SECTION 230500 BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 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 Jurisdictionprior 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:

1. 2020 Building Code of New York State.
2. 2020 Fire Code of New York State.
3. 2020 Plumbing Code of New York State.
4. 2020 Mechanical Code of New York State.
5. 2020 Fuel Gas Code of New York State.

6. 2020 Energy Conservation Code of New York State
7. Accessible and Usable Buildings and Facilities, ICC A117.1 (2009).
8. New York State Department of Labor Rules and Regulations.
9. New York State Department of Health.
10. 2017 National Electrical Code (NEC)
11. Occupational Safety and Health Administration (OSHA).
12. Local Codes and Ordinances.
13. Life Safety Code, NFPA 101.

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 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.

B. 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.

C. 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 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 meBuff-RFI-Sub-Clerk@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, 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 other than Basis of Design. 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.

B. Refer to Division 01 for additional requirements.

1.12 UTILITY COMPANY SERVICES

A. Division 26 shall make arrangements with New York State Electric and Gas for electric service to the Owner's distribution equipment. Provide underground or overhead electric service as called for and transformers, meter sockets or meter compartments as required by the Utility Company. Coordinate all activities between the Owner and Utility Company. The installation of the electric service shall comply with the published Utility Company standards.

B. Division 22 shall make arrangements with New York State Electric and Gas for gas service to the Owner's distribution system. Provide service to the building as required by the Utility Company. Coordinate all activities between the Owner and Utility Company. The installation of the gas service shall comply with the published Utility Company standards.

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 in. 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 in. 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 General Construction Trade 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 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.

1.16 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. 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.

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

1.17 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.

1.18 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 in. 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.

1.19 PENETRATION FIRESTOPPING

A. Fire-Stopping for Openings Through Fire and Smoke Rated Wall and Floor Assemblies:

1. Provide materials and products listed or classified by an approved independent testing laboratory for "Penetration Fire-Stop Systems". The system shall meet the requirements of "Fire Tests of Penetrations Fire-Stops" designated ASTM E814.
2. 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.
3. 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.
4. 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.
5. Plastic pipe/conduit materials shall be installed utilizing intumescent collars.
6. Provide a submittal including products intended for use, manufacturer's installation instructions, and the UL details for all applicable types of wall and floor penetrations.
7. Fire-stopping products shall not be used for sealing of penetrations of non-rated walls or floors.

B. Acceptable Manufacturers:

1. Dow Corning Fire-Stop System Foams and Sealants.
2. Nelson Electric Fire-Stop System Putty, CLK and WRP.
3. S-100 FS500/600, Thomas & Betts.
4. Carborundum Fyre Putty.
5. 3-M Fire Products.
6. Hilti Corporation.

1.20 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.

1.21 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.

1.22 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 in. 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.

1.23 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 in. 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.

1.24 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 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.

D. Refer to manufacturer drawings and specifications for requirements of special equipment. Verify connection requirements before bidding.

1.25 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, , and/or diesel 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.

G. Refer to Manufacturer drawings and specifications for requirements of special equipment. Verify connection requirements before bidding.

1.26 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.

C. Refer to Manufacturer's drawings/specifications for requirements of special equipment. Verify connection requirements before bidding.

1.27 STORAGE AND PROTECTION OF MATERIALS AND EQUIPMENT

A. Store Materials on dry base, at least 6 in. aboveground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.

B. Refer to Division 01 for additional information.

C. Division 23 shall provide airtight plastic covers over all supply and return air openings prior to the start of construction by any trade. The plastic shall be maintained airtight throughout the project construction and removed only with the approval of the Owner's Representative.

1.28 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.

1.29 LUBRICATION CHART

A. Provide lubrication chart, 8-1/2 in. x 11 in. 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.

1.30 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.

1.31 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 and Commissioning Agent's comments.

F. Refer to Division 01 for additional requirements.

1.32 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".

1.33 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.

1.34 COMMISSIONING

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

1.35 TEMPORARY HEATING AND COOLING

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

1.36 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.

1.37 TEMPORARY FACILITIES

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

1.38 TEMPORARY LIGHT AND POWER

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

1.39 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.

1.40 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.

1.41 TRANSFER OF ELECTRONIC FILES

A. M/E Engineering, P.C. 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 a potential $50.00 charge per drawing file and 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.

1.42 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.

1.43 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.

1.44 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

SECTION 230504 ELECTRIC WIRING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 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".

1.3 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.

1.4 QUALIFICATIONS

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

1.5 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. Refer to Section 260501 for type of conduit to be used in specific applications. Provide 18 in. length flexible conduit at motors and devices subject to vibration. Conduit supported on 5 ft. centers. Do not attach directly to hot surfaces, piping, or ductwork. Control wiring shall be in separate conduit from all other wiring. 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.

B. All temperature control wiring shall be plenum rated type, meeting the requirements of NEC Article 300.

C. Provide pushbutton stations, pilot lights, selector switches, auxiliary starter contacts, and other devices required to provide specified functions.

D. 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:

1. Be adequately supported using bridle rings spaced a maximum of 3 ft. on centers or other approved method when installed horizontally above accessible ceilings or run exposed in unfinished areas.
2. Be installed in conduit when run in wall cavity or surface metal raceway where no access is available to wall cavity, in finished areas.
3. Be installed in conduit when installed vertically in Mechanical/Utility Rooms from panels and devices up to above ceiling, or 10 ft. above finished floor if no ceiling.
4. Be installed in conduit in all cases not specifically covered by the above cases, or where subject to physical damage.

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

SECTION 230553 MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

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

1.3 QUALIFICATION

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

1.4 SUBMITTALS

A. Submit manufacturer's technical product data and installation instructions for each identification material and device. Submit valve schedule for each piping system typewritten on an 8-1/2 in. x 11 in. (minimum) indicating valve number, location, and valve function. Submit schedule of pipe, equipment and name identification for review before stenciling or labeling.

1.5 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 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: **Brass, 0.032 in., Stainless steel, 0.025 in., Aluminum, 0.032 in. or anodized aluminum, 0.032 in.** 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 in. by 3/4 in.
3. Minimum Letter Size: 1/4 in. for name of units if viewing distance is less than 24 in., 1/2 in. for viewing distances up to 72 in. 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:

1. Material and Thickness: Multilayer, multicolor, phenolic (micarta) labels for mechanical engraving, 1/8 in. 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 in. by 3/4 in.
6. Minimum Letter Size: 1/4 in. for name of units if viewing distance is less than 24 in., 1/2 in. for viewing distances up to 72 in., 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 in. x 11 in. 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. Air Cooled Condensing Unit

PART 3 - EXECUTION

3.1 GENERAL

A. Provide equipment tags for all equipment listed above.

END OF SECTION 230553

SECTION 230593 TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 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. Supply air systems, all pressure ranges; including constant volume and variable volume systems.
2. Return air systems.

D. This Section does not include:

1. Specifications for materials for patching mechanical systems;
2. 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.
3. Requirements and procedures for 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".

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 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 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 containing the system's major or entire fluid flow.

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

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

K. Branch: Duct 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).
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 or NEBB.

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

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. Prior to balancing, adjust balancing devices for full flow; replace temporary filters.
3. Initial adjustment and balancing to quantities as called for or as directed by the engineer, to satisfy job conditions.
4. All outdoor conditions (Db, Wb, and a description of the weather conditions) at the time of testing shall be documented in the report.
5. Installing contractor shall replace dampers in new systems that cannot be manipulated to satisfy balancing requirements.
6. 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.
7. 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).

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. Coordinate meetings and assistance from suppliers and contractors as required by Testing and Balancing agency.

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

D. Provide access to all dampers and other appurtenances as required by Testing and Balancing agency.

E. Installing contractor shall replace or repair insulation as required by Testing and Balancing agency.

F. Have the HVAC systems at complete operational readiness for Testing and Balancing to begin. As a minimum verify the following:

1. Airside:

a. All ductwork is complete with all terminals installed.
b. All volume dampers are open and functional.
c. Clean filters are installed.
d. All fans are operating, free of vibration, and rotating in correct direction.
e. System readiness checklists are completed and returned to Testing and Balancing agency.

G. Promptly correct deficiencies identified during Testing and Balancing.

H. 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*, 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.

D. Examine construction and notify Owner's Representative and Engineer of outstanding issues related to balancing, as part of "Examination Report" submittal.

1. Examine ceiling plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas.
2. 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.
3. 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.

4. Examine systems for installed manual volume dampers 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" and this Section.

B. Cut insulation, ducts 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 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. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

D. 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.

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

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

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and function.

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

K. 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.
3. 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.
4. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed.

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 TOLERANCES

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

1. Supply, Return, and Exhaust Fans: Zero to plus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Minimum Outside Air: Zero to plus 10 percent.
4. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.6 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 air side 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 - (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

7. Filter Banks:

a. Nameplate data
b. Static pressure drop

D. 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

SECTION 230710 INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 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.

1.3 SUBMITTAL

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

1.4 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. 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 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.
3. Asbestos or asbestos bearing materials are prohibited.
4. Comply with 2015 International Energy Conservation Code as amended by Part 1 of the 2016 Supplement to the New York State Energy Conservation Code.
5. 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.
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/Manson, Johns Manville, Owen-Corning, Certainteed. (Board, Blanket and Liner)

B. Flexible Elastomeric: Armacell, K-Flex.

C. Adhesives, Coatings, Mastics, Sealants: Childers, Foster.

2.3 FLEXIBLE TYPE INSULATION

A. Flexible Elastomeric Thermal Insulation: Closed-cell, foam material. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials. Maximum thermal conductivity (k) shall be 0.25 BTU-in/ft^2 hr. °F at 75°F mean temperature. Adhesive: As recommended by insulation material manufacturer.

B. Insulation shall have a flame-spread index of less than 25 and a smoke-developed index of less than 50 as tested by ASTM E 84 and CAN/ULC S-102, "Method of Test for Surface Burning Characteristics of Building Materials".

2.4 DUCT INSULATION

A. Duct insulation shall have a thermal resistance (R) value identification mark by the manufacturer applied no less than every 10 ft., as per Energy Code requirements.

B. Flexible Fiber Glass Blanket:

1. Product meeting ASTM C 553 Types I, II and III, and ASTM C 1290; Greenguard compliant.
2. 'K' Value of 0.27 at 75°F mean temperature. Maximum Service Temperature (Faced): 250°F.
3. Vapor Retarder Jacket: FSK conforming to ASTM C 1136 Type II.
4. Installation: Maximum allowable compression is 25%. Securement: Secured in place using outward cinching staples in combination with appropriate pressure-sensitive aluminum foil tape. **Coat taped seams with glass fabric and vapor barrier coating.**
5. Density: 0.75 or 1.0 PCF. See Exhibit II for the thickness requirement at each density.

C. Rigid Fiber Glass Board:

1. Product meeting ASTM C 612 Type IA and IB.
2. 'K' Value of 0.23 at 75°F mean temperature. Maximum Service Temperature: 450º F.

3. Vapor Retarder Jacket: ASJ conforming to ASTM C 1136 Type I, or FSK or PSK conforming to ASTM C 1136 Type II.Securement: Secured in place using adhesive and mechanical fasteners spaced a minimum of 12 in. on center with a minimum of 2 rows per side of duct. Insulation shall be secured with speed washers and all joints, breaks and punctures sealed with appropriate pressure-sensitive foil tape. **Coat taped seams with glass fabric and vapor barrier coating.**

    a. Concealed Areas: Minimum 3 lb./ft.^{3}.
    b. Exposed Areas: 6 lb./ft.^{3} minimum density for duct less than 8 ft. - 0 in. above finished floor.

2.5 FIELD-APPLIED JACKETS

A. Piping:

1. PVC Pipe Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming. Adhesive: As recommended by insulation material manufacturer. PVC Jacket Color: White.

2.6 COATINGS, MASTICS, ADHESIVES AND SEALANTS

A. Vapor Barrier Coatings: Used in conjunction with reinforcing mesh to coat insulation on below ambient services temperatures. Permeance shall be no greater than 0.08 perms at 45 mils dry as tested by ASTM F1249. Foster 30-65 Vapor Fas; Childers CP-34, or approved equal.

B. Fiberglass Adhesive: Used bond low density fibrous insulation to metal surfaces. Shall meet ASTM C916 Type II. Foster 85-60; Childers CP-127, or approved equal.

C. Elastomeric Insulation Adhesive: Used to bond elastomeric insulation. Foster 85-75; Childers CP-82, or approved equal.

D. Elastomeric Insulation Coating: Water based coating used to protect outside of elastomeric insulation. Foster 30-65, Childers CP-34 or approved equal.

E. Insulation Joint Sealant: Used as a vapor sealant on below ambient piping with polyisocyanurate and cellular glass insulation. Foster 95-50; Childers CP-76, or approved equal.

F. Reinforcing Mesh: Used in conjunction with coatings/mastics to reinforce. Foster Mast A Fab; Childers Chil Glass #10, or approved equal.

2.7 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 and duct insulation shall be continuous through hangers, walls, ceiling and floor openings, and through sleeves, unless not allowed by Fire Stop System. Refer to Section 230500 "Basic Requirements" for Fire Stop Systems.

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. 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. 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, air separators, drain valves, etc. must be totally encapsulated with Elastomeric insulation.

F. Items such as boiler manholes, handholds, clean-outs, 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 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. All pipes shall be individually insulated.

I. 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.

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.

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

C. Hanger Shields: Refer to Section 232010 "Piping Systems and Accessories".

D. Metal 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 in. 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 in. 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. When using polyisocyanurate or cellular glass on below ambient piping/duct, seal all insulation joints with insulation joint sealant.

F. Fittings, Valves and Flanges:

1. 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 ells may be continuous.
3. Where exposed outdoors, provide with PVC jacketing.

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

I. Apply 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.

3.3 DUCTWORK INSULATION

A. Provide external thermal insulation for duct. Not required where ducts have internal acoustical insulation. Make special provisions at dampers, damper motors, thermometers, instruments, and access doors. Apply as follows:

1. Rigid Board Type: Impale board over mechanical fasteners, welded pins or adhered clips, 12 in. to 18 in. centers; minimum of two (2) rows per side. Secure insulation with washer clips. Self-adhesive clips are not acceptable. Staple all joints. Seal breaks and joints in vapor barrier with 4 in. wide matching tape and 4 in. glass-fab applied with specified vapor barrier coating. Apply tape over corner beading where exposed.
2. Flexible Blanket Type: Install Duct Wrap to obtain specified R-value using a maximum compression of 25%. Installed R-value shall be per ECC of NYS. Firmly butt all joints. The longitudinal seam of the vapor retarder must be overlapped a minimum of 2 in. Where vapor retarder performance is required, all penetrations and damage to the facing shall be repaired using pressure-sensitive foil tape, and coated with vapor barrier coating prior to system startup. Pressure-sensitive foil tapes shall be a minimum 3 in. wide and shall be applied with moving pressure using a squeegee or other appropriate sealing tool. Closure shall have a 25/50 Flame Spread/Smoke Developed Rating per UL 723. Duct wrap shall be additionally secured to the bottom of rectangular ductwork over 18 in. wide using mechanical fasteners on 18 in. centers. Self-adhesive clips are not acceptable. Care should be exercised to avoid over-compression of the insulation during installation.

EXHIBIT "I" - PIPE INSULATION MATERIALS

SERVICE	**INSULATION MATERIAL**	**THICKNESS**	**REMARKS**
Refrigeration Piping (Suction and liquid lines)	Flexible	1 in. and Larger: 1 in. 3/4 in. and Smaller: 1/2 in.	
Outdoor Refrigeration Piping (Suction and liquid lines)	Flexible	1 in. and Larger: 1 in. 3/4 in. and Smaller: 1/2 in.	Insulation shall be provided with a UV resistant coating. **Cover with 30mil PVC jacketing applied per manufacturer's recommendations**

SERVICE	INSULATION MATERIAL	THICKNESS	REMARKS
Concealed AC unit condensate drains	Flexible	All Sizes: 1/2 in.	

EXHIBIT "II" - DUCT INSULATION MATERIALS

SERVICE	INSULATION MATERIAL	THICKNESS	REMARKS
HVAC Supply	Exposed at 8 feet or less above finished floor: Rigid fiberglass	……..……..1-1/2 in.	Min. installed R value of 6
	Concealed: Flexible fiberglass	….……2 in. at 1.0 PCF or ……..….2.2 in. at 0.75 PCF	Min. installed R value of 6
Supply or Return ducts in cold attic spaces or other un-conditioned spaces	Flexible fiberglass	……..……..…5 in	Min. installed R value of 12
Exhaust ducts in cold attic spaces or other un-heated spaces	Flexible fiberglass	……..……. 3 in	Min. installed R value of 8
Return-air ducts within heated building envelope	…….	…NOT INSULATED…	……
Outside air ducts and plenums, connections and mixing boxes	Rigid fiberglass	……..……. 2 in.	Min. installed R value of 8 Provide neat fit at intake plenum
Exhaust, relief or vent ducts and plenums	Exposed: Rigid fiberglass Concealed: Flexible fiberglass	……...……1-1/2 in. ……...……2 in.	Min. installed R value of 6 Insulate 15 ft. from exterior opening and plenums

END OF SECTION 230710

SECTION 232010 PIPING SYSTEMS AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

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

1.3 SUBMITTALS

A. Anchors and guides. Provide detailed fabrication drawings for all field-fabricated anchors and intermediate structural elements.

B. Schedule of pipe materials, fittings and connections.

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 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, ANSI B16.22 or cast bronze; ANSI B16.8 solder end connections.

C. Unions and Flanges: 2 in. and smaller use unions, solder type, cast bronze, ground joint, 150 lb. swp: 2-1/2 in. 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.

2.3 STAINLESS STEEL PIPE AND FITTINGS - PRESSURE-SEALED JOINTS

A. Pipe: Type 304/304L, Schedule 10S, stainless steel conforming to ASTM A312 with plain ends.

B. Couplings and fittings shall be formed of precision cold drawn stainless steel pipe with synthetic rubber O-ring seals.

C. O-ring seals shall be molded of synthetic rubber, Grade HNBR suitable for potable water up to 210°F or Grade EPDM suitable for water up to 250°F.

D. Fitting ends shall be pressed onto pipe using only a tool specifically designed for this purpose. Pipe ends must be fully inserted into the coupling and fitting housing up to the pipe stop. 500 psig maximum CWP rating.

E. Fittings: Elbows, tees, laterals, reducers, adapters as required. Same construction as couplings.

F. Design Basis: Victaulic Vic Press 316, Shurjoint, Viega Pro Press Stainless.

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 in. - 4 in. Cast bronze, rolled grooved mechanical connections, ASTM B-584, ANSI B16.18 for sizes 5 in. - 8 in., 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 A-536, 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 COPPER TUBE AND FITTINGS - BRAZED JOINT

A. Pipe: ASTM B88, Type K or L, hard temper.

B. Tees, Elbows and Reducers: Wrought copper, ANSI B16.22 or cast bronze, ANSI B16.18.

C. Unions and Flanges: Unions for 2 in. and smaller. Brazed type cast bronze ground joint, 150 lb. swp; flanged for 2-1/2 in. and larger, brazed type, cast bronze, companion type, gasketed and bolted, ASME drilled 150 lb. swp.

D. Brazing Materials: Class BcuP-2 for brazing copper to brass, bronze or copper. Harris, Inc. Stay-Silv 0 or approved equal.

2.8 **SHOP FABRICATED MECHANICALLY FORMED TEE CONNECTION WITH BRAZED JOINTS**

A. **Mechanically formed tee fittings shall be shop fabricated using jigs specifically designed for this purpose and shop brazed with BCuP-5 brazing material. Field formed and brazed tees are NOT acceptable.**

B. **Extruded tees shall conform to the Mechanical Code of New York State and ASME B31.9 Building Services Piping.**

C. **Mechanically formed extruded outlets shall be perpendicular to the axis of the run tube (header). They shall be formed by drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the branch wall.**

D. **The inner branch tube end shall conform to the shape of the inner curve of the run tube. Insertion of the branch tube shall be controlled to assure alignment with specified depth into the collar without extending into the flow stream so as to provide internal reinforcement to the collar.**

E. **Branches can be formed up to the run tube size as shown in ASTM F 2014. Forming procedures shall be in accordance with the tool manufacturer's recommendations.**

2.9 HDPE PIPING FOR CONDENSER WATER

A. Pipe: Shall be High Density Polyethylene conforming to properties established by ASTM D-3350-02 with a cell classification of PE 345464C. Piping system and fittings shall be SDR 11 rated for 160 psi at 73 deg F.

B. Fittings: Shall match the rating properties as the piping. Fittings shall be factory molded and be SDR 11 rated for 160 psi at 73 deg. Fabricated and segmented fittings with a derated pressure are not acceptable.

C. 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.

D. Design Make: ISCO Industries.

E. Acceptable Make: ISCO Industries, Performance Pipe, or approved equal.

2.10 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS

A. Interior CPVC:

1. Pipe: ASTM D1784 material manufactured to ASTM F441 standards. Seamless **Schedule 40 Schedule 80** Chlorinated Polyvinyl Chloride (CPVC) Type 4, Grade 1 (Cell Classification 23477-BK). Socket type weld couplings ASTM **F438 F439**, DR with integral bell end for solvent cementing. Solvent cement - ASTM F-493.
2. Fittings: Socket type cement weld fittings of same material and pressure class as adjoining pipe. ASTM F-438.
3. Transition fittings shall have brass male of female connections and integral CPVC socket connections.

2.11 DIELECTRIC PIPE FITTINGS

A. Description: Assembly or fitting having insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion.

B. Unions: Factory fabricated, for 250 psi minimum working pressure at 180°F, threaded or solder ends, insulating material suitable for system fluid, pressure and temperature.

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, Victaulic, or approved equal.

F. The use of brass valves, brass nipples (3 in. 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 in. through 8 in., 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.

2.12 REFRIGERATION PIPING

A. Type L hard temper deoxidized, dehydrated, and sealed copper tubing, refrigerant grade.

B. Refrigerant grade wrought copper fittings. Long radius elbows.

C. Factory made suction traps, Melco Type PT.

D. Piping and system shall meet the requirements of Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1994 and ASME/ANSI B31.5.

E. Make: Mueller, Howell Metal, Cerro, Cambridge-Lee, Universal Tube.

2.13 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 in. and smaller.
3. Adjustable steel clevis type for 4 in, and larger, and where insulation passes through hanger.
4. **Steam (over 50 psi) piping, adjustable yoke pipe roller equivalent to Grinnell Figure #181.**
5. Hangers sized to permit passage of insulation through the hanger for **all chilled water, and refrigerant and steam (over 50 psi)** piping.

6. 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 in. 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 in. 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 in. to 3-1/2 in.	9 in.	20
4 in.	9 in.	20
5 in. and 6 in.	9 in.	20
8 in. to 12 in.	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 in.	6 ft.	3 ft.	3/8 in.
1-1/4 in.	6 ft.	4 ft.	3/8 in.
1-1/2 to 2 in.	8 ft.	4 ft.	3/8 in.
2-1/2 to 4 in.	10 ft.	4 ft.	1/2 in.
5 in. and larger	10 ft.	4 ft.	3/4 in.

STEEL PIPE SIZE	STEEL PIPE HANGER SPACING	HANGER ROD SIZE
3/4 to 1 in.	8 ft.	3/8 in.
1-1/4 in.	10 ft.	3/8 in.
1-1/2 to 2-1/2 in.	12 ft.	3/8 in.
3 to 4 in.	12 ft.	1/2 in.
5 in. 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 in. to 3/4 in. 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 in. 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 in., 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 in. 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.

2.14 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.

3. **All field or shop fabricated anchor and equipment and piping supports shall include detail fabrication drawings submittals accompanied by comprehensive structural engineering design and analysis by a qualified, profession engineer licensed to practice in the State of New York, using the performance and design criteria specific to the project and system in question.**

D. Pipe Roll Stand: Cast iron roll stand. Make: Advanced Thermal Systems, Carpenter and Patterson, ITT Grinnell, Pipe Shields.

2.15 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 in. 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 in. 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 in. 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.

2.16 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.

2.17 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.

2.18 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 in. 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 ft. above the electrical equipment, or to a structural ceiling. Dedicated working space is a minimum of 30 in. wide or the width of equipment (whichever is larger) a minimum of 6 ft.-6 in. tall, with a depth of 3 ft. to 9 ft. depending on the voltage.

3.3 WATER **AND GLYCOL** 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 STEAM AND CONDENSATE PIPING

A. Install with bottom of pipes in line. Connections to mains or headers are to be made within 45° of top dead center of the pipe, unless otherwise called for. Drip ends of mains and at low points where condensation may collect. Make counter-flow piping one pipe size larger than vertical pipe. Provide 2 in. x 6 in. (minimum) deep-capped scale pocket, ends of steam mains, drip points, and return ends of steam coils.

B. Grade:

1. Steam Mains, Branches and Connections to Equipment: Down 1 in. in 20 ft.

2. Coil Connections Necessarily Grading Opposite to Steam Flow: Up 1/4 in. per ft.
3. Condensate Mains, Branches and Runouts, and Drip Lines: Down 1 in. in 10 ft.
4. Wet Returns: Down to low point, use tees instead of ells.
5. Pumped Condensate Piping: Just off level down to drain points.

3.5 REFRIGERATION PIPING

A. Fittings brazed with silver brazing alloy. Guarantee refrigerant charge for one year from date of final acceptance. Provide for flexibility at compressor connections. Piping and system shall meet the requirements of Mechanical Refrigeration Safety Code, ANSI B9.1. Clean piping, then pump-down and evacuate system to 0.1 in. VAC break vacuum with dry nitrogen and re-evacuate to 0.1 in. VAC and hold for four (4) hours; then charge system. Charge with refrigerant as recommended by manufacturer.

3.6 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 in. 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 in., "C" types are permitted for piping 2-1/2 in. and smaller. Provide riser clamps for each riser at each floor.

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

3.7 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.

3.8 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. "Walseal" fittings may be used; if sufficient alloy is showing, face braze such joints.

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 Pipe Fittings: Provide dielectric protection devices 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. Dielectric protection devices are not required in typical closed systems such as heating water, chilled water, heat pump loop, etc. except for the 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.

3.9 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 in. 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 in., maximum 1/4 in., 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. **Welding is prohibited in existing building, except in following areas: Boiler Rooms, Mechanical Rooms, Crawl Spaces.** When welding galvanized pipe, apply cold galvanizing on joint after welding.

3.10 WELDING

A. Piping shall comply with the provisions of the latest revision of the ANSI Code for Pressure Piping, B31.1 - Power Piping. Boiler external piping shall comply with the provisions of the latest revision of Section I of the ASME Boiler and Pressure Code. Before welding is performed, the Contractor shall submit to the Owner's Representative, a copy of his Standard Welding Procedure Specifications together with the Procedure Qualification Record as required by Section IX of the ASMEE Boiler and Pressure Vessel Code. Before welder shall perform welding, the Contractor shall submit to the Owner's Representative, a copy of the Manufacturer's Record of Welder or Welding Operator Qualification Tests as required by Section IX of the ASME Boiler and Pressure Vessel Code. The types and extent of non-destructive examinations required for pipe welds are as shown in Table 136.4 of ANSI Code for Pressure Piping, B31.1 - Power Piping. If requirements for non-destructive examinations are to be other than that stated above, the degree of examination and basis of rejection shall be a matter of prior written agreement between Contractor and the Owner. Contractor shall be responsible for the quality of welding shall repair or replace any work not in accordance with these specifications.

3.11 HANGER SHIELDS

A. Provide at hangers for **all chilled water, and refrigerant**, **and steam (over 50 psi)** piping. Pre-insulated type or field-insulated type at Contractor's option.

3.12 SLEEVES

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

B. Pre-Insulated Type: Required for **chilled water, and refrigerant and steam (over 50 psi)** piping.

C. Standard Type: Provide for piping, except as called for.

D. Extend 1/8 in. above finished areas. In above grade mechanical and other areas with floor drains; use steel pipe sleeves 2 in. 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.

3.13 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.

3.14 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.

3.15 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.

3.16 ESCUTCHEON PLATES

A. Provide polished chrome escutcheon plates for uninsulated exposed piping passing through floors, walls or ceilings in finished areas.

3.17 CLEANING **HOT WATER** AND **CHILLED WATER** AND **GLYCOL** SYSTEMS

A. Provide the services of an experienced Water Treatment Subcontractor.

B. After each closed system has been tested and thoroughly flushed, the entire piping system shall be cleaned by, or as per, the Water Treatment Subcontractor.

C. Operate pumps and arrange control system so that all control valves are open. Fill, vent and circulate system with this solution, while rising to design temperature.

D. Remove, clean and/or replace air vents, strainers, and check valves, which do not function properly. After cleaning strainers, circulate for additional time, then clean strainers again; repeat until strainers are found clean. Drain and refill system.

E. Provide a batch chemical feed tank, valving and accessories as shown in the Contract Documents. Add water treatment as necessary to prevent deterioration of piping systems and equipment due to oxygen, acid, scaling, etc. Submit typewritten letter to inform Owner's Representative upon completion of the work.

F. Pumps shall not be operated continuously until system is flushed, strainers cleaned and water treatment is complete.

G. Water Treatment:

1. After system cleaning, furnish report of water test to determine quality.
2. Provide complete water treatment facilities to Owner, including water analysis, feed equipment, metering equipment, pumps, and chemical, obtained from Calgon, Vulcan, Bird Archer, Heating Economy Service, Inc., Mogul, Garratt-Callahan Company, Metropolitan, or Allen-Murray.
3. Recommendations for water treatment reviewed by Owner's Representative before systems are placed into service.
4. Add water treatment as necessary to prevent deterioration of piping system and equipment due to oxygen, acid, scaling, etc.
5. Water treatments shall be deemed complete when circulation has been established throughout, and water runs clear and clean from deposits and discoloration. Submit typewritten letter to inform Owner's Representative upon completion of the Work.

3.18 CLEANING STEAM HEATING SYSTEM

A. Waste returns to sewer until condensate is clean, but not more than 48 hours. Make and remove temporary pipe connections as required. Pipe to nearest waste point. Clean system until strainers are found clean. Temper with domestic water to keep waste below 140°F.

Water Treatment:

WRITE SPECIAL, GENERALLY NOT REQUIRED IF WATER QUALITY IS GOOD, EXCEPT FOR PROCESS STEAM AND STEAM SYSTEMS ABOVE 50 psi.

3.19 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. Schedule of Test Requirements:

1. **Hot, Chilled, Glycol, Condenser, Domestic** Water: Hydrostatic, 100 psig at high point of system; two (2) hours duration.
2. Steam (50 psi and Lower), Drip and Condensate Piping: 125 psig hydrostatic pressure; two (2) hours duration.
3. Steam (over 50 psi), Drip, and Condensate Piping: Hydrostatic test, 1-1/2 times working pressure; two (2) hours duration.
4. Oil Piping:

    a. Isolate from tank and pumps and test with nitrogen to maximum pressure of 50 psi for 2 in. and smaller piping and 30 psi for 2-1/2 in. and larger for not less than two (2) hours. Provide a pressure relief valve in the system being tested set for 10% more than the test pressure.
    b. In addition, test suction piping under 20 in. of mercury vacuum for three hours. Test storage tank with nitrogen at 5 psi pressure for three (3) hours.

5. Refrigeration:

    a. After installation, charge system with dry nitrogen to manufacturer's recommended pressure.
    b. System shall hold this charge with no pressure drop for 24 hours.

6. Gas Piping: Test with air to a maximum test pressure of 50 psi for 2 in. and smaller piping, 30 psi for 2-1/2 in. and larger piping for two (2) hour duration and as required by local utility purveyor. Provide a pressure relief valve in the system set for 10 psi more than the test pressure.
7. Bottled Gas Piping: As required by supplier; but not for less than six (6) hours at 15 psi.
8. Compressed Air Piping (Other than Temperature Controls): Test with air to a maximum test pressure of 1.5x working pressure or 100 psi, whichever is fewer, two (2) hour duration. Provide a pressure relief valve in the system being tested set for 10% more than the test pressure.
9. Test: No change in pressure under stable temperature conditions.
10. Equipment: Test at working pressures.

3.20 CONNECTIONS TO SPECIAL EQUIPMENT

A. Sterilizers:

1. Sterilizing equipment will be furnished and set in place by **this Contractor**.
2. This Contractor closely coordinates piping connections to equipment with other trades.
3. Control valves, individual pressure reducing valves and thermostatic traps for sterilizing equipment provided by **this Contractor equipment manufacturer**.
4. This Contractor shall provide necessary piping, valves, strainers and fittings.

3.21 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 in. 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 in. (No. 16 gage) shall cover the area of the pipe where the member is notched or bored, and shall extend note less than 2 in. above sole plates and below top plates.

3.22 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)

SERVICE	**PIPE MATERIALS**	**FITTINGS**	**CONNECTIONS**
Refrigerant	Type L refrigerant grade hard temper, deoxidized copper	Wrought copper, solder end	Sil-Flo "5" silver brazing
Drain	Type M copper or PVC	Wrought copper or Socket type PVC	Solder or Solvent welding

END OF SECTION 232010

SECTION 233100 SHEET METAL AND DUCTWORK ACCESSORIES CONSTRUCTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

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

1.3 QUALITY ASSURANCE

A. Ductwork shall be fabricated and installed in compliance with latest edition of the following standards.

1. SMACNA Duct Construction Standards - Metal and Flexible Ductwork.
2. SMACNA Duct Liner Application Standard.
3. SMACNA HVAC Air Duct Leakage Test Manual.
4. 2015 International Energy Conservation Code.
5. Plans and Specifications which exceed the requirements in any of the referenced standards.
6. 2015 International Mechanical Code.

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.

1.4 SUBMITTALS

A. Ductwork Shop Drawings.

B. Duct Access Doors.

C. Flexible Duct.

D. 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.

1.5 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.

1.6 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 in. 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 in. w.g. unless otherwise stated or required as per below.
3. Pressure classes above 3 in. 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 in. up to 4 in. w.g.	4 in. w.g.
Over 4 in. up to 6 in. w.g.	6 in. w.g.
Over 6 in. up to 10 in. w.g.	10 in. w.g.

1.7 DUCTWORK SHOP DRAWINGS

A. Prepare minimum 1/4 in. scale drawings:

1. 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.
2. Constructed from actual field inspections and measurements so as to assure a complete job.
3. Incorporate dimensions of actual equipment proposed for use on the project.
4. Showing adequate sections, elevations, and plan views and indicating the bottom of ductwork elevations from the finished floor.

5. Indicating all volume dampers, fire dampers, smoke dampers, damper access doors and other accessories required for a completed project.

B. Call to the attention of the Engineers immediately, any major deviations from the Contract Drawings, which must be made. All deviations shall be documented in writing.

C. Indicate roof, wall and floor opening dimensions and locations shown on shop drawings.

D. Submit prints to each Contractor of the other trades for review for interference's and coordination with their work.

PART 2 - PRODUCTS

2.1 DUCTWORK MATERIALS

A. Unless otherwise called for, provide materials in accordance with Exhibit I at the end of this section.

2.2 SQUARE AND RECTANGULAR DUCTWORK

A. Galvanized Sheetmetal: Comply with ASTM A653 and A924, with G90/Z275 coating. Stainless-steel Sheets: Comply with ASTM A 480/A 480M, 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". 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. Gauges per SMACNA HVAC Duct Construction Standards, Metal and Flexible.

B. 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.

C. Corner closures shall be required as described and illustrated by SMACNA Duct Construction Standards.

D. 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.

E. Bracing and hanging of ductwork shall be per SMACNA Standards for size and system class of ductwork being used.

F. 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. Galvanized Sheetmetal: Comply with ASTM A653 and A924, with G90/Z275 coating. Stainless-steel Sheets: Comply with ASTM A 480/A 480M, 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". 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. Gauges per SMACNA Duct Construction Standards. Spiral lock-seam or longitudinal fusion-welded.
2. 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.
3. **Longitudinal seam duct with snap lock longitudinal sealed seams may be used on ductwork where pressure class is 2 in. 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.**
4. Round Ductwork Fittings:

    a. All fittings fabricated per SMACNA Standards for round and flat-oval ductwork, 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 in. 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.

5. Elbows:

    a. Diameters 3 in. through 8 in.: Two-section stamped and continuously welded elbows, material to match straight pieces of ductwork.
    b. Over 8 in.: Gored construction with standing seam construction and internally sealed or continuously welded. Less than 35° - two gores, 36° to 71° - 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 in. diameter in Velocity-Pressure Classes 2 in. w.g. and below. Seal adjustable joints airtight after installation.**

6. Joints:

a. For duct construction pressure 3 in. w.g. or greater:

1) Round Joints:

a) Unexposed Duct 3 in. - 30 in. 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 in. - 72 in. 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 in. 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.

d) Dust collection systems and exposed duct 3 in. - 14 in. use a one piece, polyethylene lined gasket connector with integrated bolt for the closure system.

(1) Acceptable Manufacturer: Ductmate Industries "Quicksleeve" or approved equal.

b. Pipe-to-pipe joints in diameters up to 60 in. shall be by the use of sleeve couplings, reinforced by rolled beads.

c. Pipe-to-fitting joints in diameters up to 60 in. 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 in. up to 36 in. diameter.

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. 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.

C. Duct sealant for outdoor applications shall be fibrated, water based, Hardcast Versa-Grip VG-102, Ductmate Fiberseal, Foster 32-17 or Childers CP148.

D. Sealants and tapes shall be listed and labeled in accordance with UL 181A or UL181B and marked according to type.

E. **For renovation projects with less cure time available than the recommended 72 hours (for above products), Hardcast "Aluma Grip" pressure sensitive duct joint sealing tape may be used.**

2.5 TURNING VANES

A. Provide in mitered elbows as shown on contract drawings. Vanes 36 in. 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 in. sq., cold rolled steel operator rod. Provide Ventlock 639 elevated dial regulator for 2 in. insulated ductwork.

B. Multiple Blade Type Volume Dampers: Provide multiple blade volume dampers in ductwork above 12 in. in height.

1. Heavy duty, manual balancing dampers suitable for application in HVAC systems with velocities to 1,500 ft. per minute, open position and max. pressure of 3 in. w.g. close position. Ruskin MD 35 or equivalent.
2. Fabrication:

    a. Frame: 5 in. 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 in.

4. Bearings: Molded synthetic sleeve, turning in extruded hole in frame.
5. Linkage: Concealed in frame.
6. Axles: Minimum 1/2 in. diameter, plated steel, hex-shaped, mechanically attached to blade.
7. Control Shaft: 3/8 in. square plated steel.
8. Finish: Mill galvanized.

    a. Actuator: Hand quadrant for 3/8 in. square extended shaft.
    b. Hand Quadrant Standoff Bracket: 2 in. standoff for insulated ductwork.
    c. Oillite bearings.
    d. Factory Sleeve: Minimum 20 gauge thickness, minimum 12 in. length.

2.7 FLEXIBLE AIR DUCTS AND CONNECTORS

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 or R 8.0) fiberglass **(R 8.0) cotton** 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 C-518, 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 in. w.g. positive pressure for 4 in. - 20 in. dia., 5 in. wg. negative pressure through 16 in. dia., 1 in. negative pressure for 18 in. and 20 in. dia. Maximum velocity of 5500 fpm.
5. Operating temperature range - 20°F to 250°F, intermittent @1/2 in. 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 E 477 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) **or 8B (R-8.0)**.

G. Acceptable Manufacturers:

1. Dundas-Jafine Type SPC R6.0/ Type SPC R8.0.
2. Hart & Cooley Type F216 (R-6.0)/ Type F218 (R-8.0)

3. Flexible Technologies, Inc. Thermaflex Type M-KE (R-6.0)/ Type M-KE (R-8.0)
4. Atco Rubber Products, Inc. Type 036 (R-6.0)/Type 031 (R-8.0).

2.8 FLEXIBLE DUCT ELBOW SUPPORT

A. Provide flexible duct elbow support for flexible duct connected directly to a diffuser collar.

B. Elbow support shall be a radius forming brace designed to form flexible duct into a 90° elbow not less than one duct diameter in centerline radius.

C. Elbow support shall be manufactured from 100% recycled copolymer polypropylene with a universal fit of 4 in. thru 16 in. and be UL listed.

D. Basis-of-Design: Titus Flexright.

2.9 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 in.** wide attached to two (2) strips of 2-3/4-in. wide, 0.028-in. thick, galvanized sheet steel or 0.032 in. 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.

2.10 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 in. w.g. or less shall utilize a hinged, cam, or hinged and cam square framed access door.
4. Systems 4 in. 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 in. or less in depth is 12 in. x 8 in.
13. MINIMUM access door size for ducts 12 in. to 18 in. in depth is 18 in. x 14 in.
14. MINIMUM access door size for ducts more than 18 in. in depth is 24 in. x 18 in.

B. Door Types:

1. Low Pressure Systems (2 in. w.g. pressure class): National Controlled Air ADH-1, Ruskin ADH22, Vent Products 9701, Air Balance FSA-100, Safe Air SAH, Nailor.

2.11 CABLE SUSPENSION SYSTEM

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.

2.12 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. 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. Provide 14 gauge sleeves for ducts passing through Mechanical Room floors. Set sleeves 4 in. above finished floor in Mechanical Rooms, seal watertight to floor.

J. Where a return or exhaust duct is shown to be left open ended, provide hardware mesh screen at opening.

K. Do not utilize flexible ductwork or connection in any way to connect variable or constant volume boxes to ductwork.

L. 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.

M. For duct penetrations of rated walls, see Specification Section 230500 - Basic Mechanical and Electrical Requirements.

N. 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 FLEXIBLE CONNECTIONS

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 in. centers.

D. Connections shall be made with a minimum of 2 in. space between duct and equipment collars, installed in line, and with 1 in. 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.

3.3 FLEXIBLE AIR DUCTS AND CONNECTORS

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. Flexible air ducts and connectors shall be provided in fully extended condition, free from kinks.

C. Flexible air ducts and connectors shall not be used in systems with entering air temperatures in excess of 250°F.

D. 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 in., fully extended.

E. Flexible air ducts and connectors shall use minimum 1/2 in. 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 181 B-C.

F. Collars to which flexible duct is attached shall be beaded and a minimum of 2 in. 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 in. in length. The draw band shall be positioned behind the bead on the metal collar.

G. 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.

H. 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.

I. 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 in. per foot of support spacing. Provide a minimum of one hanger on each run of flexible duct.

J. 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.

K. 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 in. wide. Factory installed suspension systems integral to the flexible duct are an acceptable alternative hanging method when the manufacturer's recommended procedures are followed.

L. 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.

M. Provide flexible duct connections and splices in accordance with manufacturer's recommended installation instructions.

N. Seal flexible duct connections with sealing materials listed and labeled in accordance with UL 181B. Mechanically secure connections with approved clamping materials.

3.4 TURNING VANES

A. Install only in square elbows of equal dimensions.

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 in. w.g.

3.5 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.
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 is 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 start up. 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.

3.6 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 in. 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.

3.7 TEST OF DUCTWORK

A. Conduct duct leakage tests per SMACNA "HVAC Air Duct Leakage Test Manual" and per the requirements of the 2015 International Energy Conservation Code, for all ductwork systems designed to operate at static pressures of 3.0 in. 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 shall be as selected by the Engineer. 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, as determined by equation 4 - 8 in 2015 IECC, which reads: $CL=F/P^{0.65}$ 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 repair 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. Provide test reports indicating pressure tests performed. Include date, section tested, test pressure and leakage rate.

C. 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. 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.

3.8 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.

3.9 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 in. 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.

3.10 DUCT SUPPORTS

A. Provide per SMACNA, same material as duct. Hanger bands to extend down sides and turn under bottom 2 in. Minimum two metal screws per hanger. Angle iron on larger duct spaced per building structural system but not greater that 8 ft. Provide extra support angles as required.

3.11 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 at smoke detectors, where required for proper installation, per smoke detector manufacturer's recommendations. Coordinate minimum duct size required with Division 26 "Electrical" .

3.12 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.

EXHIBIT I - DUCTWORK MATERIALS

SERVICE	**MATERIAL**	**SPECIAL REQUIREMENTS**
Supply, return, vent, relief, outside and exhaust	Lock forming quality, galvanized steel ASTM A653 and A924, galvaneal/paint grip if not insulated and exposed	Joints and features as called for

END OF SECTION 233100

SECTION 233713 REGISTERS AND DIFFUSERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

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

1.3 SUBMITTALS

A. Registers/Grilles/Diffusers: Submit room schedule listing size, cfm, throw, direction of throw, accessories, finish, material type, color chart, pressure drop and noise criteria.

1.4 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 shop drawing 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.

1.5 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: Price unless otherwise noted.

E. Manufacturers: Anemostat, Carnes, Krueger, Titus, Price, Tuttle and Bailey, Nailor.

1.6 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 the 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 surfaced-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 type ceiling in which diffuser is to be installed.

D. Design Equipment: Price.

E. Manufacturers: Anemostat, Carnes, Krueger, Titus, Price, 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 in. 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. With equalizing grid.
8. Panel Size: 24 in. x 24 in.
9. Model: Price SPD.

B. Type 2 (High Induction Diffuser):

1. Steel 22 gauge construction with removable inner vane assembly without use of tools.
2. Square or round neck as indicated or scheduled.
3. Four-way directional flow pattern.
4. With equalizing grid and throw reducing vanes.
5. Frame suitable for ceiling type.
6. Panel size: 24 in. x 24 in., neck size as indicated by diffuser tag.
7. Color selected by Architect.
8. Model: Price SMX.

C. Type 3 (Supply Air Register):

1. Steel 20 gauge frame construction with double 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 in. centers.
2. Key operated opposed blade damper.
3. 1-1/4 in. wide flange with sponge rubber gasket.
4. Color selected by Architect.
5. Model: Price 520D.

D. Type 4 (Security Diffuser)

1. Steel construction with 22 gauge back pan, 22 gauge face panel with rolled edges and a 12 gauge hot rolled steel lattice faced with 13/16 in. square holes and 3/16 fret.
2. Round neck 1-1/4 in. collar for duct connections.

3. Face panel shall be removed and securely held in place to the back pan without noise or vibration.
4. Tamper-resistant screws.
5. Price Model MSD.

E. Type 5 (Linear Supply):

1. Solid heavy wall extruded aluminum frame and border.
2. Frames shall include compressible space bars with integral hangers on approximate 24 in. centers.
3. Fully adjustable steel, black pattern controller.
4. One (1) 1.5 in. slot, inlet connection and length as called for on the drawings.
5. Border type shall be suitable for ceiling.
6. Provide optional accessories as required to achieve continuous slots.
7. Provide insulated plenum.
8. Color selected by Architect.
9. Model: Price ASPI215

2.2 RETURN/EXHAUST TYPES

A. Type A (Perforated Return):

1. Steel frame construction with 3/16 in. staggered holes in perforated steel face (50% minimum free area).
2. Face shall be removable and fitted with hinges to facilitate cleaning.
3. Steel backpan with inlet collar.
4. Frame suitable for ceiling type.
5. Color selected by Architect.
6. Panel size 24 in. x 24 in. as shown on the plans. Neck size as indicted by register tag.
7. Model: Price PDDR.

B. Type B (Exhaust Register):

1. Steel construction with 22 gauge frame and blades with horizontal bars on a 3/4 in. spacing set at 35 degree fixed deflection.
2. 1-1/4 in. wide flange.
3. The blades shall be parallel-to-long dimension.
4. Color selected by Architect.
5. Panel size as shown on the plans.
6. Key operated opposed blade damper.
7. Model: Price 535D

C. Type G (Staff Return and Exhaust Registers):

1. Perforated Face Plate:

a. Steel: Minimum 12 gauge plate.
b. Hole Size: 13/16 in. square holes.

c. Hole Spacing: 1 in. on center.

2. Damper: Opposed blade, constructed of steel, adjustable thru face with removable key.
3. Register Sleeve: 10 gauge cold rolled steel, formed with flanged face and welded seams.
4. Model: Price MSLP

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 in. minimum height plenum box must be supplied to all grilles. Plenum dimensions shall match grille size. Paint inside of plenum box flat black. Provide 1 in. acoustical lining in plenum box. Oversize the plenum to account for the thickness of the lining.

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 233723.16 LOUVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION

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

1.3 SUBMITTALS TO THE ARCHITECT/ENGINEER

A. Louvers including all blade types, finishes, and arrangements.

B. Penthouses including materials, finishes and accessories.

C. Provide original color charts for selection of finish.

PART 2 - PRODUCTS

2.1 LOUVERS

A. Factory constructed high performance drainable, fixed, extruded aluminum 4 in. deeplouvers.

B. Sill extension and sill style as required by job conditions.

C. Heads, sills and jambs to be one piece structural members of 6063-T6 alloy with integral caulking slot and retaining beads.

D. Mullions shall be sliding interlock with internal drain(s).

E. Blades to be one piece extrusions with gutter(s) designed to catch and direct water to jamb and mullion drains.

F. Extrusion thicknesses shall be as follows: Heads, Sills, jambs and mullions: 0.115". Fixed Blades: 0.081"

G. Closed cell PVC compression gaskets shall be provided between bottom of the mullion or jamb and the top of the sill to insure leak tight connections.

H. All fasteners to be aluminum .

I. All louvers to be furnished with 5/8 in. flattened expanded mesh, aluminum bird screen with a .055 in. thick extruded aluminum frame. Screens and screen frames to be standard mill finish.

J. All louvers shall be finished with powder coating of a color to be selected at the time of submittal review. Coating to be 1.5 to 3 mil. thick full strength 100% resin Fluoropolymer coating. Finish to adhere to a 4H Hardness rating. The louver manufacturer shall supply an industry standard 20-year limited warranty against failure or excessive fading of the Fluoropolymer powder coat finish.

K. Design Equipment: Greenheck ESD-403.

L. Makes: Construction Specialties, Inc., American Warming & Ventilating Inc., Arrow United Industries, Louvers & Dampers, Inc., Ruskin, Nailor, Greenheck.

PART 3 - EXECUTION

3.1 GENERAL

A. Install louvers as per manufacturer's recommendations.

3.2 LOUVERS

A. Size called for is approximate wall/or masonry opening size. Adjust slightly to suit construction or coursing (review field conditions for rough opening sizes.) Slope ductwork, and plenum to louver weephole or provide drain.

B. Structural supports shall be designed and furnished by the louver manufacturer to carry a wind load in accordance with the Building Code of New York State.

END OF SECTION 233723.16

SECTION 235416.13 GAS-FIRED FURNACE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 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.

1.3 SUBMITTALS

A. Submit product data for gas-fired furnace, complete with accessory items and wiring diagrams.

PART 2 - PRODUCTS

2.1 CENTRAL HEATING SYSTEM

A. General:

1. All equipment associated with this system shall be furnished by one equipment manufacturer.
2. Provide all accessories, control devices and wiring required for a complete operable system.

B. Gas-Fired Furnace:

1. The furnace shall be verticaltype, sealed combustion direct vent, propane gas fired unit with capacity as scheduled.
2. Factory assembled and wired and test operated. The furnace shall consist of:

    a. Heavy gauge steel cabinet with baked enamel finish.
    b. Ceramic coated steel heat exchanger.
    c. Centrifugal type multi-speed blower, with direct drive and sealed bearings. The motor shall have built-in thermal overload protection, with manual reset.
    d. Atmosphere gas burner with combustion, operating and safety controls with 100% safety shut-off. Gas train shall include pressure regulating valve and main gas shut-off valve.
    e. Fan and limit control arranged for automatic blower operation and for protection against abnormal operating condition.
    f. 24 volt control transformer.
    g. Electronic 7 day programmable thermostat with battery back-up.
    h. Solid state electronic spark ignition.

i. Provide 1 in. thick throw-away filter box.

3. Complete unit to be ANSI tested and AGA and UL labeled.

C. Design Equipment: Trane

D. Make: Bryant, Carrier, Lennox, Trane, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with all applicable state and local Plumbing/Mechanical/Fuel/Gas Codes and with manufacturer's installation instructions.

B. Set furnace on 2 in. thick concrete bricks.

C. Provide control wiring, thermostat mounting.

END OF SECTION 235416.13

SECTION 235533.16 GAS-FIRED UNIT HEATER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION

A. Provide labor, materials, equipment and services as required for the complete installation and related work as shown on the Contract Documents.

1.3 SUBMITTALS

A. Submit product data for gas fired 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. 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. Ceiling suspended.
2. Factory assembled, piped, and wired, and complying with ANSI Z83.8
3. Gas Type: Design burner for propane gas having characteristics same as those of gas available at Project site.
4. Type of Venting: Poweredvented.
5. Access for servicing the heating element, motors, and controls.
6. Horizontal discharge units with adjustable horizontal and/or vertical outlet vanes.
7. 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. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513.

3. Propeller Fan:

    a. Formed steel or Aluminum propeller blades riveted to heavy-gage steel spider bolted to cast-iron hub, dynamically balanced, and resiliently mounted.
    b. Fan Blade Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.

4. Wall mounted line voltage thermostat.

C. Heating Element (Propane Gas):

1. Heat Exchanger: The heat exchanger shall be aluminized steel. Die-formed burners shall be of aluminized steel and include flared ports and a stainless steel insert. The units shall be designed to provide 80% thermal efficiency.
2. Controls: include a 24-volt control transformer; single stage gas control system, an intermittent spark pilot with electronic flame supervision (intermittent spark pilot with electronic flame subversion and timed lockout); fan and limit safety controls; an open, drip-proof (totally enclosed) fan motor with internal overloads; and a blocked vent switch system.

D. Provide with options as called for in the Schedule.

E. Design Equipment: Modine

1. Acceptable Makes: Trane, Reznor, Modine.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Install equipment in accordance with manufacturer's printed instructions. Report cases where clearance below suspended heaters is less than 7-1/2 ft. Provide clearance for piping and conduit. Support units independent of piping

B. Install and connect gas-fired unit heaters according to NFPA 54, applicable local codes and regulations, and manufacturer's written installation instructions.

C. Suspend from structure using threaded rods and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

END OF SECTION 235533.16

SECTION 236213.10 AIR-COOLED CONDENSING UNITS (RESIDENTIAL)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

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

1.3 SUBMITTALS

A. Submit product data for air-cooled condensing unit, complete with accessories.

B. Submit complete wiring and piping diagrams, showing all piping and control interconnection.

C. Submit Installation Manuals.

1.4 GENERAL REQUIREMENTS

A. Equipment Manufacturer shall be responsible for the following:

1. Capacity, size and arrangement, component parts and accessories as scheduled and/or as necessary to obtain required results and allow for proper maintenance.
2. Unit capacities to be ARI, ASHRAE and AMCA rated.
3. Each unit shall be ETL listed for safety approval.
4. Guaranteed sound-power level ratings not exceeding those of design equipment.
5. Complete start-up for each unit shall be performed under the direction of the manufacturers authorized representative.

B. Electrical Wiring:

1. Division 26 will provide power wiring to condensing unit.
2. Division 23 will provide control wiring interlocks at units and interlocks to air handling units as required.

C. Start-Up, Testing and Instructions:

1. Provide complete installation, testing, wiring, start-up, and instructions to Owner's Representatives.

PART 2 - PRODUCTS

2.1 AIR-COOLED CONDENSING UNITS

A. General:

1. Factory assembled air-cooled condensing units with galvanized steel casings and baked enamel finish. Units selected for operation in conjunction with respective air handling units.
2. Units constructed in accordance with ANSI B9.1 and NEC.
3. Unit performance shall be certified in accordance with ARI Standard 460, latest edition.
4. Condensing unit capacities as scheduled.

B. Compressors:

1. Condensing unit with internally isolated refrigeration scroll compressor provided with overload and inherent winding thermostat protection, and crankcase heaters.
2. Five year compressor parts and labor warranty from date of shipment.

C. Condenser Coils:

1. Condenser coils of aluminum fins mechanically bonded to seamless copper tubing, pressure tested for 425 psi working pressure.
2. Tubes cleaned, dehydrated, sealed and leak tested at 150 psig.

D. Refrigeration Circuits:

1. Refrigeration circuits with sub-cooling coils, service valves gauge ports, and dryers.

E. Controls:

1. High and low pressure cut-outs incorporating automatic reset.

F. Condenser Fans and Motors:

1. Direct driven propeller fans, vertical discharge, with fan guards.
2. Motors resiliently mounted and pre-lubricated, with built-in overload protection and equipped with corrosion protected fan shafts.
3. Fans statically and dynamically balanced, steel or aluminum blades and zinc plated steel hubs.

G. Casings:

1. Zinc-coated steel, phosphatized casings coated with epoxy resin primer and finished with baked enamel.
2. Equipped with unit base mounting holes and drain holes.

H. Design Equipment: Trane

I. Make: Carrier, Daikin Applied, Trane, York.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Connect services to the unit where called for, in complete accordance with the Manufacturer's Installation Instructions. Furnish Division 26 with wiring diagrams and electrical data to permit power wiring connections to the unit. Provide control wiring serving air handling unit associated condensing unit, and the auxiliary control panel in accordance with Section "Electric Wiring." Charge system with Refrigerant after evacuating and leak testing, and in accordance with Manufacturer's Installation Instructions. Provide a prefabricated concrete mounting pad. Anchor condensing unit to pad with expansion anchors.

END OF SECTION 236213.10

SECTION 237219 ENERGY RECOVERY VENTILATOR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 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.

1.3 SUBMITTALS

A. Submit certified dimensional shop drawings and product data on components and accessories.

B. Product data: For each type or model of Energy Recovery Ventilator, include the following:

1. Unit performance data for both Supply Air and Exhaust Air, with system operating conditions indicated.
2. Enthalpy plate performance data for both summer and winter operation.
3. Motor ratings and unit electrical characteristics.
4. Dimensioned drawings for each type of installation, showing isometric and plan views, to include location of attached ductwork and service clearance requirements.
5. Estimated gross weight of each installed unit.
6. Filter types.

1.4 GENERAL REQUIREMENTS

A. The heat recovery system shall be of modular design consisting of three basic modules:

1. Exhaust blower and intake blower with heat recovery, and intake with filters.
2. Capacity, size and arrangement, static pressure, brake horsepower, component parts and accessories as called for and/or as necessary to obtain required results and allow for proper maintenance.
3. Ratings based on tests made in strict accordance with AMCA Standard 210.
4. The energy recovery ventilator shall be certified by the Home Ventilating Institute (HVI) under CSA 438. Both a heating and a cooling test must be run to demonstrate year round energy recovery.
5. Equipment statically and dynamically balanced to acceptable tolerances with weights permanently fastened.
6. Factory assembled fully automatic controls and powered dampers including necessary relays, transformers and devices to permit operation. Refer to "Motors, Starters and Auxiliaries" Section for starters and wiring.
7. Coil performance certified in accordance with ARI Standard 410.

8. Major electrical components shall be UL listed.

B. Services and Warranty:

1. Arrange with the unit supplier to:

a. Instruct for proper installation and operation of components.
b. Supply required and certified-correct wiring diagrams, indicating factory wired components and field wiring required for unit and to remotely located equipment and panels.

2. Provide free inspection, adjustment and call-back unit service within one (1) year from initial start of an operation.
3. The ERV core shall be arranged to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of ten (10) years from the date of purchase. The balance-of-unit shall be warranted to be free of manufacturing defects and to retain the functional characteristics, under circumstances of normal use, for a period of five (5) years from the date of purchase.

PART 2 - PRODUCTS

2.1 ENERGY RECOVERY UNIT

A. General:

1. Factory assembled, wired and tested.
2. Shipped to site as one complete package.
3. Unit housing of galvanized steel panel casing, insulated.
4. Housing corrosion resistant coated, painted and weatherproofed.
5. Hinged access door on both sides of unit at intake and discharge plenums, and removable panels for access to transfer medium, fans, motors, filters and dampers.

B. Energy Transfer:

1. The ERV shall be capable of transferring both sensible and latent energy between airstreams. Latent energy transfer shall be accomplished by direct water vapor transfer from one airstream to the other, without exposing transfer media in succeeding cycles directly to the exhaust air and then to the fresh air.

C. Passive Frost Control:

1. The ERV core shall perform without condensing or frosting under normal operating conditions (defined as outside temperatures above -10°F and inside relative humidity below 40%). Occasional more extreme conditions shall not affect the usual function, performance or durability of the core. No condensate drains will be allowed.

D. Continuous Ventilation and Boost Mode:

1. Unit shall have the capacity to operate continuously without the need for bypass, recirculation, pre-heaters, or defrost cycles under normal operating conditions.
2. The unit shall be capable of operating intermittently at the low airflow (adjustable) setting with the ability to go temporarily to the high airflow (adjustable) boost mode.

E. Positive Airstream Separation:

1. Water vapor transfer shall be through molecular transport by hydroscopic resin and shall not be accomplished by "porous plate" mechanisms. Exhaust and fresh airstreams shall travel at all times in separate passages, and airstreams shall not mix. No metal separators or metal core material shall be acceptable.

F. Laminar Flow:

1. Airflow through the ERV core shall be laminar over the products entire operating airflow range, avoiding deposition of particulates on the interior of the energy exchange plate material.

G. Construction:

1. The energy recovery component shall be of fixed-plate cross-flow construction, with no moving parts.
2. No condensate drain pans or drains shall be allowed and unit shall be capable of operating in both winter and summer conditions without generating condensate.
3. The unit case shall be constructed of 18-gauge G90 galvanized steel.
4. Access doors shall provide easy access to blowers, ERV cores, and filters. Doors shall have an airtight compression seal using closed cell foam gaskets.
5. Case walls and doors shall be fully insulated with 1 inch, expanded polystyrene foam insulation faced with a cleanable foil face on all exposed surfaces.
6. The ERV cores shall be protected by a MERV-8 rated filters in both airstreams.

H. Design Equipment: Greenheck (Model as scheduled)

I. Acceptable Make: Broan, Greenheck, Ruskin, RenewAire.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Location as called for.

B. Provide in strict accordance to manufacturer's instructions.

END OF SECTION 237219

SECTION 238113.11 PACKAGED TERMINAL HEAT PUMP (PTHP)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 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.

1.3 SUBMITTALS

A. Submit product data for packaged terminal heat pump units and accessories, including installation details.

1.4 QUALIFICATIONS

A. Shall comply with New York State Energy Conservation Construction Code and ARI Standard 310-82 certification for "Package Terminal Heat Pumps."

PART 2 - PRODUCTS

2.1 PACKAGED TERMINAL HEAT PUMP

A. General:

1. Single piece through-the-wall self-contained packaged air cooled air conditioning unit with reverse cycle heat pump function, electrical heating coil and arranged for manual heating-cooling changeover.

B. Wall Sleeve:

1. 16 gauge zinc coated steel, phosphatized and coated with a corrosion resistant finish and four sided heavy duty neoprene seals or of heavy duty, crackfree polymeric material.
2. Stainless steel fasteners.

C. Room Cabinets:

1. 16 gauge steel, welded construction.
2. Phosphatized and finished in baked enamel.
3. Four-way adjustable discharge grilles.
4. Factory installed hinged access door to control compartment.
5. Removal of front panel for access to filters and coil.

D. Heating Section:

1. UL listed electric resistance element. Approved for use in assembly.

E. Cooling Chassis:

1. Manual reset overload protection. Completely self-contained hermetically sealed air-cooled refrigeration system, including evaporator fan and controls.
2. Provisions shall be made for easy removal or insertion of the chassis as a unit without removal or disconnection of heating element, heating controls, or room-side fan.
3. Compressor shall be mounted on vibration isolators.
4. Cooling coils shall be copper tubes tested at twice maximum operating pressure.
5. Provide means whereby the cooling cycle cannot be damaged when the heating coil is hot.
6. Suitable for low ambient operation. Guarantee operation of compressor at 35°F without short cycling or coil frosting.
7. Precharged factory tested refrigeration circuit.
8. Reversing valve and charge balancing device.

F. Fans:

1. Single or double inlet aluminum or corrosion resistant centrifugal dynamically balanced blowers.
2. Direct connected to resiliently mounted, PSC motor with built-in overload protection.
3. Two speed, permanently lubricated, totally enclosed motor.

G. Controls and Safeties:

1. Factory installed and wired controls.
2. Controls shall consist of push-button OFF/FAN/HEAT/COOL selector switch, adjustable thermostat with upper and lower limits, and FAN CYCLE switches.
3. Unit mounted thermostat controlling both heating and cooling mode of operation.
4. Safeties shall consist of automatic reset overtemperature and overcurrent protection for compressor; inherent, automatic reset overtemperature protection for fan motor; 2 overtemperature protectors for heater.

H. Ventilation Assembly: Lined duct, gear motor electric damper operator, override switch, etc.

I. Condensate Disposal System: Guaranteed to eliminate moisture without drip, splash or spray on building exterior.

J. Louver: Extruded anodized aluminum outside air louver with 1/8 in. thick horizontal bars assembled in extruded aluminum struts and frame suitable for installation in type of wall installed.

K. Accessories:

1. Plug cord power connection
2. Throwaway type air filters.
3. Architectural grille.
4. Drain kit.
5. Subbase.
6. Wall sleeve.

L. Manufacturer's Warranty:

1. Room Unit: Twelve (12) months.
2. Hermetic refrigerant system: Sixty (60) months.

M. Design Equipment: Amana

N. Make: Amana, Carrier, Daikin Applied, Trane.

PART 3 - EXECUTION

3.1 GENERAL

A. Install in strict accordance to manufacturer's instructions.

B. Complete service shall be supplied for one (1) year from date of final acceptance including trouble shooting, parts and labor.

C. Mount at height as called for; provide additional support to assure rigid installation.

D. Provide necessary field wiring in accordance with NEC.

E. Provide insulation in wall sections around sleeve.

F. Seal and caulk around entire perimeter both inside and out between wall sleeve and wall section.

END OF SECTION 238113.11