on three working days' notice.

L. 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 Engineer. Have cross sections taken to determine the quantity of such excavation. Do not backfill this excavation prior to quantity measurement.

3.6 DEWATERING

A. 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.

B. Prevent surface and subsurface water from flowing into excavations and trenches and from flooding the site and surrounding area.

C. Do not allow water to accumulate in excavations or trenches. Remove water from all excavations immediately to prevent softening of undercutting footings, and soil changes detrimental to the stability of subgrades. Furnish and maintain pumps, sumps, suction and discharge piping systems, and other system components necessary to convey the water away from the Site.

D. Convey water removed from excavations, and rainwater, 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.

E. Provide temporary controls to restrict the velocity of discharged water as necessary to prevent erosion and siltation of receiving areas.

3.7 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 1 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 1/2 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.

3.8 PLACING GEOTECH FABRIC

A. Place and overlap geotech fabric in accordance with the manufacturer's installation instructions, unless otherwise shown.

B. Cover tears and other damaged areas with additional fabric layer extending three feet beyond the damage.

C. Do not permit traffic or construction equipment directly on fabric.

D. Backfill over fabric within two weeks after placement. Backfill in accordance with the fabric manufacturer's instructions and in a manner to prevent damage to the fabric.

3.9 PLACING FILL AND BACKFILL

A. Surface Preparation of Fill Areas: Strip topsoil, remaining vegetation, and other deleterious materials prior to placement of fill. Remove all asphalt pavement in its entirety from areas requiring the placement of fill or break up old pavements to a maximum size of four inches. Prior to placement of fill, smooth out and compact areas where wheel rutting has occurred due to stripping or earthwork operations.

B. Place backfill and fill materials in layers not more than eight 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 six-inch-thick loose depth layers.
   2. For large fill areas, the layer thickness may be modified by the Engineer, at the Contractor's written request, if in the Engineer's judgment, the equipment used is capable of compacting the fill material in a greater layer thickness. This request will include the type and specifications of compaction equipment intended for use.

C. Under Exterior Concrete Slabs and Steps:
   1. Up to Subgrade Surface Elevation: Place selected fill when fill or backfill is required.
   2. Subbase Material: Place 12 inches of select granular material over subgrade surface.

D. Under Pavements and Walks:
   1. Up to Subgrade Surface Elevation: Place selected fill when fill or backfill is required.
   2. Subbase Material: Place as indicated.

E. 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 four inches in diameter within the top 12 inches of suitable material.

F. Plastic Pipe in Trenches: Place cushion material a minimum of six inches deep under pipe, 12 inches on both sides, and 12 inches above top of pipe. Complete balance of backfill as specified.
   1. Trench in Rock: Place a minimum six-inch-deep bed of cushion material under pipe.

G. Backfilling Excavation Resulting from Removal of Unsuitable Material Beneath Structures and Other Improvements: Backfill the excavation with compacted select granular material.

3.10 COMPACTION

A. All materials with exception of open graded stone:

1. 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 three percent drier or more than two percent wetter than the optimum content as determined by ASTM D698 (Standard Proctor) or 1557 (Modified Proctor).
    a. Structures (entire area within ten feet outside perimeter): 95 percent (Modified)
    b. Concrete Slabs and Steps: 95 percent (Modified)
    c. Landscaped Areas: 90 percent (Standard)
    d. Pavements and Walks: 95 percent (Modified)
    e. Pipes and Tunnels: 95 percent (Modified)
    f. Pipe Bedding: 95 percent (Modified)
2. 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.
3. Moisture Control:
    a. 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.
    b. 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.
4. If a compacted layer fails to meet the specified percentage of maximum density, the layer will be recompacted and retested. If compaction cannot be achieved the material/layer will be removed and replaced. No additional material may be placed over a compacted layer until the specified density is achieved.

3.11 ROUGH GRADING

A. Exterior Grading: Trim and grade area within the grading limit line and excavations outside the limit line, required by this Contract, to a level of 4 inches below the finish grades indicated unless otherwise specified herein or where greater depths are indicated. Provide smooth uniform transition to adjacent areas.
    1. Slope cut and fill in transition areas, outside of the grading limit line, to meet corresponding levels of existing grades at a slope of 1 vertical to 2 horizontals unless otherwise indicated.

2. Landscaped Areas: Provide uniform subgrade surface within 1 inch of required level to receive topsoil thickness specified. Compact fill as specified to within three inches of subgrade surface. Remove objectionable material detrimental to proper compaction or to placing full depth of topsoil. If the top three inches of subgrade has become compacted before placement of topsoil, harrow or otherwise loosen rough graded surface to receive topsoil to a depth of three inches immediately prior to placing topsoil.

3.12 FINISH GRADING

A. Uniformly grade rough graded areas within limits of the grading limit line 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 one inch above or below the required subgrade surface elevations.
2. Walks: Place and compact subbase material as specified. Shape surface of areas under walks to required line, grade, and cross section, with the finish surface not more than 1/2 inch above or below the required subbase elevation.
3. Pavements: Place and compact subbase material as specified. Shape surface of areas under pavement to required line, grade and cross section, with the finish surface not more than 1/2 inch above or below the required subbase elevation.

3.13 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. Water seeded areas as required until physical completion of the work.

3.14 DISPOSAL OF EXCESS AND UNSUITABLE MATERIALS

A. Remove from property and dispose of excess and unsuitable materials, including materials resulting from clearing and grubbing and removal of existing improvements.

B. Transport excess and unsuitable materials, including materials resulting from clearing and grubbing and removal of existing improvements, to spoil areas on property, and dispose of such materials as directed.

C. Transport excess topsoil to areas on property designated by the Owner's Representative. Smooth grade deposited topsoil.

3.15 FIELD QUALITY CONTROL

A. Special Inspections: A qualified special inspector shall perform the following special inspections:
   1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
   2. Determine that fill material and maximum lift thickness comply with requirements.
   3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

B. Testing Agency: A qualified geotechnical engineering testing agency shall perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify, and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.16 PROTECTION

A. Protect graded areas from traffic and erosion and keep them free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
   1. Scarify or remove and replace soil material to depth as directed by Owner's Representative; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

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SECTION 312316 - ROCK REMOVAL

PART 1 GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   1. Section 312000: Excavation and Fill

1.2 DEFINITIONS

A. Rock: Limestone, sandstone, shale, granite, and similar material in solid beds or masses in its original or stratified position which can be removed only by blasting operations, drilling, wedging, or use of pneumatic tools, and boulders with a volume greater than 1.0 cu yd. Concrete building foundations and concrete slabs, not indicated, with a volume greater than 1.0 cu yd shall be classified as rock.
   1. Limestone, sandstone, shale, granite, and similar material in a broken or weathered condition which can be removed with an excavator or backhoe equipped with a bucket with ripping teeth or any other style bucket shall be classified as earth excavation.
   2. Masonry building foundations, whether indicated or not, shall be classified as earth excavation.

B. Unauthorized Rock Removal:
   1. The removal of any rock prior to performing the measurements/work required to determine quantities (Paragraph 3.1 B).
   2. The removal of material below required elevation indicated on the Drawings or beyond lateral dimensions indicated or specified without specific written direction by the Owner.

C. General Rock Removal: Quantities of rock removal will be paid for as General Rock Removal when:
   1. The width of rock removed, as per measurement limits, is greater than or equal to the total excavation depth required.
   2. Boulders removed have a volume greater than 1.0 cu yd.

D. Trench and Pier Rock Removal: Quantities of rock removal will be paid for as Trench and Pier Rock Removal when the width of rock removed, as per measurement limits, is less than the total excavation depth required.

1.3 SUBMITTALS

A. Rock Removal Procedure: Submit a detailed outline of intended rock removal procedure for the Owner's information. This submittal will not relieve the Contractor of responsibility for the successful performance of method used.
   1. Where blasting is permitted, show drill hole pattern, method of blasting, explosive types, and amount of explosive load.

B. Quality Control Submittals:
   1. Certificates: Competency affidavit required under Quality Assurance Article.
   2. Blasters Qualifications Data: Submit the following for each blaster:
   3. Name, and employer's name, business address and telephone number.
   4. Names and addresses of the required number of similar projects which meet the experience criteria.

C. Measurement data for quantities of rock removal.

1.4 QUALITY ASSURANCE

A. Blasters' Qualifications: The persons performing the blasting operations shall be personally experienced in the handling and use of explosives, shall furnish satisfactory evidence of competency in performing in a safe manner the type of blasting required, and shall have performed blasting operations on 5 similar projects.

B. Regulatory Requirements: Obtain the proper Permit to Blast from authorities having jurisdiction before explosives are bought to the site.

C. Certifications: Affidavit, for each blaster, certifying that blaster is competent in performing the type of blasting required.

D. Pre-Rock Removal Conference: Before the rock removal work is scheduled to commence, a conference will be called by the Owner's Representative at the site for the purpose of reviewing the Contract Documents and discussing requirements for the Work. The conference shall be attended by the Contractor's Representative and the person supervising the rock removal operations.

1.5 PROJECT CONDITIONS

A. Blasting and the use of explosive materials will not be permitted unless a Contractor-prepared Blasting Plan and Safety Plan have been approved by the Engineer and accepted by the Owner.
   1. Contractor shall secure and maintain all permits and regulatory approvals if blasting is approved.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 EXAMINATION, VERIFICATION & MEASUREMENT

A. Examination of Existing Property and Construction: Prior to starting rock removal Work, thoroughly examine the existing property and construction at the site and record, with notes and drawings or other documentation, existing defects and deterioration. Make this information available to the Engineer upon request.

B. Prior to removing material classified as rock, excavate test pits down to rock for the purpose of verifying the presence of sound rock and determining top of rock elevations.
   1. Verification of Sound Rock: Demonstrate to the Engineer that materials to be classified as rock cannot be removed utilizing a backhoe or excavator equipped with any form of bucket, including a bucket equipped with ripping teeth.
   2. Required Measurements: Take elevations and measurements as required for the purpose of determining the quantities of rock removal. Record all measurement data and submit a copy of the data to the Engineer. Backfill test pits prior to rock removal as directed. Unless otherwise indicated or directed, excavate test pits as follows:
      a. For Structures: One pit for each structure or one pit for each 1000 sq ft, whichever is greater.
      b. For Paved Areas: 3 pits for each 2500 sq ft.
      c. For Utility Lines: One pit for each 100 lin ft.

3.2 SITE PREPARATION

A. Schedule a site meeting with the Engineer and facility personnel to review the rock removal procedures in detail.

B. If required, have seismographs in place and operational as well as all safety equipment and/or fencing.

3.3 ROCK REMOVAL

A. Remove rock as required and necessary for the installation of the work on as shown on the Contract Drawings. Make sufficient clearance, within the limits specified, for the proper execution of the work.

B. Volume Determination: Top of Rock Elevations established prior to the performance of any rock removal (Section 3.01 B) will be used to determine the depth of rock removed. Measurements for the base and width of the rock excavation shall be taken of the actual rock cut, as required for the Work, or to the specified measurement limits, whichever is smaller. Unless otherwise directed in writing, measurement limits for this work shall be as follows:
   1. Cast-In-Place Concrete:

a. Vertical Limit: Bottom of rock cut for cast-in-place concrete bearing on rock shall be the bottom of concrete elevation indicated on the Drawings.
b. Horizontal Limit: Limit measurement between vertical side surfaces at bottom of rock cut to the following:

Actual Depth of Rock Cut	Distance Beyond Edge of Concrete in Each Direction
Under 3 Feet	18 Inches
3 to 15 Feet	24 Inches
Over 15 Feet	30 Inches

2. Precast Concrete Structures: Measurement will be based on the size of the precast concrete structure specified or indicated on the Drawings.
   a. Vertical Limit: Bottom of rock cut for precast concrete structure shall be 12 inches below the required bottom of structure elevation.
   b. Horizontal Limit: Limit measurement between vertical side surfaces at bottom of rock cut to the following:

Actual Depth of Rock Cut	Distance Beyond Edge of Concrete in Each Direction
Under 5 Feet	12 Inches
5 to 15 Feet	18 Inches
Over 15 Feet	24 Inches

3. Pipe:
   a. Vertical Limit: Bottom of rock cut for pipe in trench shall be 6 inches below the required pipe invert elevation, with depth measured from the mean surface of the rock.
   b. Horizontal Limit: Limit measurement between vertical side surfaces at bottom of rock cut to the following:

Actual Depth of Rock Cut	Trench Width
Under 10 Feet	24 Inches plus Pipe OD
10 to 15 Feet	36 Inches plus Pipe OD
Over 15 Feet	48 Inches plus Pipe OD

3.4 FIELD QUALITY CONTROL

A. Provide the Engineer with the recorded top of rock elevations. Prior to the performance of any rock removal operations obtain, in writing, that the Engineer as reviewed the information and is in agreement with the measurements taken.

B. Notify the Engineer at least 3 work days in advance of all phases of blasting operations.

C. Allow time for visual inspection of bottom of rock cut required for the work.

3.5 DISPOSAL OF EXCESS AND UNSUITABLE MATERIALS

A. Remove from site and dispose of excess and unsuitable rock materials.

B. Transport excess and unsuitable rock materials to spoil areas on site designated by the Engineer, and dispose of such materials as directed.

3.6 ADJUSTING

A. Unauthorized Rock Removal:
   1. Horizontal Direction: Backfill and compact unauthorized rock removal in the horizontal direction as specified for authorized excavation of the same classification, unless otherwise directed.
   2. Vertical Direction: Immediately report unauthorized rock removal in the vertical direction to the Engineer. Correct unauthorized rock removal in the vertical direction in accordance with directions of the Engineer.

3.7 CLEANING

A. Where footings and walls will rest entirely on rock, clean rock surfaces free of soil and loose rock.

END OF SECTION 312316

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SECTION 312319 - DEWATERING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes construction dewatering.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 312000: Excavation and Fill

1.3 SUBMITTALS

A. Field quality-control reports.

B. Existing Conditions: Using photographs, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before work begins.

C. Record Drawings: Identify locations and depths of abandoned-in-place dewatering equipment.

D. Shop Drawings: Submit drawings and diagrams, with all pertinent data, showing the dewatering system proposed for use. Indicate the spacing and location of wellpoints and reading wells, and location of header lines, pumps, valves and discharge lines.

1.4 QUALITY ASSURANCE

A. Qualifications: The work of this Section shall be performed by a firm experienced in wellpoint dewatering work. The firm shall have satisfactorily completed such work for at least 3 projects of comparable size.

B. The dewatering system shall consist of equipment, appliances and materials designed or suitable for controlling groundwater in construction work.

1.5 PROJECT CONDITIONS

A. Blasting and the use of explosive materials will not be permitted.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
   1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.
   2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
   3. Prevent surface water from entering excavations by grading, dikes, or other means.
   4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
   5. Remove dewatering system when no longer required for construction.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

PART 3 EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
   1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
   2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

3.2 INSTALLATION

A. Install the dewatering system in accordance with approved shop drawings and as required by site conditions. Locate elements of the system to allow a continuous dewatering operation without interfering with the installation of any permanent project work.
   1. Space well points or wells at intervals required to provide sufficient dewatering.
   2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATIONS

A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
   1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
   2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
   3. Maintain piezometric water level a minimum of 24 inches below bottom of excavation.

C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

D. Remove dewatering system from project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap below overlying construction.

3.4 FIELD QUALITY CONTROL

A. Maintain a careful check to detect any settlement in existing adjacent Work. Notify the Engineer of any signs of settlement. Establish settlement point benchmarks and take periodic readings when directed.

B. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation. Prepare reports of observations.

3.5 PROTECTION

A. Protect and maintain dewatering system during dewatering operations. Promptly repair damages to adjacent facilities caused by dewatering.

3.6 REMOVAL

A. When the dewatering system is no longer required and when directed, dismantle and remove the system and all appurtenances from the site.

END OF SECTION 312319

SECTION 312513 - EROSION AND SEDIMENT CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes:
   1. Furnish, install, inspect, maintain, and remove soil erosion and sediment control measures during construction as shown on the Contract Documents prepared for this project.
   2. Minimize the potential short-term adverse environmental impacts associated with construction activity in environmentally sensitive areas.
   3. Assure the quantity and quality of stormwater runoff is not substantially altered due to construction activities.
   4. Stabilize slopes and protect offsite areas by the installation and maintenance of stabilization and erosion control measures.
   5. Dewatering operation procedure.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Plans and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 312000: Excavation and Fill

1.3 REFERENCE STANDARDS

A. New York Standards and Specifications for Erosion and Sediment Control, NYSDEC, latest edition.

B. NYSDEC: Reducing the Impacts of Stormwater Runoff for New Development, latest edition.

C. NYSDEC Environmental Conservation Law, Article 17. Titles 7, 8 and Article 70.

D. 6 NYCRR Parts 611 – 613 and all additions.

E. OSHA 40 CFR Part 258 and all additions. New York State: Standards and Specifications for Erosion and Sediment Control, latest edition.

1.4 PROJECT CONDITIONS

A. An Erosion and Sediment Control plan (ESC) has been prepared for this project. Install and maintain the temporary storm water and diversion control items as shown on the Plans before starting any grading or excavation and maintain compliance with all SPDES regulations. Provide any temporary sediment and erosion control measures that may be required within limits of the work, including any staging areas, throughout construction in conformance with the plan, and as directed by the Owner's Representative. Place the permanent control practices required before the removal of the temporary storm water diversion and control items.

B. During construction conduct operations in such a manner as to prevent or reduce to a minimum any damage to any water body from pollution by debris, sediment, chemical or other foreign material, or from the manipulation of equipment and/or materials in or near a stream or ditch flowing directly to a stream. Any water which has been used for wash purposes or other similar operations which become polluted with sewage, silt, cement, concentrated chlorine, oil, fuels, lubricants, bitumens, or other impurities shall not be discharged into any water body.

C. In the event of conflict between these specifications and the regulation of other Federal, State, or local jurisdictions, the more restrictive regulations shall apply.

D. The Contractor shall adhere to all requirements of the Erosion and Sediment Control plan.

E. The Contractor will submit copies of certificates documenting that on-site workers have completed a NYS Department of Environmental Conservation endorsed Erosion & Sediment Control training as required by State Pollutant Discharge Elimination System (SPDES) General Permit for Stormwater Discharges from Construction Activity (GP-0-25-001).

F. The Work shall consist of furnishing, installing, inspecting, maintaining, and removing soil and erosion control measures as shown on the contract documents or as ordered by the Owner's Representative during the life of the contract to provide erosion and sediment control.

G. Temporary structural measures provide erosion control protection to a critical area for an interim period. A critical area is any disturbed, denuded slope subject to erosion. These are used during construction to prevent offsite sedimentation. Temporary structural measures shall include check dams, construction road stabilization, stabilized construction entrance, dust control, earth dike, level spreader, perimeter dike/swale, pipe slope drain, portable sediment tank, rock dam, sediment basin, sediment traps, silt fence, storm drain inlet protection, straw/hay bale dike, access waterway crossing, storm drain diversion, temporary swale, turbidity curtain, water bars or other erosion control devices or methods as required.

H. Permanent structural measures also control protection to a critical area. They are used to convey runoff to a safe outlet. They remain in place and continue to function after completion of construction. Permanent structural measures shall include debris basins, diversion, grade stabilization structure, land grading, lined waterway (rock), paved channel, paved flume, retaining wall, riprap, rock outlets, and stream bank protection or other erosion control devices or methods as required.

I. Vegetative measures shall include brush matting, dune stabilization, grassed waterway, vegetating waterway, mulching, protecting vegetation, seeding, sod, straw/hay bale dike, stream bank protection, temporary swale, topsoil, and vegetating waterways.

J. Biotechnical measures shall include wattling (live fascines, brush matting, brush layering, live cribwall, and branchpacking) vegetated rock gabions, live staking, tree revetment, and fiber rolls.

K. Weekly inspections will be completed by the Engineer on behalf of the Owner. Contractor shall retain their own inspector to perform weekly inspections on behalf of the contractor. Comply with and correct all deficiencies found as a result of these inspections. At the end of the construction season when soil disturbance activities will be finalized or suspended until the following spring, the frequency of the inspections may be reduced. If soil disturbance is completely suspended and the site is properly stabilized, a minimum of monthly inspections must be maintained. The stabilization activities must be completed before snow cover or frozen ground. If vegetation is required, seeding, planting and/or sodding must be scheduled to avoid die-off from fall frosts and allow for proper germination/establishment. Weekly inspections must resume no later than March 15.

1.5 DEFINITIONS

A. Stabilized Construction Entrance: A stabilized pad of aggregate underlain with geo-textile where traffic enters a construction site to reduce or eliminate tracking of sediment to public roads.

B. Dust Control: Prevent surface and air movement of dust from disturbed soil surfaces.

C. Portable Sediment Tank: A compartmented tank to which sediment laden water is pumped to retain sediment before pumping the water to adjoining drainage ways.

D. Sediment Basin: A barrier constructed across a drainage way to intercept and trap sediment.

E. Sediment Traps: A control device formed by excavation to retain sediment at a storm inlet or other points of collection.

F. Silt Fence: A barrier of geo-textile fabric installed on contours across the slope to intercept runoff by reducing velocity. Replace after 1 year.

G. Storm Drain Inlet Protection: A semi-permeable barrier installed around storm inlets to prevent sediment from entering a storm drainage system.

H. Straw/Hay Bale Dike: Intercept sediment laden runoff by reducing velocity. Replace after 3 months.

I. Storm drain Diversion: The redirection of a storm drain line or outfall channel for discharge into a sediment trapping device.

J. Temporary Swale: A temporary excavated drainage swale.

K. Protecting Vegetation: Protecting trees, shrubs, ground cover and other vegetation from damage.

L. Temporary Seeding: Erosion control protection to a critical area for an interim period. A critical area is any disturbed, denuded slope subject to erosion.

M. Permanent Seeding: Grasses established and combined with shrubs to provide perennial vegetative cover on disturbed, denuded, slopes subject to erosion.

N. Sod: Used where a quick vegetative cover is required.

1.6 SUBMITTALS

A. Product Data: Manufacturer's catalog cuts, specifications and installation instructions.

B. Contingency Action Plan for prompt remedial action in the event spillage of petroleum products or other pollutants should occur. Contingency Action Plan shall be submitted to the Engineer for acceptance prior to the start of construction.

C. Name and location of all material suppliers.

D. Certificate of compliance with the standards specified above for each source of each material.

E. List of disposal sites for waste and unsuitable materials and all required permits for use of those sites.

F. Where a Stormwater Pollution Prevention Plan has been prepared, the Engineer shall file a Notice of Intent (NOI) with NYSDEC prior to commencing construction activities and a Notice of Termination (NOT) with NYSDEC following construction.

G. Where a Stormwater Pollution Prevention Plan and/or Erosion and Sediment Control Plan has been prepared, the Contractor will submit copies of certificates documenting that on-site workers have completed a NYS Department of Environmental Conservation endorsed Erosion & Sediment Control training as required by General Permit GP-0-25-001. The Contractor will submit copies of certificates documenting that on-site workers have completed a NYS Department of Environmental Conservation endorsed Erosion & Sediment Control training as required by General Permit GP-0-25-001.

PART 2 PRODUCTS

2.1 MATERIALS

A. Silt Fence
   1. Mirafi, Envirofence365 South Holland Drive, Pendergrass, Ga, 30567, (888) 795-0808, http://www.tencategeo.us/en-us/
   2. Filter X
   3. Stabilinka T140N
   4. Approved equivalent

B. Filter fabric inlet protection

C. Stone and block inlet protection

D. Temporary filters for inlet protection

E. Hardwood staking material

F. Stone material

G. Dry Rip Rap
   1. NYSDOT Standard Specification Section 620

PART 3 EXECUTION

3.1 PREPARATION

A. Prior to any construction activities, install temporary erosion and sediment control barriers or measures as indicated on the Contract Plans, per manufacturer's specifications.

B. The Contractor shall comply with all provisions of the Erosion and Sediment Control Plan and/or Stormwater Pollution Prevention Plan prepared by Passero Associates.

C. The Contractor shall be required to protect and preserve existing trees and shrubs within the Limit of Disturbance. Contractor shall replace any tree or shrubs damaged in kind to the satisfaction of the Owner.

D. The Contractor shall contact the Engineer once the erosion and sediment control structures have been installed.

E. Prior to commencement of construction, the Owner's Representative shall conduct an assessment of the site and certify that the appropriate erosion and sediment control structures as shown on the Contract Plans have been adequately installed and implemented.

F. Staging of Earthwork Activities: All earthwork shall be scheduled so that the smallest possible areas will be unprotected from erosion for the shortest time feasible.

G. Vegetation adjacent to or outside of access roads or rights-of-way shall not be damaged.

H. The Engineer has the authority to limit the surface area of erodible earth exposed by earthwork operations and to direct the Contractor to provide immediate temporary or permanent erosion measures to minimize damage to property and contamination of watercourses and water impoundments. Under no circumstances will the area of erodible earth material exposed at one time exceed 5 acres. The Engineer may increase or decrease this area of erodible earth material exposed at one time as determined by their analysis of project, weather and other conditions. The Engineer may limit the area of clearing and grubbing and earthwork operations in progress commensurate with the Contractor's demonstrated capability in protecting erodible earth surfaces with temporary, permanent, vegetative or biotechnical erosion control measures.

I. Schedule the work so as to minimize the time that earth areas will be exposed to erosive conditions. Provide temporary structural measures immediately to prevent any soil erosion.

J. Provide temporary seeding on disturbed earth or soil stockpiles exposed for more than 7 days or for any temporary shutdown of construction. In spring, summer or early fall apply rye grass at a rate of 1 lb/ 1000 sq.ft. In late fall or early spring, apply certified Aroostook Rye at a rate of 2.5 lbs./ 1000 sq. ft. Apply hay or straw at a rate of 2 bales/ 1000 sq. ft. or wood fiber hydromulch at the manufacturer's recommended rate. Hay or straw shall be anchored.

K. Provide temporary grading to facilitate dewatering and control of surface water.

L. Coordinate the use of permanent controls or finish materials shown with the temporary erosion measures.

M. After final stabilization has been achieved, temporary sediment and erosion controls must be removed. Areas disturbed during removal must be stabilized immediately.

N. Disposal of spoil material shall not be in any flood plain, wetland, stream, brook, or sensitive environmental area. The Contractor shall dispose of spoils within staging areas and provide sediment control barriers accordingly.

3.2 CLEARING

A. Tree trunks and roots, vegetation, and project debris shall not be buried on site.

B. Staging areas (for storage of materials and stockpiles) shall be located as shown on the plans. Where areas must be cleared for staging area temporary structures, provisions shall be made for regulating drainage and controlling erosion.

C. All abandoned or useless objects including equipment, supplies, personal property, rubbish, (including those present prior to construction activities) should be removed from the project work area and properly disposed of in accordance with local, state, and federal regulations.

3.3 COMPLIANCE

A. The Owner shall have a qualified professional, as described in the NYSDEC SPDES General Permit for Stormwater Discharge from Construction Permit No. GP-0-20-001, conduct a site inspection following the commencement of construction at least every 7 calendar days.

B. All erosion and sediment control devices must be maintained in working order until the site is stabilized. All preventative and remedial maintenance work, including clean out, repair, replacement, re-grading, re-seeding, or re-mulching, must be performed immediately.

C. The Contractor shall, at the direction of the Engineer, use necessary methods to minimize erosion within access roads, especially in areas that drain to watercourse areas.

D. Cuts, fills, and other disturbed areas will be maintained to prevent erosion until adequate vegetative/impervious cover is established.

E. Water, resulting from dewatering operations that will reduce the quality of receiving waters shall not be directly discharged. The Contractor shall provide, install, and maintain sump pits where necessary to dewater operations as detailed on the plans. Stone used within the sump pits shall be washed clean stone. The Contractor shall provide, install and maintain dewatering bags, as deemed necessary to control sediment deposits at critical environmental areas. Lifting straps shall be placed under the unit to facilitate removal after use. Dewatering bags shall be placed on stabilized areas over grass. Discharge hose from pump shall be inserted a minimum of six inches and tightly secured with attached strap to prevent water from flowing out of the unit without being filtered. Water from dewatering operations shall be treated to eliminate the discharge of sediment and other pollutants to streams and watercourses. The unit shall be replaced when it is half full of sediment or when the sediment has reduced the flow rate of the pump discharge to an impractical rate. Remove and dispose of sediment and dewatering bag off-site.

F. Silt fence, where identified on plans, shall be installed at down gradient locations to control sediment deposits off-site at critical environmental areas. The silt fence shall be staked (unless noted otherwise), anchored and set as per manufactures specifications. The silt fence shall be inspected on a daily basis and after a rain fall event and repaired as necessary.

G. A stabilized construction entrance shall be installed and maintained for vehicular access on and off site. The entrance shall be constructed in accordance with the NYSDEC Erosion and Sediment Control Standards and the Contract Plans. The condition of the entrance shall be inspected daily and repaired as necessary.

H. Dust control shall be controlled by the use of water, or calcium chloride application. Water application shall be applied at a rate where mud is not produced. The rate of application of the calcium chloride shall not exceed Federal, State and Local application rates or manufactures recommendations. Dust control shall be applied on adjacent public streets.

I. Dry rip-rap shall conform to the lines, grades and thicknesses indicated on construction plans. It shall be a well-graded mass of variable size stones with no areas of uniform size material. Align stones to obtain a close fit and to minimize voids. Fill spaces between stones with spalls of suitable size.

J. Paved areas within access corridors and parking areas shall be swept on a regular basis (minimum twice per week) as needed to minimize sediment and dust tracked from the work area. Should sediment and dust be tracked off-site, Contractor shall be responsible for sweeping public streets.

K. During the final site restoration, the Contractor shall remove all sediment and debris deposited in the temporary and permanent erosion and sediment control barriers or measures including but not limited to all culverts and drainage swales, at no additional cost to the Owner.

L. When all disturbed areas are stable, all temporary erosion and sediment control measures shall be removed per the approval of the Engineer. The measures are temporary and shall be removed and the areas restored to its original condition when they are no longer required, at no additional cost to the Owner.

M. The Owner and Contractor shall maintain a record of all erosion and sediment control inspection reports at the site in a log book. The site log book shall be maintained on the site and be made available to the permitting authority. The Owner / Contractor shall post at the site, in a publicly accessible location, a summary of the site inspection activities on a monthly basis.

N. The Contractor is fully responsible for maintaining, repairing, and protecting his work throughout the project, at no additional cost to the Owner, until the Owner accepts the work.

END OF SECTION 312513

SECTION 321216 - ASPHALT PAVING

PART 1 GENERAL

1.1 SUMMARY

A. Hot-mixed asphalt pavement for roads

B. Hot-mixed asphalt patching

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   1. Section 312000: Excavation and Fill
   2. Section 321723: Pavement Marking

1.3 REFERENCE STANDARDS

A. AI MS-2 - Asphalt Mix Design Methods; 2015.

B. AI MS-22 - Construction of Quality Asphalt Pavements; 2020.

C. ASTM D1073 - Standard Specification for Fine Aggregate for Asphalt Paving Mixtures; 2016 (Reapproved 2022).

D. New York State Department of Transportation (DOT) Specification Section 40X, latest edition.

1.4 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Discontinue paving when surface temperatures fall below requirements listed in DOT Table 402-1 unless otherwise specified in the General Conditions of this Contract or as directed by the Engineer.
   2. Do not place asphalt concrete on wet surfaces, or when weather conditions otherwise prevent the proper handling or finishing of bituminous mixtures as determined by the Engineer.
   3. Pavement is restricted by dates listed in the General Conditions or by temperatures.

1.5 SUBMITTALS

A. Product Data:

1. Paving Synthetics: including Manufacturer's name, specifications, MSDS as required and installation instructions (including adhesion type and rate) for each item specified.
2. Asphaltic Pavement: Include mix design from NYSDOT approved Batch Plant, Mix Design Test results that are less than 6 months old

B. Batch plant name, NYSDOT Plant Number, and location of asphalt plant.

C. Pavement Quality Control Submittals: Material Delivery Tickets
1. At the time of delivery, a copy of the delivery ticket must be presented to the Director's Representative with the following minimum information:
   a. Ticket Number.
   b. Plant Identification.
   c. Project Name.
   d. Mix Type.
   e. Quantity of material in vehicle.
   f. Date and Time.

D. Qualification Data: For manufacturer and testing agency.

E. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the NYSDOT.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the NYSDOT for asphalt paving work.

D. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

PART 2 PRODUCTS

2.1 AGGREGATES

A. All aggregate used in design mixes shall be as specified in DOT Specification Section 401-2.02 B.; Coarse Aggregate Type F2 Conditions.

B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel.

C. Fine Aggregate: ASTM D1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel.

2.2 ASPHALT MATERIALS

A. General: Use locally available materials and gradations that exhibit a satisfactory record of previous installations.

B. Asphalt Pavement: Paving materials shall comply with the New York State Department of Transportation Standard Specification dated "Current Version." Section 404 – Hot Mix Asphalt.

C. Trueing & Leveling Course: DOT Table 401-1 Composition of Hot Mix Asphalt Mixtures, Type 5 (Shim).

D. Asphalt Cement: ASTM D 3381 for viscosity-graded material. ASTM D 946 for penetration-graded material.

E. Asphalt Cement Tack Coat: Material shall conform to NYSDOT Section 407 – Tack Coat.

F. Prime Coat: Cut-back asphalt type, ASTM D 2027; MC-30, MC-70 or MC-250.

2.3 AUXILIARY MATERIALS

A. Sand: ASTM D1073 or AASHTO M 29, Grade Nos. 2 or 3.

B. Joint Sealant: ASTM D 3405 or AASHTO M 301, hot-applied, single-component, polymer-modified bituminous sealant.

C. Paving Synthetics: A non-woven fabric designed for use in pavement rehabilitation to reduce reflective cracking, act as a vapor barrier and have one side heat bonded only.
1. Tensar Triax Geogrid
2. Tencate
3. Propex Fabrics
4. Fibertex
5. Approved equivalent

2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:
1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: NYSDOT (Type 37.5 F9 Base Course HMA, series 80 compaction) per Contract Drawings.
3. Binder Course: NYSDOT (Type 19 F9 Binder Course HMA, series 80 compaction) per Contract Drawings.

4. Top Course: NYSDOT (Type 9.5 F2 Top Course HMA, series 80 compaction) per Contract Drawings.
5. True and Leveling Course: Binder Course mix to be used in placed in a lift greater than 2 inches thick. Top Course mix to be used in a lift less than 2 inches thick.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that sub-grade is dry and in suitable condition to support paving and imposed loads.

B. Proof-roll subgrade in accordance with Specification Section 312000: Excavation and Fill

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving

B. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

C. Tack Coat: If top course is not placed within twenty-four (24) hours of binder placement, a tack coat shall be applied to clean surface prior to placement of top course. Apply uniformly to surfaces of pavement at a rate of 0.05 to 0.15 gal./sq. yd.

D. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

E. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off using a self-propelled paving machine with vibrating screed. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
1. Clean cracks and joints in existing hot-mix asphalt pavement.
2. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
3. Spread mix at minimum temperature of 250 degrees Fahrenheit.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.

5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
   1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
   2. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.4 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.
   1. Clean contact surfaces and apply tack coat to joints.
   2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
   3. Offset transverse joints, in successive courses, a minimum of 12 inches.
   4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."
   5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
   6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.5 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
   1. Complete compaction before mix temperature cools to 185 degrees Fahrenheit.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.6 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
1. Binder Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.7 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Re-compact existing unbound-aggregate base course to form new sub-grade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.
1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.8 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.
   1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.
   1. Clean cracks and joints in existing hot-mix asphalt pavement.
   2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.9 FIELD QUALITY CONTROL

A. Special Inspections: Contractor shall engage a qualified special inspector to perform the following special inspections:

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses shall be determined according to ASTM D 3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course shall be tested for compliance with smoothness tolerances.

E. In-Place Density: Testing agency shall take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.
   1. Reference maximum theoretical density shall be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
   2. In-place density of compacted pavement shall be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
      a. One core sample shall be taken for every 1000 sq. yd or less of installed pavement, with no fewer than three cores taken.
      b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

F. Replace and compact hot-mix asphalt where core tests were taken.

G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION 321216

SECTION 321723 - PAVEMENT MARKING

PART 1 GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Plans and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   1. Section 321216: Asphalt Paving

1.2 REFERENCE STANDARDS

A. New York State Department of Transportation (DOT) Specification Section 400, latest edition.

1.3 PROJECT CONDITIONS

A. Perform the painting operations after working hours, on weekends or at such time so as not to interfere with the flow of traffic. Provide temporary barriers to prevent vehicles from driving over newly painted areas.

B. Apply paint on dry pavement surface, when the air temperature is above 40 degrees Fahrenheit and not exceeding 95 degrees Fahrenheit, or as recommended by the manufacturer.

1.4 SUBMITTALS

A. Product Data: Include technical data and tested physical and performance properties. Indicate pavement markings to be used, colors, dimensions and symbols.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable.

B. Requirements of NYSDOT for pavement-marking work and the "National Manual on Uniform Traffic Control Devices" latest edition and the "NYS Supplement."

PART 2 PRODUCTS

2.1 MATERIALS

A. Paint: DOT Section 640-2, yellow or white as indicated, or if not indicated as directed. Delete reference to Glass Beads.

B. Rapid Dry Paint:
   1. Aexcel Corp., www.aexcelcorp.com, 72W-A042 White, 72Y-A082 Yellow
   2. Sherwin-Williams, www.swpavementmarkings.com, TM2152 White, TM2153 Yellow, TM2224 Blue.
   3. Franklin Paint Company, Inc., www.franklinpaint.com, 2014 White, 2015 Yellow.
   4. Approved equivalent

PART 3 EXECUTION

3.1 PREPARATION

A. Remove dust, dirt, and other foreign material detrimental to paint adhesion.

B. Mark layout of stripes and lines with chalk or paint.

3.2 APPLYING PAVEMENT MARKING

A. Apply paint in accordance with DOT Section 640-3.02.

B. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Owner’s Representative.

C. Allow paving to cure for 30 days before starting pavement marking.

D. Sweep and clean surface to eliminate loose material and dust.

E. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.3 PROTECTING AND CLEANING

A. Protect pavement markings from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 321723

SECTION 323113 - CHAIN LINK FENCE AND GATE

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes:
   1. Fence framework, fabric and accessories.
   2. Excavation for post bases and center drop for gates.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   1. Section 033000: Cast in Place Concrete
   2. Section 312000: Excavation and Fill

1.3 REFERENCE STANDARDS

A. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric; 2011a (Reapproved 2022).

B. ASTM F567 - Standard Practice for Installation of Chain-Link Fence; 2023.

C. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures; 2018 (Reapproved 2022).

D. ASTM A 53 for requirements of Schedule 40 piping.

1.4 SUBMITTALS

A. 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 specifications.

B. Product Data: Manufacturer's catalog cuts, specifications, and installation instructions for each item specified.

C. Samples:
   1. Fence Fabric: Minimum one square foot.
   2. Fence and Gate Posts: Two each, one foot long, if requested.
   3. Miscellaneous Materials and Accessories: One each, if requested.

D. Quality Control Submittals:

E. Certificates: Affidavit required under Quality Assurance Article.

1.5 QUALITY ASSURANCE

A. Comply with standards of the Chain Link Fence Manufacturer's Institute.

B. Fence shall be installed in accordance with ASTM F567 and gates shall be installed in accordance with ASTM F-900.

C. Provide steel fence and related gates as a complete compatible system including necessary erection accessories, fittings, and fastenings.

D. Posts and rails shall be continuous without splices.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which installer agrees to repair or replace components of chain-link fences that fail in materials or workmanship within specified warranty period.

B. Failures include, but are not limited to, the following:
1. Faulty operation of gate operators and controls.
2. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
3. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 STEEL FRAMEWORK

A. All pipe shall be Schedule 40, conforming with ASTM F1083.

B. End Posts, Corner Posts and Pull Posts:
1. 4' Fence Height Pipe: 2 inches O.D.
2. 6' and 8' Fence Height Pipe: 3 inches O.D.
3. 10' Fence Height Pipe: 6 inches O.D.

C. Line Posts:
1. 4' Fence Height Pipe: 2 inches O.D.
2. 6' and 8' Fence Height Pipe: 2 1/2 inches O.D.
3. 10' Fence Height Pipe: 3 inches O.D.

D. Rails and Post Braces:
1. 4' Fence Height Pipe: 1 5/8 inches O.D.
2. 6' and 8' Fence Height Pipe: 1 5/8 inches O.D.
3. 10' Fence Height Pipe: 1 5/8 inches O.D.

E. Metallic Coating for Steel Framework:
   1. Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
   2. External, Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil thick, zinc-pigmented coating.
   3. Coatings: Any coating above.

2.2 STEEL FABRIC

A. One-piece widths for fence heights up to 12′-0″.

B. Chain link, 2 inch mesh, No. 9 gauge

C. Selvages: Top edge; bottom edge knuckled.

D. Zinc-Coated (galvanized) Fabric: ASTM A392, Type II, Class 1, 1.2 oz./sq. ft. with zinc coating applied after weaving.

E. Aluminum wire ties shall not be allowed.

2.3 PRIVACY SLATS:

A. Slats shall be 1-1/4″ wide, single wall UV stabilized PVC.

B. Slats shall lock at bottom and top of fence and be secured with wire ties.

C. Owner/Architect to select color.

2.4 BANDS:

A. 6′ Fence Height: 6 each bands per fence direction.

B. 8′ Fence Height: 8 each bands per fence direction.

C. 10′ Fence Height: 10 each bands per fence direction.

2.5 SWING GATE POSTS

A. Single width of gate up to 6′-0″ wide and less than 10′-0″ high:
   1. Pipe: [2.875] inches OD (Schedule 40).

B. Single width of gate 6′-0″ to 12′-0″ wide or over 10′-0″ high:
   1. Pipe: 4 inches OD (Schedule 40).

2.6 SWING GATE FRAMES

A. Up to 6′-0″ high, and leaf width 8′-0″ or less.
   1. Pipe: [1.660] inches OD (Schedule 40).

B. Height: 6′-0″ - 12′-0″, or leaf width exceeding 8′-0″:
   1. Pipe: 1.90 inches OD (Schedule 40).

C. Assemble gate frames by welding or with special steel fittings and rivets for rigid connections. Install mid-height horizontal rails on gates over 10 feet high. When width of gate leaf exceeds 10 feet, install mid-distance vertical bracing of the same size and weight as frame members. When either horizontal or vertical bracing is not required, provide truss rods as cross bracing to prevent sag or twist.

2.7 SWING GATE HARDWARE

A. Hinges: Non-lift-off type, offset to permit 180 degree swing, and of suitable size and weight to support gate. Provide 1-1/2 pair of hinges for each leaf over 6 feet high.

B. 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. Padlock eye shall be an integral part of latch construction.

2.8 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Rails and Post Braces:
   1. Pipe: [1.660] inches OD, 2.27 pounds per linear foot (Schedule 40).

B. Fittings and Post Tops: Steel, wrought iron, or malleable iron.
   1. Fasteners: Tamper-resistant cadmium plated steel screws.

C. Stretcher Bars: One piece equal to full height of fabric, minimum cross-section 3/16 inch by 3/4 inch.

D. Metal Bands (for securing stretcher bars): Steel, wrought iron, or malleable iron.

E. Wire Ties: Conform to American Steel Wire gauges.
   1. For tying fabric to line posts, rails and braces: 9 gauge .1483 inch steel wire.

F. Truss Rods: 3/8 inch diameter.

G. Concrete: Portland Cement concrete having a minimum compressive strength of 4000 psi at 28 days.
   1. Terminal/ End/ Corner Post Foundations:
      a. 4′ and 6′ Fence Height Foundations: 3′-6″ deep post embedment in 4′ deep concrete footing, 12″ inches diameter.

b. 8′ Fence Height Foundations: 4′-6″ deep post embedment in 5′ deep concrete footing, 18″ inches diameter.
c. 10′ and greater Fence Height Foundations: 5′-0″ deep post embedment in 5′ deep concrete footing, 18″ inches diameter.

2. Line Post Foundations:
a. 4′ and 6′ Fence Height Foundations: 3′-6″ deep post embedment in 4′-0″ deep concrete footing, 12″ inches diameter.
b. 8′ Fence Height Foundations: 4′-6″ deep post embedment in 5′ deep concrete footing, 12″ inches diameter.
c. 10′ and greater Fence Height Foundations: 5′-0″ deep post embedment in 5′ deep concrete footing, 12″ inches diameter.

H. Spiral Paper Tubes:
1. Sonotube by Sonoco Products Co., North Second St., Hartsville, SC 29550, (800) 377-2692.
2. Sleek/tubes by Jefferson Smurfit Corp., P.O. Box 66820, St. Louis, MO 63166, (314) 746-1100.
3. Approved equivalent

I. Cold Galvanizing Compound: Single component compound giving 93 percent pure zinc in the dried film, and meeting the requirements of DOD-P-21035A (NAVY).

2.9 FINISHES

A. Steel Framework:
1. Pipe: Galvanized in accordance with ASTM A 53, 1.8 ounces zinc per square foot.

B. Fabric
1. Galvanized Finish: ASTM A392 class II zinc coated after weaving, with 2.0 ounces per square foot.

C. Fence and Gate Hardware, Miscellaneous Materials, Accessories:
1. Wire Ties: Galvanized Finish, ASTM A 90 1.6 ounces zinc per square foot, or aluminized finish, ASTM A 809 0.40 ounces per square foot.
2. Hardware and Miscellaneous Items: Galvanized Finish, ASTM A 153 (Table 1).

PART 3 EXECUTION

3.1 PREPARATION

A. Clear and grub along fence line as required to eliminate growth interfering with alignment. Remove debris from State property.

B. Do not begin installation of fence in areas to be cut until finished grading has been completed.

3.2 APPLYING PAVEMENT MARKING

A. Install chain-link fencing according to ASTM F567 and more stringent requirements specified.

B. Space posts equidistant in the fence line with a maximum of 10 feet on center. For fences 16 feet and higher space posts a maximum of 8 feet on center.

C. Setting Posts in Earth: Drill holes for post footings. If existing grade at the time of installation is below finished grade, provide spiral paper tubes to contain concrete to finish grade elevation. Set posts in center of hole and fill hole with concrete. Plumb and align posts. Vibrate or tamp concrete for consolidation. Finish concrete in a dome shape above finish grade elevation to shed water. Do not attach fabric to posts until concrete has cured a minimum of 7 days.

D. Setting Posts in Rock: Drill holes into solid rock one inch wider than post diameter, 18 inches deep for end, pull, corner, and gate posts, and 12 inches deep for line posts. Set posts into holes and fill annular space with shrink-resistant grout.

E. Locate 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 the line posts.

F. Install top rail continuously through post tops or extension arms, bending to radius for curved runs. Install expansion couplings as recommended by fencing manufacturers.

G. Install bottom and intermediate rails in one piece between posts and flush with post on fabric side using special offset fittings where necessary.

H. Brace corner posts, pull posts, end posts, and gate posts to adjacent line posts with horizontal rails.

I. Diagonally brace corner posts, pull posts, end posts, and gate posts to adjacent line posts with truss rods and turnbuckles.

J. Attach fabric to security side of fence. Maintain a 2 inch clearance above finished grade except when indicated otherwise. Thread stretcher bars through fabric using one bar for each gate and end post and 2 for each corner and pull post. Pull fabric tight so that the maximum deflection of fabric is 2 inches when a 30 pound pull is exerted perpendicular to the center of a panel. Maintain tension by securing stretcher bars to posts with metal bands spaced 15 inches oc. Fasten fabric to steel framework with wire ties spaced 12 inches oc for line posts and 24 inches oc for rails and braces. Bend back wire ends to prevent injury. Tighten stretcher bar bands, wire ties, and other fasteners securely.

K. Position bolts for securing metal bands and hardware so nuts are located opposite the fabric side of fence. Tighten nuts and cut off excess threads so no more than 1/8 inch is exposed. Peen ends to prevent loosening or removal of nuts.
   1. Secure post tops and extension arms with tamper-resistant screws.

L. Install gates plumb and level and adjust for full opening without interference. Install ground-set items in concrete for anchorage, as recommended by fence manufacturer. Adjust hardware for smooth operation and lubricate where necessary.

M. Tension Wire: Support bottom edge of fabric with tension wire. Weave tension wire through fabric or fasten with hog rings spaced 24 inches oc. Tie tension wire to posts with 9 gauge wire ties.

N. Wire brush and repair welded and abraded areas of galvanized surfaces with one coat of cold galvanizing compound.

O. Restore disturbed ground areas to original condition. Topsoil and seed to match adjacent areas.

3.3 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.4 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

END OF SECTION 323113

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SECTION 329200 - TOPSOIL AND SEEDING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes:
   1. Topsoil.
   2. Soil Amendments.
   3. Fertilizing.
   4. Mulches.
   5. Lawn.
   6. Lawn Restoration.
   7. Erosion Control Materials.
   8. Maintenance.

1.2 RELATED WORK SPECIFIED ELSEWHERE

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

B. Section 312000: Excavation and Fill.

1.3 SUBMITTALS

A. Product Certification: Certification signed by manufacturers certifying that their products comply with specified requirements.
   1. Manufacturer's certified analysis for standard products.
   2. Analysis for other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

B. Certification of grass seed from seed vendor stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

C. Material test reports from qualified independent testing agency indicating and interpreting test results relative to compliance of the following materials with requirements indicated. Include percentages of organic matter, inorganic matter (silt, clay, and sand), deleterious material, pH, and mineral and plant-nutrient content.
   1. Analysis of existing surface soil.
   2. Analysis of imported topsoil.

D. Report suitability of existing surface soil and imported topsoil for lawn and plant growth. State recommended quantities of soil amendments to be added to produce satisfactory results.

1.4 DEFINITIONS

A. Weeds: Vegetative species other than specified species to be established in given area.

B. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

1.5 REFERENCE STANDARDS

A. ASTM C602 - Standard Specification for Agricultural Liming Materials; 2023.

B. ASTM E699 - Standard Specification for Agencies Involved in Testing, Quality Assurance, and Evaluating of Manufactured Building Components; 2016.

1.6 CLOSEOUT SUBMITTALS

A. Before expiration of required maintenance periods, Contractor is to submit maintenance instructions recommending procedures to be performed by Owner for maintenance of landscape during an entire year.

1.7 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, germination percentage, inert matter percentage, weed percentage, year of production, net weight, date of packaging, and location of packaging.

1.8 QUALIFICATIONS

A. Seed Supplier: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section with minimum three years documented experience and a record of successful landscape establishment.
   1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Project site during times that work of this section is in progress.

C. Testing Agency: To qualify for acceptance, an independent testing agency must demonstrate to Owner's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the work.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver packaged materials in sealed containers showing weight, analysis, and name of manufacturer.

B. Protect materials from deterioration during delivery and while stored at site.

1.10 PROJECT CONDITIONS

A. Utilities: Determine location of above grade and underground utilities prior to the start of Work. Perform Work in a manner which will avoid damage. Hand excavate, as required. Maintain grade stakes until removal is mutually agreed upon by the Engineer.

B. Excavation: When conditions detrimental to lawn growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify the Engineer before planting.

1.11 COORDINATION AND SCHEDULING

A. Coordinate with other site operations to avoid conflict and damage to new work.

B. Time for seeding: Optimum period to sow permanent grass seed is generally between April 1 and May 15 or between August 15 and October 1. Schedule application for when weather conditions permit.
   1. Provide temporary seed and mulch when final grading is complete and waiting for optimal seeding period.
   2. Provide temporary seed and mulch for temporary cover on disturbed ground not to be worked on for more than seven days.
   3. Provide temporary seed and mulch on disturbed earth prior to temporary shutdown of construction.

1.12 WARRANTY

A. General: The guarantee specified in this Section shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Guarantee: Upon completion and acceptance of the landscaping, guarantee the materials for two years. Guarantee shall include material and labor costs. At the end of the guarantee period, the Owner’s onsite representative shall inspect all planter materials. The Contractor shall promptly make all required replacements with plant materials meeting specifications.

1.13 LAWN MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until acceptable lawns and plants are established, but for not less than the following periods:
   1. Lawns and Seeded Areas: 120 days after date of Substantial Completion.
   2. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established at that time, continue maintenance during the next planting season.

B. Maintain and establish seeded areas by watering, weeding, replanting, and other operations. Roll, re-grade, and replant bare or eroded areas and re-mulch to produce a uniformly smooth surface.

C. Watering: Provide and maintain temporary piping, hoses, and watering equipment to convey water from sources and to keep grass uniformly moist to a depth of 4 inches. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   1. Water all seeded areas at the minimum rate of 1 inch per week.

D. Mow lawns as soon as there is enough top growth to cut with mower set at specified height for principal species planted. Repeat mowing as required to maintain specified height without cutting more than 40 percent of the grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain a grass height of 1½ to 2½ inches.

PART 2 PRODUCTS

2.1 PLANTING BACKFILL

A. Mixture shall be 4 parts topsoil (on-site or imported), 1 part peat moss, ½ part well-rotted manure and 10 pounds 5-0-5 planting fertilizer, mixed thoroughly per cubic yard.

2.2 TOPSOIL

A. Source: Provide topsoil from existing stockpiles stripped from the project site and approved by the Engineer.

B. Where existing topsoil is not available, 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 5 percent nor more than 20 percent organic matter in that portion of a sample passing a 1/4-inch sieve when determined by the wet combustion method on a sample dried at 221 degrees Fahrenheit.
3. Containing a pH value within the range of 6.5 to 7.5 on that portion of the sample that passes a 1/4-inch sieve.
4. Containing the following gradations:

SIEVE DESIGNATION	PERCENT PASSING
1 inch	100
1/4 inch	97 - 100
No. 200	20 - 60

2.3 SOIL AMENDMENTS

A. Lime: ASTM C602, Class T, agricultural limestone containing a minimum 85 percent calcium carbonate equivalent, with a minimum 90 percent passing a No. 10 mesh sieve and a minimum 50 percent passing a No. 100 mesh sieve.
1. Provide lime in the form of dolomitic limestone.
2. Add lime soil as necessary to achieve a soil pH between 5.5 – 7.0.

B. Aluminum Sulfate: Commercial grade, unadulterated.

C. Herbicides: EPA registered and approved, of type recommended by manufacturer.

D. Sand: Clean, washed, natural or manufactured, free of toxic materials.

E. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch sieve; soluble salt content of 5 to 10 decimeters/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
1. Organic Matter Content: 50 to 60 percent of dry weight.

2.4 FERTILIZER

A. Application of any fertilizer is prohibited between December 1st and April 1st and cannot be applied within 20’ of a water body.

B. Fertilizer: Mixed commercial fertilizers shall contain total nitrogen, available phosphoric acid and soluble potash in the ratio of 10-0-10. No fertilizer containing phosphorus is permitted on site.

C. Other fertilizers meeting DOT Specification Section 713-03 Fertilizer can be used.

2.5 MULCH

A. Dry Application, Straw: Stalks of oats, wheat, rye or other approved crops that are free of noxious weed seeds. Weight shall be based on a 15 percent moisture content.

B. Hydro Application: Colored wood cellulose fiber product specifically designed for use as a hydro-mechanical applied mulch. Acceptable Product: Conwed Hydro Mulch, Conwed Fibers, 231 4th Street SW, Hickory, NC or approved equivalent.

2.6 SEED

A. Furnish fresh, clean, new-crop seed mixed in the proportions specified for species and variety and conforming to Federal and State Standards.

B. Acceptable material in a seed mixture other than pure live seed consists of nonviable seed, chaff, hulls, live seed of crop plants and inert matter. The percentage of weed seed shall not exceed 0.1 percent by weight.

C. All seed will be rejected if the label or test analysis indicates any of the following contaminates: Timothy, Orchard Grass, Sheep Fescue, Meadow Fescue, Canada Blue Grass, Alta Fescue, Kentucky 31 Fescue, and Bent Grass.

D. Provide seed mixture equal to Scotts Pure Premium Sun and Shade North Grass Seed Mixture or approved equal. Install in accordance with manufacturer's recommendations.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas to receive landscaping for compliance with requirements and for conditions affecting performance of work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PLANTING SOIL PREPARATION

A. Before mixing, clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful to plant growth.

B. Mix soil amendments and fertilizers with topsoil as necessary to meet applicable ASTM standards.

C. For lawns, mix planting soil either prior to planting or apply on surface of topsoil and mix thoroughly before planting.
   1. Mix lime with dry soil prior to mixing fertilizer. Prevent lime from contacting roots of acid-tolerant plants.
   2. Apply lime per manufacturer instructions based on soil pH.

3.3 LAWN AREA PLANTING PREPARATION

A. Limit sub-grade preparation to areas that will be planted in the immediate future.

B. Loosen sub-grade to a minimum depth of 4 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous materials.

C. Spread topsoil to depth 4 inches minimum) required to meet the thickness, grades, and elevations shown, after light rolling and natural settlement. Do not spread if planting soil or sub-grade is frozen.
   1. Place approximately 1/2 the thickness of planting soil mixture required. Work into top of loosened sub-grade to create a transition layer and then place remainder of planting soil mixture.

D. Grade lawn and grass areas to a smooth, even surface with loose, uniformly fine texture. Roll (112-pound roller maximum) and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future. Remove trash, debris, stones larger than 1-1/2 inches in any dimension, and other objects that may interfere with planting or maintenance operations.

E. Moisten prepared lawn and grass areas before planting when soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Restore prepared areas if eroded or otherwise disturbed after fine grading and before planting.

3.4 FERTILIZING

A. The soil shall be tested for pH and lime added as necessary. All amendments shall be checked and approved by the Landscape Architect before amendments are made.

B. Apply fertilizer at a rate of 20 LBS/1,000 SF.

3.5 SEEDING

A. Contractor shall assume all risks when seed is sowed before approval of seed analysis.

B. Sow seed by hand broadcasting or hydroseeding. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in 2 directions at right angles to each other.
   1. Do not use wet seed or seed that is moldy or otherwise damaged in transit or storage.
   2. Do not sow immediately following rain, when ground is too dry, or during windy periods.

C. Sow seed at the following rates:
   1. Per manufacturer recommendations
   2. Low Maintenance Fescue Lawn, Seeding Rate: 6 lbs per 1000 sq. ft.
   3. Seed Mix for Wet Locations, Seeding Rate: 4 lbs per 1000 sq. ft.

D. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray, immediately after each area has been mulched. Saturate to 4 inches of soil.

E. Protect seeded areas with slopes less than 1:3 against erosion by spreading mulch after completion of seeding operations.
   1. Mulch rates.
      a. Oat or wheat straw applied at a minimum rate of 2 tons per acre to form a continuous blanket 1-1/2 inches loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.
      b. Fill tank with water and agitate while adding seeding materials. Use sufficient fertilizer, mulch, and seed to obtain the specified application rate. Add seed to the tank after the fertilizer and mulch have been added. Maintain constant agitation to keep contents in homogenous suspension. Prolonged delays in application or agitation that may be injurious to the seed will be the basis of rejection of material remaining in tank.
      c. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply mulch at a minimum rate of 57 gal/1000 sf (2500-lb/acre dry weight but not less than the rate required to obtain specified seed-sowing rate.

F. Anchor mulch by spraying with asphalt-emulsion tackifier at the rate of 10 to 13 gal. per 1000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

3.6 LAWN RESTORATION

A. Renovate existing lawn within work limit.

B. Renovate existing lawn damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

C. Reestablish lawn where settlement or washouts occur or where minor regrading is required.
   1. Install new planting soil as required.

D. Remove lawn from diseased or unsatisfactory existing lawn areas; do not bury in soil.

E. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

F. Where substantial lawn remains, mow, dethatch, core aerate, and rake. Remove weeds before seeding.

G. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

H. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and lawn, and legally dispose of them off Owner's property.

I. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

J. Apply soil amendments and fertilizers required for establishing new lawn and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

K. Apply seed and protect with straw mulch as required for new lawn.

L. Provide lawn maintenance as required for new lawn.

3.7 SATISFACTORY LAWNS, GRASS, AND LAWN RESTORATION

A. Satisfactory Lawns, Grass, and Lawn Restoration: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 95 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

B. Reestablish those that do not comply with requirements and continue maintenance until satisfactory.

3.8 CLEANUP AND PROTECTION

A. During landscaping, keep pavements clean and work area in an orderly condition.

B. Protect landscaping from damage due to landscape operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.

3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of it off the Owner's property.

END OF SECTION 329200

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SECTION 334100 - STORMWATER UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 REFERENCE STANDARDS

A. AASHTO M 252 - Standard Specification for Corrugated Polyethylene Pipe, 75- to 250-mm (3- to 10-in.) Diameter; 2025.

B. AASHTO M 294 - Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter; 2025.

C. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2021.

D. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals; 2019 (Reapproved 2025).

E. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2014 (Reapproved 2021).

1.2 SUMMARY

A. Under this section the Contractor shall provide all labor, equipment and material necessary to furnish, install and test all storm utility drainage pipe and fittings as shown on the Contract Plans.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Plans and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   1. Section 312000: Excavation and Fill
   2. Section 334900: Storm Drainage Structures

1.4 PROJECT CONDITIONS

A. Location of Sewers and Sewer Structures: The location, elevation, and grades of sewers and sewer structures are shown on the Contract Plans and shall be adhered to as closely as possible. If during construction of the project, it becomes necessary to make changes in the location or grades of the sewers, the Engineer will issue appropriate directions after being contacted by the Contractor.

B. Site Information: Perform site survey, research public utility records, and verify existing utility locations. Verify that storm sewerage system piping may be installed in compliance with original design and referenced standards.

1.5 SUBMITTALS

A. Shop Drawing: Pipes and associated fittings.

B. Product Data: Manufacturer's specifications, including dimensions, allowable height of cover information, and installation instructions.

C. Manufacturer's product literature, installation instructions and shop Plans for infiltration systems.

D. As-built record Plans at project closeout of installed storm sewerage piping and products. An as-built survey prepared by licensed NYS Surveyor depicting the installed storm sewer piping and structures including rim and invert elevations of structures pipe size, pipe type, and invert of all piping. Both hard copy and electronic copy shall be provided to the Owner and Engineer.

1.6 QUALITY ASSURANCE

A. Comply with standards of the Chain Link Fence Manufacturer's Institute.

B. Provide steel fence and related gates as a complete compatible system including necessary erection accessories, fittings, and fastenings.

C. Posts and rails shall be continuous without splices.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of the General Conditions.

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.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate with other utility work.

PART 2 PRODUCTS

2.1 MATERIALS

A. Corrugated Polyethylene Pipe (HDPE, Dual Wall with Smooth Interior): Conform to AASHTO M 294.
   1. Classification: Soil-tight, integral bell and spigot joints. Joints shall be sealed with factory installed rubber O-ring gaskets that meet ASTM F477.
   2. Coefficient of Roughness (interior pipe surface): 0.012 maximum (Manning formula).
   3. Joint Couplings (Soil-tight): Polyethylene, bell-and-spigot type couplers utilizing an elastomeric gasket conforming to ASTM F477.
   4. Fittings:
      a. High density polyethylene meeting the properties specified for the pipe.
      b. Either molded or fabricated.
      c. Designed specifically for the pipe furnished and manufactured by the pipe manufacturer.
   5. Acceptable Manufacturer:
      a. ProLink ST (N-12 IB ST), Smooth Interior Pipe & Fittings by Advanced Drainage Systems, Inc., (ADS) 3300 Riverside Dr., Columbus, OH 43221; (614) 457-3051
      b. Approved equivalent.

B. High Density Polyethylene Pipe (HDPE) Perforated Pipe: Perforated double wall smooth interior pipe complying with the following:
   1. 4" to 10" diameter pipe to conform to AASHTO M 252.
   2. 12" to 36" diameter pipe to conform to AASHTO M 294
   3. Coefficient of Roughness (Interior Pipe Surface): 0.012 maximum (Manning Formula).
   4. Classification: Type S
   5. Joint Couplings: Polyethylene, bell and spigot type couplers utilizing an elastrometric gasket conforming to ASTM F477. Snap on type or split collar through 24" diameter.
   6. Corrugated to match pipe corrugations, width not less than one half the pipe diameter.
   7. Split couplings shall engage an equal number of corrugations on each side of the joint.
   8. Fittings: Either molded or fabricated, high density polyethylene components meeting the properties specified for, and designed specifically for the pipe manufactured by the pipe manufacturer.
   9. Perforated Pipe: Conform to AASHTO M 252 or AASHTO M 294, Type SP with Class I perorations.
   10. Specifications have been based on products manufactured by Advanced Drainage Systems, Inc, Columbus, Ohio (Tel. #614-457-3051) or Hancor, Inc., Findlay, Ohio (Tel. #800-847-5880).

C. Polyvinyl Chloride (PVC) Pipe for in-line drain piping, solid: Conform to ASTM D3034 and ASTM F1336 (SDR-35)
   1. Conform to shape, dimensions, and thickness shown on the Contract Drawings.
   2. Provide fittings of the same size and pressure rating as the pipe to which they are connected.
   3. Rubber gasketed joints manufactured in accordance with ASTM D3139.
   4. Rubber gaskets shall comply with ASTM D3212 Internal Pressure Test and Vacuum Test at 5 degrees of gasket joint deflection.
   5. AdvanEdge Pipe and Couplings, as manufactured by Advanced Drainage Systems, Inc., (ADS) 3300 Riverside Dr., Columbus, OH 43221; (614) 457-3051, or approved equivalent.

D. Synthetic Turf Flat Panel Composite Drain
   1. Flat panel underdrain system complying with the following:
      a. 1-1/2" X 12" flat panel underdrain, wrapped in geotextile fabric.
      b. End connectors fabricated for use with 5" solid HDPE riser pipe.
      c. Solid HDPE collector pipe.
      d. Materials manufactured by Multi-Flow Drainage Systems (Model #12000) or approved equal.
   2. Fittings: Either molded or fabricated, high density polyethylene components meeting the properties specified and designed specifically for and by the same manufacturer as the flat panel underdrain system.
      a. Flat panel underdrain tee connection: Multi-Flow Drainage Systems (Model #12CTH) or approved equal.
      b. Snap coupler connection: by Multi-Flow Drainage Systems or approved equal.
      c. Flat panel underdrain end cap: Multi-Flow Drainage Systems (Model #12001) or approved equal.
      d. Specifications have been based on Multi-Flow Drainage System products manufactured by Varicore Technologies, Inc, Prinsburg, Mn. Approved equivalents acceptable.

2.2 NON-WOVEN GEOTEXTILE FABRIC

A. Continuous filament fabric consisting of polypropylene fibers and heat bonded nylon sheathed polypropylene fibers.

2.3 STORM SEWER PIPE, COLLECTOR PIPE, RISER PIPE, AND FITTINGS

A. General: Provide pipe and pipe fitting materials compatible with each other. Where more than one type of materials or products is indicated, provide as indicated on plans.

B. High Density Polyethylene Pipe (HDPE): smooth interior corrugated polyethylene type pipe, Type ADS N-12 as manufactured by Advanced Drainage Systems, Inc. of Columbus, Ohio or equal. Pipe and fittings shall be made of polyethylene compounds which conform with the physical requirements of Type III, Category 3, 4 or 5, P23, P33 or P34, Class C, with the applicable requirements defined in ASTM D1248. Approved equivalents acceptable.

C. Polyethylene (HDPE) Plastic Pipe and Fittings, ADS N-12 ProLink WT Couplers.

D. Couplings: Rubber or elastomeric sleeve and stainless steel band assembly fabricated to match outside diameters of pipes to be joined or
   1. Sleeves: ASTM F477, elastomeric seal for plastic pipe. Sleeves for dissimilar or other pipe materials shall be compatible with pipe materials being joined.
   2. Bands: Stainless steel, one at each pipe insert.

PART 3 EXECUTION

3.1 MAINTENANCE OF EXISTING STORMWATER FLOWS

A. Provide all temporary facilities required to safely and adequately bypass existing stormwater flows from the Work area during construction.

B. The bypassing of such flows shall prevent any hazards to public health and welfare when the stormwater flows are bypassed from the Work area during construction.

C. The Contractor is fully responsible for any and all damages to construction, adjacent properties, utilities, and/or buildings in the area caused by these operations.

3.2 INSPECTION

A. Inspect pipe and fittings before installation. Remove defective materials from the Site.

B. Concrete pipes shall be free from fractures, cracks, and surface roughness.

C. Pipe with damaged ends will not be accepted when such damage would prevent making a satisfactory joint.

3.3 INSTALLATION

A. General Locations and Arrangements: Contract Plans (plans and details) indicate the general location and arrangement of the underground storm sewerage system piping. Location and arrangements of piping layout take into account many design considerations. Install the piping as indicated, to the extent practical. If, during construction of the project, it becomes necessary to make changes in the location or grades of the sewers, the Engineer will issue appropriate directions after being contacted by the Contractor.

B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's recommendations for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

C. Use manholes or catch basins for changes in direction, except where a fitting is indicated. Use fittings for branch connections, except where direct tap into existing sewer is indicated.

D. Use proper size increasers, reducers, and couplings, where different size or material of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited.

E. Install piping pitched down in direction of flow, at minimum slope of 1 percent, except where indicated otherwise.

F. Extend storm sewerage system piping to connect to building storm drains, of sizes and in locations indicated.

G. Fill excess excavation with suitable materials and tamp.

3.4 STORM SEWER RELATION TO WATER PIPE

A. Horizontal Separation: Storm sewers should be laid at least 10 feet, horizontally, from any existing or proposed water or sanitary sewer pipe.

B. Vertical Separation: Whenever sewers must cross water or sanitary sewer pipe, the storm sewer shall be laid at such so there is an 18-inch vertical separation between the two lines. When the elevation of the sewer cannot be varied to meet the above requirements, the water main shall be relocated to provide this separation or reconstructed with push-on joint pipe for a distance of 10 feet on each side of the sewer. One full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.

3.5 PROTECTING PIPE

A. During the progress of the Work keep pipe clean from all sediment, debris, and other foreign material.

B. Close all open ends of pipes and fittings securely with removable plugs at end of Work day, during storms, when the Work is left at any time, and at such times as Owner’s Representative may direct.

3.6 TAP CONNECTIONS

A. Make connections to existing piping and underground structures so that finished work will conform as nearly as practicable to the requirements specified for new work.

B. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap, with not less than 6 inches of 3000-psi 28-day compressive-strength concrete.

C. Make branch connections from side into existing 4- to 21-inch piping by removing section of existing pipe and installing wye fitting, into existing piping. Encase entire wye with not less than 6 inches of 3000-psi 28-day compressive-strength concrete or,

D. Make branch connections from side into existing 24-inch or larger piping or to underground structures by cutting opening into existing unit sufficiently large to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
   1. Provide concrete that will attain minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
   2. Use epoxy bonding compound as interface between new and existing concrete and piping materials.
      a. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris, concrete, or other extraneous material that may accumulate.

3.7 FIELD QUALITY CONTROL

A. Cleaning: Clear interior of piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.
   1. In large, accessible piping, brushes and brooms may be used for cleaning.
   2. Place plugs in ends of uncompleted pipe at end of day or whenever work stops.
   3. Flush piping between manholes, if required by local authority, to remove collected debris.

B. Interior Inspection: Inspect piping to determine whether line displacement or other damage has occurred.
   1. Make inspections of pipe between manholes/fittings, after pipe has been installed and approximately 2 feet of backfill is in place, and again at completion of project.
   2. If inspection indicates poor alignment, debris, displaced pipe, infiltration, or other defects, correct such defects and re-inspect.

C. Water Tightness of Sewer Structures: It is the intent of the Contract Plans and these Specifications that the completed storm sewer lines shall be as watertight and free from infiltration as practical, unless specified otherwise. All visible leaks or points of infiltration shall be repaired.

END OF SECTION 334100

SECTION 334900 - STORM DRAINAGE STRUCTURES

PART 1 GENERAL

1.1 REFERENCE STANDARDS

A. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar; 2018.

B. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2019a, with Editorial Revision.

C. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets; 2021.

1.2 This Section includes:

A. Under this section the Contractor shall provide all labor, equipment and material necessary to furnish, install and test all storm utility drainage structures and fittings as shown on the Contract drawings, specified herein and approved by the Engineer.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   1. Section 312000: Excavation and Fill
   2. Section 334100: Storm Drainage Piping

1.4 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO)

B. American Society for Testing and Materials (ASTM)

1.5 PROJECT CONDITIONS

A. Location of Sewers and Sewer Structures: The location, elevation, and grades of sewers and sewer structures are shown on the Contract Drawings and shall be adhered to as closely as possible. If during construction of the project, it becomes necessary to make changes in the location or grades of the sewers, the Engineer will issue appropriate directions after being contacted by the Contractor.

B. Site Information: Perform site survey, research public utility records, and verify existing utility locations. Verify that storm sewerage system may be installed in compliance with original design and referenced standards.

1.6 SUBMITTALS

A. Shop drawings for precast concrete storm drainage structures, including cast iron frames, grates, covers, precast dry well and infiltrator system components. Submittal shall include installation, inspection and maintenance instructions for the infiltration system.

B. Product Data: Manufacturer’s catalog cuts, specifications, and installation instructions and manufacturer's certificates.

C. As-built record drawings at project closeout of installed storm sewerage piping and products. An as-built survey prepared by licensed NYS Surveyor depicting the installed storm sewer piping and structures including rim and invert elevations of structures pipe size, pipe type, and invert of all piping. Both hard copy and electronic copy shall be provided to the Owner and Engineer.

1.7 QUALITY ASSURANCE

A. Manufacturer data: All products must be produced by a facility that demonstrations five (5) years of experience in the production of similar products.

B. All material utilized in construction of structures shall comply with all applicable ASTM and NYSDOT standards.

C. Environmental Compliance: Comply with applicable portions of local health department and environmental agency regulations pertaining to storm sewerage systems.

D. Utility Compliance: Comply with local utility regulations and standards pertaining to storm sewerage.

E. All storm sewer system components shall be installed in accordance with applicable plumbing code requirements and in accordance with all license requirements.

F. All storm sewer construction shall be subject to inspection by the Engineer prior to backfilling.

1.8 DELIVERY, STORAGE AND HANDLING

A. Contractor shall check all materials upon delivery to assure that the proper materials have been received.

B. Contractor shall check the structures for shipping damage prior to installation. Units that have been damaged must not be installed. Contractor shall contact manufacturer immediately upon discovery of any damage.

C. All material shall be delivered to the site and unloaded with handling that conforms to the manufacturer’s instructions for reasonable care.

D. Protect material from dirt and damage.

E. All material shall be protected against impact, shock and free fall, and only equipment of sufficient capacity and proper design shall be used in the handling of the pipe. Storage of the structure on the job shall be in accordance with the manufacturer's recommendations.

PART 2 PRODUCTS

2.1 MATERIALS

A. Precast Rectangular Reinforced Concrete Drainage Structures:
   1. Structure shall be manufactured by the Fort Miller Co. Inc. or approved equivalent.
   2. Structure shall be designed for HS20-44 vehicular loading plus 25% impact if indicated on the Contract Plans.
   3. Riser Sections: ASTM C 478.
   4. Joints Between Riser Sections - One of the following:
      a. Rubber Gaskets: ASTM C443.
      b. Butyl Joint Sealant: ConSeal CS-202 by Concrete Sealants, Inc., or approved equivalent.
   5. Concrete for Precast Units: Air content 6% by volume with an allowable tolerance of 1.5% +/-. Minimum compressive strength of 4,500 PSI after 28 days.
   6. Concrete Reinforcement: Reinforcement for structure shall be designed by a Licensed New York State Professional Engineer prior to construction.
      a. Welded Wire Fabric: ASTM A 185.
      b. Steel Bars: ASTM A 615, Grade 60.
   7. Steps:
      a. Reinforced Plastic: 1/2-inch steel reinforced (ASTM A-615, Grade 60) polypropylene, or other plastic material complying with NYSDOT 725-02.01.
      b. Capable of withstanding a 300 lb. concentrated live load without permanent distortion and with rungs a minimum 10 inches wide designed to prevent feet from slipping off the ends.
      c. Manufactured by MA Industries or approved equivalents.

B. Precast Square Reinforced Concrete Drainage StructureS:
   1. Structure shall be manufactured by the Fort Miller Co. Inc. or approved equivalent.
   2. Structure shall be designed for HS20-44 vehicular loading plus 25% impact if indicated on the Contract Plans.
   3. Structure shall have integral base.
   4. Riser Sections: ASTM C 890, height and width as indicated on the Contract Documents.

5. Concrete for Pre-Cast Units: Air content 6% by volume with an allowable tolerance of +/-1.5%. Minimum compressive strength of 4,500 psi after 28 days.
6. Pre-Cast Concrete Structure Load Rating: AASHTO HS-20 with 30% impact and 130 lb/cf equivalent soil pressure.
    a. Casting Load Rating: AASHTO H20 wheel loading requirements. Manufacture, workmanship, and certified proof-load tests shall conform to AASHTO M306-89 Standard Specification for Drainage Structure Castings.
    b. Coatings: Minimum one shop coat of asphaltum to be applied to all frame and grate surfaces.
    c. Acceptable Casting: As indicated on Contract Drawings.

C. Frames, Grates, and Covers for Precast Reinforced Concrete Drainage Structures:
1. Style: Heavy Duty Frame and Grate Assembly
2. Size: As required for structure size shown on Contract Plans.
3. Frame and Grate: Provide castings of uniform quality, free from blow holes, porosity, hard spots, shrinkage defects, cracks or other injurious defects. Manufacture all castings true to pattern and free from surface imperfections. Provide heavy duty frames and grates with machined horizontal bearing surfaces.
4. Design of each shall be the same throughout the project unless otherwise specified or indicated on the Contract Drawings.
5. Units shall meet AASHTO HS20-44 vehicular loading plus 25% impact. Manufacturer, workmanship, and certified proof-load tests shall conform to AASHTO M306-89-Standard Specification for Drainage Structure Castings.
6. A.D.A. and Bicycle compliant.
7. aterial:
    a. Cast iron: ASTM A48, Class 30B or 35B.
    b. Delivered to site free of any coatings, unless otherwise specified.

D. Basin and Grate for Yard Inlet Basins:
1. In-Line Drain and Grate: As manufactured by Nyloplast-ADS or approved equal,
2. Acceptable Drainage Structure Basin and Grate: Pattern 1899CGD and 0899CGD by NYLOPLAST, or approved equal.

E. Frame, Grate and Cover for Storm Manholes:
1. Heavy Duty, Round Frame and Grate or Frame and Cover Assembly
2. Grates shall be A.D.A. and Bicycle compliant.
3. Material:
    a. Cast iron: ASTM A48, Class 30B or 35B.
    b. Delivered to site free of any coatings, unless otherwise specified.

F. Slot Drain System: Basis of design is ACO System 3000. Approved equivalents are acceptable.
1. Physical & Mechanical Characteristics:
    a. Overall width - 5.75 inches

b. Internal width - 4.09 inches
c. Unit depth - 5.67 inches
d. Unit length - 39.37 inches
e. Compressive strength - 14,000 psi
f. Flexural strength - 4,000 psi
g. Water absorption rate - <0.1% by weight.
h. Inlet slot - 0.5 inches - ADA compliant

2. Channel Profile - Each unit will feature a full radius in the trench bottom and male to female interconnecting ends. Units shall have horizontal cast-in anchoring features on outside walls to ensure maximum mechanical bond to surrounding bedding material. Each unit shall have a 0.5-inch longitudinal inlet slot on the top surface.
3. Radius Channels - Shall be manufactured to enable a radius of 39.92 yards, per IAAF guidelines.
4. In-line Catch Basins - Shall be manufactured from polymer concrete, be 21.75" in length.

G. Pipe-to-Drainage Structure Connection:
1. Non-shrink cement mortar, ASTM C270, Type M.
2. Concrete Coating: Waterborne, non-flammable, VOC Compliance, 3 mil dry film thickness, catonic asphalt emulsion (55% - 60% petroleum asphalt), PGS 96 by Pipe Gasket & Supply Co., 2701 South Coliseum Boulevard, Suite 1010, Fort Wayne, Indiana, 46003, (219) 426-4575, or approved equivalent.

H. Materials for use in mortar shall conform to the following requirements:
1. Cement: Cement shall conform to the Standard Specifications for Portland Cement, ASTM Serial Designation C150 with latest amendments.
2. Sand: Sand shall be sharp, clean, free from deleterious substances and shall be uniformly graded and shall conform to the "Standard Specification for Aggregate for Masonry Mortar", ASTM C144 with the latest amendments.
3. Water: Water used in making mortar or concrete shall be clean and free from oil, alkali, sugar or other deleterious substances. When potable water is in reach, no other water shall be used.

I. Stormwater Water Quality Unit
1. General: Stormwater water quality unit (SWTU) standard of quality to be "CDS Unit" Model Number 3030 as manufactured by Contech Construction Products Inc. Approved equivalents are acceptable.
2. SWTU components to be installed within a precast concrete structure. Installation of unit shall be in accordance with the manufacture's installation requirements.

2.2 INSPECTION OF MATERIALS

A. The manufacturers of materials shall furnish the Engineer a Certificate of Inspection, certified by factory inspector, or reports of tests made by an independent testing laboratory, in three copies, showing that materials furnished conform to applicable specifications set out herein. Each inspection certificate or laboratory report shall identify the materials by number of pieces shipped and date of invoice.

B. A careful field inspection shall be made of all material before installation, and any material found to be damaged in shipment or not meeting the requirements of the Specifications will be rejected and replaced.

PART 3 EXECUTION

3.1 STRUCTURE INSTALLATION

A. Construct structures with precast reinforced riser sections to the dimensions shown on the Contract Drawings. Seal joints between precast riser sections with material specified. Install steps 12 inches o.c. from top to bottom and in a manner capable of withstanding a lateral pull of 1,000 lbs.

B. Position tops of structures flush with finished grade.

C. All lifting holes shall be sealed by driving a tapered rubber plug into to hole and filling the remaining void with a non-shrink grout.

D. Cast iron frames, grates and covers shall be set to the proper elevation in a full bed of mortar. The frame shall be completely mortared onto the manhole as shown on the Contract Drawings.

E. Temporary Shoring: Provide and maintain shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of existing structures and construction to remain. Strengthen or add new supports when required during progress of selective demolition.

3.2 SLOT DRAIN INSTALLATION

A. Install in accordance with manufacturer’s recommendations.

B. Excavate an area wide enough and deep enough to accommodate the channel and sufficient depth for concrete encasement to provide support beneath channel.

C. Top of channel must be evenly aligned to the surface of the surrounding slab.

D. Install channel sections from the outlet or catch basins. Insert channels from above to allow ends to interconnect.

E. Channel sections shall be placed on brick, rebar basket, low slump concrete slurry, or with installation devices, to obtain correct finished elevation.

F. Cutting will be made, if required, by masonry or concrete saw.

G. Use tape or plastic to protect top surface of channel from concrete splash during concrete pour. Place concrete in a manner that will not dislodge the channels.

H. Finishing and Clean-up - Following final set of concrete, remove protection covering the top of channel and thoroughly flush system to remove debris.

3.3 BRICK TO BRING STORM DRAINAGE STRUCTURE TO GRADE

A. Brick shall be used in conjunction with precast concrete spacers to bring frames to grade for heights under twelve (12) inches in the following manner:
   1. Bricks shall be thoroughly wet when used and each brick shall be laid in a full bed of mortar including side and end joints.
      a. Normal 3/8-inch joints shall be used except when the brick is laid radially, in which case the narrowest part of the joint will not exceed ¼ inch.
   2. Brick shall be laid neatly with sufficient width to adequately support the cast iron frame.
   3. The entire stack shall be completely plastered on the exterior side when initially constructed.
   4. The brick work shall be kept moist for a period of five (5) days aftercompletion and adequately protected to prevent freezing during cold weather.
   5. The interior of the brick shall be neatly plastered once final grading and paving is completed so that the frame and cover will not the disturbed by additional work.

3.4 FIELD QUALITY CONTROL

A. Cleaning: Clear interior of structures of dirt and other superfluous material as work progresses.

B. Flush piping between manholes, if required by local authority, to remove collected debris.

C. Interior Inspection: Inspect piping to determine whether line displacement or other damage has occurred.

D. Make inspections of pipe between manholes/fittings, after pipe has been installed and approximately 2 feet of backfill is in place, and again at completion of project.

E. If inspection indicates poor alignment, debris, displaced pipe, infiltration, or other defects, correct such defects and re-inspect.

F. Water Tightness of Storm Sewer Structures: It is the intent of the Contract Drawings and these Specifications that the completed storm sewer structure shall be as watertight and free from infiltration as practical. All visible leaks or points of infiltration shall be repaired.

3.5 INSPECTION AND MAINTENANCE

A. Slot drain in-line catch basins shall have resilient track surface topping that is scored and identifiable to allow for removal of catch basin cover for regular maintenance and removal.

END OF SECTION 334900