DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

SECTION 230000 – GENERAL PROVISIONS

PART 1 – GENERAL

1.01 SUMMARY OF ITEMS INCLUDED

A. This Section contains General Provisions related specifically to the Mechanical Work.

1. Quality Assurance.
2. Terminology.
3. Protection.
4. Coordination and Sequencing.
5. General Completion.
6. Demolition.
7. Cutting and Patching.
8. Excavation for Mechanical Work.
9. Concrete for Mechanical Work.

B. Drawings and General Provisions of Contract, including General and Supplementary Conditions, apply to this section.

1.02 QUALITY ASSURANCE

A. Laws, Permits, Inspections.

1. Comply with latest revisions of New York State Uniform Fire Protection and Construction Code, NYSED Manual of Planning Standards, any Local Codes or Regulations that apply.
2. Underwriters Laboratories label required for all electrical materials carrying 50 volts or more.
3. Comply with New York State Energy Conservation Construction Code.
4. Comply to requirements of drawings and specifications that are in excess of governing codes.
5. Comply with Section 1613 of the New York State Building Code for seismic requirements.
6. Do not install work as specified or shown if in conflict with governing code. Notify Engineer and request direction.
7. Pay all Inspection and Permit fees.
8. Provide Certificate of Inspection from all governing authorities.

B. Reference to technical society, organization, body or section made in accordance with the following abbreviations:

1. AIA American Institute of Architects
2. AMCA Air Moving and Conditioning Association, Inc.
3. ANSI American National Standards Institute.
4. ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers
5. ASME American Society of Mechanical Engineers
6. ASTM American Society of Testing Materials
7. AWSC American Welding Society Code
8. AWWA American Water Works Association
9. IEEE Institute of Electric and Electronics Engineers
10. NEC National Electric Code
11. NEMA National Electrical Manufacturer's Association
12. NFPA National Fire Protection Association
13. NYBFU New York Board of Fire Underwriters
14. NYCRR - Codes, Rules and Regulations of the State of New York.

15. NSF - National Sanitation Foundation
16. PDI - Plumbing and Drainage Institute.
17. SMACNA Sheet Metal and Air Conditioning Contractors National Association
18. UL Underwriters' Laboratories, Inc.

C. Contractor submission of equivalent or substitute items other than those specified is at Contractor convenience only. If a substitution or equivalent is accepted, the Contractor shall coordinate the installation of the substitute or equivalent and make all associated changes required. The Contractor also waives any claim for additional costs associated with the substitute / equivalent which becomes apparent before, during or after installation. The Contractor agrees to bear any and all additional costs to all other contractors or subcontractors which are caused by the incorporation of the substitution / equivalent.

D. The Contractor shall, as part of his contract, furnish and install all equipment, materials, wiring accessories, and on-site installation of equipment as required by current standards of good practice.

E. All materials and equipment to be furnished and installed shall be new and of first quality and be free from all defects.

1.03 TERMINOLOGY

A. The following terminology and definitions are used on this project as related to the Mechanical Work.

1. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces and tunnels.
2. Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
3. Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
4. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
5. Concealed Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
6. Sewers: Refer to underground connections from building to street mains. Sewers begin at points 5 feet outside building wall.
7. Service Connections: Refer to underground connections from 5 feet outside building wall to street mains.
8. Underground Lines: Refer to piping buried in earth inside and within 5 feet outside building.
9. Building Lines: Refer to all other lines.
10. For other definitions refer to latest issue of New York State Plumbing Code, and all revisions.

1.04 PROTECTION

A. Protect equipment from damage, including water, chemical, mechanical injury and theft.

B. Replace damaged equipment or components.

C. Close and waterproof between sleeves, openings, pipes and voids in walls, floors and foundations to prevent entrance of water or moisture.

D. Holes made in fire walls, partitions, fire stops, shall be patched to maintain fire rating integrity.

E. Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris and moisture.

F. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.

G. Protect flanges, fittings, and piping specialties from moisture and dirt.

H. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

I. If permanently installed air handler equipment/systems are used during construction, filtration media with a Minimum Efficiency Reporting Value (MERV) of 8 shall be used in each unit and at each return air grille/opening, as determined by ASHRAE 52.2 Replace all unit filtration media with a Minimum Efficiency Reporting Value (MERV) of 13 immediately prior to occupancy and verify ductwork cleanliness; if ductwork is found contaminated, clean ductwork and associated air handling equipment and replace filtration media.

1.05 COORDINATION AND SEQUENCING

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for chases, slots and openings in building structure during progress of construction, to allow for mechanical installations.

C. Coordinate the installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces. Access panels and doors shall be submitted and approved by the engineer.

G. Coordinate installation of identifying devices after completion of covering and painting, where devices are applied to surfaces. Install identifying devices prior to installation of acoustical ceilings and similar concealment.

H. Coordination with other trades: Right-of-Way as follows:

1. Light Fixtures.
2. Drain Pipes and Vents.
3. Ductwork.
4. HVAC Piping.
5. Domestic Water Piping.
6. Electrical Conduit.

I. Work in existing building.

1. Verify existing locations of pipe, ductwork equipment and conduit in field.

2. Extend existing systems as required for proper tie-in to new systems.
3. Leave existing equipment to be reused in satisfactory working order.
4. Remove from building all existing piping, ductwork, equipment and similar items which do not conform to new layout. Before disposing of these items, determine if Owner wishes to retain them.

J. Changeovers and continuity of services.

1. Make changeovers, tie-ins, removal, and perform similar work that affect operation of present building at times approved by Owner.
2. Make temporary connections required to keep present building systems and equipment in operation.
3. Prior to any shutdown of present building, have necessary materials at site.

1.06 GENERAL COMPLETION

A. Oiling Equipment.

1. Lubricate equipment and motors in accordance with manufacturer's requirements.

B. Instructions to Owner's Representative.

1. Give notice to Engineer when all systems are installed and operating.
2. Obtain name of Owner's Representative to receive instructions.
3. Schedule instructions of Owner's Representative by manufacturer's representative and instruct Owner in system installation and operation for:

a. Heating, Ventilating & Air Conditioning Equipment.
b. Fan equipment.
c. Pumps.
d. Temperature control.
e. Equipment lubrication.
f. Packaged systems.

C. Provide Operation and Maintenance manuals in accordance with the requirements of Division 01 "Project Closeout" Section. Provide an instructional video to the owner of the training / maintenance instruction sessions with the owner.

1.07 PAINTING AND FINISHING

A. Refer to "Painting" Section 099000 for field painting requirements.

B. Damage and Touch-up: Repair marred and damaged factory painted finishes with materials and procedures to match original factory finish.

1.08 DEMOLITION

A. Disconnect, demolish, and remove work specified under Division 23 and as indicated.

B. Where pipe, ductwork, insulation or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.

C. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.

D. Abandoned Work: Cut and remove buried pipe abandoned in place, 2 inches beyond the face of adjacent construction. Cap and patch surface to match existing finish.

E. Removal: Remove indicated equipment from the project site.

F. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation. Add cap off and pressure test prior to putting back in service.

1.09 CUTTING AND PATCHING

A. All cutting required to facilitate the proper installation of all work to be installed under Division 23, shall be done by the Mechanical Contractor.

B. Cut, channel, chase and drill floors, walls, partitions, ceilings and other surfaces necessary for mechanical installations in the maner specified and approved by the architect. Perform cutting by skilled mechanics of the trades involved.

C. Repair cut surfaces to match adjacent surfaces.

1.10 EXCAVATION FOR MECHANICAL WORK

A. Description of Work: Types of excavation for mechanical related work specified in this section include:

1. Underground mechanical utilities and services.
2. Underground tanks, casings and equipment enclosures.
3. Exterior water circulation and distribution systems.

B. Project Conditions.

1. Locate and protect existing utilities and other underground work in manner which will ensure that no damage or service interruption will result from excavating and backfilling. Liabilities arising out of performance of work is responsibility of Contractor doing excavation.
2. Protect persons from injury at excavations by barricades, warnings, and illumination.
3. Provide temporary covering or enclosure and temporary heat as necessary to protect bottoms of excavations from freezing and frost action. Do not install mechanical work on frozen excavation bases or subbases.

1.11 CONCRETE FOR MECHANICAL WORK.

A. Types of concrete for mechanical related work specified in this section include:

1. Lean concrete backfill to support mechanical work.
2. Encasement of mechanical work.
3. Mechanical equipment foundations and housekeeping pads.
4. Inertia bases for isolation of mechanical work.
5. Rough grouting in and around mechanical work.
6. Patching concrete cuts to accommodate mechanical work.
7. Thrust block.

1.12 REBATES

A. The Mechanical Contractor shall assist the Owner in applying for any available rebates from manufacturer’s, utility companies, etc. on equipment or materials installed under the contract. Provide all required documentation and assist in the completion of applications as required to complete the rebate process. All proceeds from rebates remain the property of the Owner.

PART 2 – PRODUCTS

Reference Section 033000.

PART 3 - EXECUTION

3.01 EXCAVATION - GENERAL

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

B. Excavate with vertical sided excavations to greatest extent possible, except where otherwise indicated. Where necessary, provide sheeting and cross bracing to sustain sides of excavation. Remove sheeting and cross bracing during backfilling wherever such removal would not endanger work or other property. Where not removed, cut sheeting off at sufficient distance below finished grade to not interfere with other work.

C. Width: Excavate for piping with 6" to 9" clearance on both sides of pipe, except where otherwise shown or required for proper installation of pipe joints, fittings, valves and other work. Excavate for other mechanical work to provide minimum practical but adequate working clearances.

D. Depth for direct support: For work to be supported directly on undisturbed soil, do not excavate beyond indicated depths, and hand excavate bottom cut to accurate elevations, undercut at pipe hubs.

E. Depth for subbase support: For large piping (6" pipe size and larger), tanks, and where indicated for other mechanical work, excavate for installation of subbase material in depth indicated or, if not otherwise indicated, 6" below bottom of work to be supported.

F. Depth for unsatisfactory soil or rock conditions: Where directed, (because of unsatisfactory conditions at bottom of indicated excavation), excavate additional depth as directed to reach satisfactory conditions. Backfill with subbase material, compacted as directed, to indicated excavation depth.

G. Store excavated material (temporarily) near excavation, in manner which will not interfere with or damage excavation or other work. Do not store under trees (within drip line).

1. Dispose of excavated material which is either in excess of quantity needed for backfilling, or does not comply with requirements for backfill material.

    a. Remove unused material from project site, and dispose of in lawful manner.

3.02 WATER CONTROL

A. Maintain dry excavations for mechanical work, by removing water. Protect excavations from inflow of surface water. Pump inflow of ground water from excavations, protect excavations from inflow of ground water, by installing temporary sheeting and waterproofing as well as dewatering as required. Provide adequate barriers which will protect other excavations and below grade property from being damaged by water, sediment or erosion from or through mechanical work excavations. Need permit for dewatering – contractor to obtain and pay for.

3.03 BACKFILLING (REFERENCE 310000)

A. Do not backfill until installed mechanical work has been tested and accepted, wherever testing is indicated.

B. Install drainage fill where indicated, and tamp to uniform firm density.

C. Backfill with finely graded subbase material to 6" above wrapped, coated and plastic piping and tanks, and to centerline of other tanks.

D. Condition backfill material by either drying or adding water uniformly, to whatever extent may be necessary to facilitate compaction to required densities. Do not backfill with frozen soil materials.

E. Backfill simultaneously on opposite sides of mechanical work, and compact simultaneously, do not dislocate work from installed positions.

F. Backfill excavations in 8" high courses of backfill material, uniformly compacted to the following densities (% of maximum density, ASTM D1557), using power-driven hand operated compaction equipment.

1. Lawn and landscaped areas: 85% for cohesive soils, 90% for cohesionless soil.
2. Paved areas and roadways: 90% for cohesive soils, 95% for cohesionless soils.

G. Backfill to elevations matching adjacent grades, at time of backfilling excavations for mechanical work. Return surfaces to original condition.

H. After covering piping with 6" layer of approved fill, employ General Contractor to backfill, compact excavations beneath:

1. New foundations.
2. Slabs on grade.
3. Areas to be paved by General Contractor.

3.04 CONCRETE BASES

A. Construct concrete equipment bases of dimensions required, but not less than 4 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations.

3.05 CONCRETE GENERAL

Reference Section 033000.

3.06 CONCRETE CURING AND PROTECTION

Reference Section 033000.

3.07 MISCELLANEOUS CONCRETE ITEMS

A. Fill in holes and openings left in concrete structures for passage of work by trade unless otherwise shown or directed, after work of other trades is in place. Mix, place and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.

3.08 CONCRETE SURFACE REPAIRS (REFERENCE 030130)

A. Repair and patch areas with epoxy or non-shrink grout immediately after removal of forms, when acceptable to Architect/Engineer.

B. Repair areas, except single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4" clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

C. Use epoxy-based mortar for structural repairs, where directed by Architect/Engineer.

D. Repair methods not specified above may be used, subject to acceptance of Engineer.

3.09 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. Quality Control: Owner's acceptable testing laboratory will perform sampling and testing during concrete placement, which may include the following, as directed by Engineer. This testing does not relieve Contractor of responsibility of providing concrete in compliance with specifications. Contractor shall perform additional testing as necessary, at no expense to Owner, to ensure quality of concrete.

1. Sampling Fresh Concrete: ASTM.
2. Slump: ASTM, one test for each load at point of discharge.
3. Air Content: ASTM C 173, one for each set of compressive strength (specimens of freshly mixed concrete).
4. Compressive Strength: ASTM, one set for each 50 cu. yds. or fraction thereof of each class and type of concrete; 2 specimens tested at 7 days, 3 specimens tested at 28 days, and one retained for later testing if required.
5. Laboratory Cured Test Cylinders: ASTM.

END OF SECTION

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

SECTION 230010 – CODES, STANDARDS, AND PERMITS

PART 1 – GENERAL

1.01 GENERAL

The entire installation shall be made in accordance with State rules and regulations and shall also conform with the Standards of the National Board of Fire Underwriters for this installation and the local Board of Fire Underwriters having jurisdiction. The installation shall also comply with air pollution requirements of the State of New York and Industrial Code Rule 4 of the State of New York Department of Labor, Board of Standards and Appeals, dated March 31, 1965, and all other ordinances having jurisdiction.

The Contractor shall submit to all authorities having jurisdiction all required applications and shall secure all necessary permits, tests, and inspections required for final approval.

Certain standard and staple materials are described by reference to standard specifications. These standards are as follows:

ASA-B9	Safety Code for Mechanical Refrigeration
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing Materials
AWWA	American Water Works Association
CS	Commercial Standard
FS	Federal Specification
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation
PDI	Plumbing and Drainage Institute
SMACNA	Sheet Metal and Air Conditioning Contractors Association
USASI	United States of America Standards Institute
UL	Underwriters' Laboratories
	New York State Uniform Fire Prevention and Building Code
A.A.B.C.	Associated Air Balance Council
N.E.B.B.	National Environmental Balancing Bureau
NYSED	Manual of Planning Standards (Latest Edition)

All new equipment shall bear U.L. label and conform to the latest edition of the National Electric code.

END OF SECTION

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

SECTION 230300 – BASIC MECHANICAL MATERIALS AND METHODS

PART 1 – GENERAL

1.01 SUMMARY OF ITEMS INCLUDED

A. This Section includes the following basic mechanical materials and methods to complement other Division 23 Sections.

1. Submittals.
2. Welder certification.
3. Pipe joining materials and installation instructions common to piping systems.
4. Piping specialties: Escutcheons, dielectric fittings, sleeves and seals.
5. Identifying devices and labels.
6. Nonshrink grout for equipment installations.
7. Drip pans.
8. Fire stopping.
9. Pipe supports: Hangers, clamps, support spacing, building attachments, shields and saddles, flashing, miscellaneous materials, anchors.
10. Field fabricated metal and wood equipment supports.

B. Pipe and pipe fitting materials are specified in piping system sections.

1.02 RELATED DOCUMENTS

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

1.03 SUBMITTALS

A. General - Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

B. Product data for following piping specialties:

1. Mechanical sleeve seals.
2. Identification materials and devices.

C. Samples of color, lettering style and other graphic representation required for each identification material and device.

D. Shop drawings detailing fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.

E. Coordination drawings for access panel and door locations.

F. Prepare coordination drawings to a 1/4 inch equals 1 foot scale or larger. Detail major elements, components and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Show where sequence and coordination of installations are important to the efficient flow of the Work. Include the following:

1. Proposed locations of piping, ductwork, equipment and materials. Include the following:

a. Planned piping layout, including valve and specialty locations and valve stem movement.
b. Planned duct systems layout, including elbows radii and duct accessories.
c. Clearances for installing and maintaining insulation.
d. Clearances for servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.
e. Equipment service connections and support details.
f. Exterior wall and foundation penetrations.
g. Fire-rated wall and floor penetrations.
h. Sizes and location of required concrete pads and bases.

G. Floor plans, elevations and details to indicate penetrations in floors, walls and ceilings and their relationship to other penetrations and installations.

H. Reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

I. Submit weld procedure specifications.

1.04 WELD AND WELDER CERTIFICATION

A. Welder certificates signed by Contractor certifying that welders comply with requirements of this Section.

B. Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code - Steel".

1. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".

1. Comply with provisions of ASME B31 Series "Code for Pressure Piping".

1.05 STANDARDS FOR MATERIALS AND WORKMANSHIP

A. All materials and workmanship shall, at a minimum be in accordance with (in no order of precedence):

1. New York State Codes – latest edition as adopted by the Authority Having Jurisdiction, unless otherwise noted.

2. State and municipal Building Codes and related subcodes.

3. Occupational and Safety Act (OSHA) Requirements.

4. Rules and Regulations of the Authority Having Jurisdiction applicable to the work.

5. National Electrical Standards Association Standard for Good Workmanship in Electrical Construction (NECA-1)

6. Serving utility’s rules and regulations for providing service.

7. Contract Drawings and Specifications.

8. Manufacturer recommended installation instructions, practices and procedures for the products being utilized or installed.

9. Where conflicts arise between the above, the more stringent requirement shall be adhered to.

PART 2 - PRODUCTS

2.01 PIPE AND PIPE FITTINGS

A. Refer to individual piping system specification Sections for pipe and fitting materials and joining methods. Joining methods and pipe installation shall be performed in complete accordance with section 1613 of the Building Code of New York State for building seismic type II, zone C.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.02 PIPE JOINING MATERIALS

A. Refer to individual piping system specification Sections in Division 23 for special joining materials not listed below.

B. Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8 inch maximum thickness, except where thickness or specific material is indicated.

    a. Full-Face Type: for flat-face, Class 125 cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: for raised-face, Class 250 cast-iron and steel flanges.

2. ASME B16.20 for grooved, ring-joint, steel flanges. Note that grooved, ring joint piping / accessories may be used for sprinkler or condenser water piping systems only.

3. AWWA C110, rubber, flat face, 1/8 inch thick, except where other thickness is indicated; and full-face or ring type, except where type is indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, except where other material is indicated.

D. Solder Filler Metal: ASTM B 32.

1. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent) and silver (approximately 5 percent).
2. Alloy E: Tin (approximately 95 percent) and copper (approximately 5 percent).
3. Allow HA: Tin-antimony-silver-copper-zinc.
4. Alloy HB: Tin-antimony-silver-copper-nickel.
5. Alloy Sb5: Tin (95 percent) and antimony (5 percent).

E. Brazing Filler Metals: AWS A5.8.

1. BCuP Series: Copper-phosphorus alloys.
2. BAg1: Silver alloy.

F. Welding Fill Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Flanged, Ductile-Iron Pipe Gasket, Bolts and Nuts: AWWA C110, rubber gasket, carbon steel bolts and nuts.

H. Couplings: Iron body sleeve assembly, fabricated to match outside diameters of plain-end, pressure pipes.

1. Sleeve: ASTM A 126, Class B, gray iron.
2. Followers: ASTM A 47, Grade 32510 or ASTM A 536 ductile iron.
3. Gaskets: Rubber.
4. Bolts and Nuts: AWWA C111.
5. Finish: Enamel paint.

2.03 PIPING SPECIALTIES

A. Escutcheons: Manufactured wall, ceiling and floor plates; deep-pattern type, where required to conceal protruding fittings and sleeves.

1. Inside Diameter: Closely fit around pipe, tube and insulation of insulated piping.
2. Outside Diameter: Completely cover opening.
3. Cast Brass: One-piece, with set-screw.

    a. Finish: Rough brass.
    b. Finish: Polished chrome plate.

4. Cast Brass: Split casting, with concealed hinge and set-screw.

    a. Finish: Rough brass.
    b. Finish: Polished chrome plate.

5. Stamped Steel: One-piece, with set screw and chrome plated finish.
6. Stamped Steel: One-piece with spring clips and chrome plated finish.
7. Stamped Steel: Split plate with concealed hinge, set-screw, and chrome plated finish.
8. Stamped Steel: Split plate with concealed hinge, spring clips and chrome plated finish.
9. Cast-Iron Floor Plate: One piece casting.

B. Dielectric Fittings: Assembly or fitting having insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types and matching piping system materials.
2. Insulating Material: Suitable for system fluid, pressure and temperature.
3. Dielectric Unions: Factory-fabricated, union assembly, for 250 psig minimum working pressure at 180 deg F temperature.
4. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150 or 300 psig minimum pressure to suit system pressures.
5. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers and steel backing washers.

    a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure to suit system pressures.

6. Dielectric Couplings: Galvanized steel coupling, having inert and non-corrosive, thermoplastic lining, with threaded ends and 300 psig minimum working pressure at 225 deg F temperature.

7. Dielectric Nipples: Electroplated steel nipple, having inert and non-corrosive, thermoplastic lining, with combination of plain or threaded end types and 300 psig working pressure at 225 deg F temperature.

C. Mechanical Sleeve Seals: Modular, watertight, mechanical type. Components include interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve. Connecting bolts and pressure plates cause rubber sealing elements to expand when tightened.

D. Sleeves: The following materials are for wall, floor, slab and roof penetrations.

1. Steel Sheet-Metal: 24 gage or heavier, galvanized sheet metal, round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A53, Type E, Grade A, Schedule 40, galvanized, plain ends.
3. Cast-Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, having plain ends and integral water stop, except where other features are specified.
4. Wall Penetration Systems: Wall sleeve assembly, consisting of housing, gaskets and pipe sleeve, with 1 mechanical-joint end conforming to AWWA C110 and 1 plain pipe-sleeve end.

    a. Penetrating Pipe Deflection: In accordance with the Building Code of New York State (latest edition), Chapter 16: seismic requirements, without leakage.
    b. Housing: Ductile-iron casting having waterstop and anchor ring, with ductile-iron gland, steel studs and nuts, and rubber gasket conforming to AWWA C111 of housing and gasket size as required to fit penetrating pipe.
    c. Pipe Sleeve: AWWA C151, ductile-iron pipe.
    d. Housing-to-Sleeve Gasket: Rubber or neoprene, push-on type, of manufacturer's design.

5. Cast-Iron Sleeve Fittings: Commercially-made, sleeve having integral clamping flange, with clamping ring, bolts and nuts for membrane flashing.

    a. Underdeck Clamp: Clamping ring with set screws.

2.04 IDENTIFYING DEVICES AND LABELS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 23 Sections. Where more than single type is specified for listed application, selection is Installer's option, but provide single selection for each product category.

B. Equipment Nameplates: Metal nameplate with operational data engraved or stamped; permanently fastened to equipment.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.
2. Location: An accessible and visible location.

C. Snap-On Plastic Pipe Markers: Manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, conforming to ASME A13.1.

D. Pressure-Sensitive Pipe Markers: Manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, conforming to ASME A13.1.

E. Plastic Duct Markers: Manufacturer's standard laminated plastic, color coded duct markers. Conform to following color code:

1. Green: Cold air.
2. Yellow: Hot air.
3. Yellow/Green: Supply air.
4. Blue: Exhaust, outside, return and mixed air.
5. For hazardous exhausts, use colors and designs recommended by ASME A13.1.
6. Nomenclature: Include following:

a. Direction of air flow.
b. Duct service (supply, return, exhaust, etc.).
c. Duct origin (from).
d. Duct destination (to).
e. Design cfm.

F. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock: Grade ES-2, black surface, black phenolic core, with white (letter color) melamine subcore, except when other colors are indicated.

1. Fabricate in sizes required for message.
2. Engraved with engraver's standard letter style, of sizes and with wording to match equipment identification.
3. Punch for mechanical fastening.
4. Thickness: 1/16 inch, except as otherwise indicated.
5. Thickness: 1/8 inch, except as otherwise indicated.
6. Thickness: 1/16 inch, for units up to 20 square inches or 8-inches long; 1/8 inch for larger units.
7. Fasteners: Self-tapping stainless-steel screws or contact-type permanent adhesive.

G. Plastic Equipment Markers: Laminated-plastic, color-coded equipment markers. Conform to following color code:

1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.
3. Yellow/Green: Combination cooling and heating equipment and components.
4. Brown: Energy reclamation equipment and components.
5. Blue: Equipment and components that do not meet any of above criteria.
6. For hazardous equipment, use colors and designs recommended by ASME A13.1.
7. Nomenclature: Include following, matching terminology on schedules as closely as possible:

a. Name and plan number.
b. Equipment service.
c. Design capacity.
d. Other design parameters such as pressure drop, entering and leaving conditions, and rpm.

8. Size: Approximately 2-1/2 by 4 inches for control devices, dampers, and valves; and 4-1/2 by 6 inches for equipment.

H. Underground Type Plastic Line Marker.

1. Manufacturer's standard permanent, bright colored, continuous printed plastic tape, intended for direct burial service, not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.

I. Lettering and Graphics: Coordinate names, abbreviations and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, lettering and wording indicated for proper identification and operation/maintenance of mechanical systems and equipment.

1. Multiple Systems: Where multiple systems of same generic name are indicated, provide identification that indicates individual system number as well as service such as "Boiler No. 3", "Air Supply No. 1H", or "Standpipe F12".

2.05 GROUT

A. Nonshrink, Nonmetallic Grout: ASTM C1107, Grade B.

1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000 psi, 28-day compressive strength.
3. Packaging: Premixed and factory-packaged.

2.06 DRIP PANS

A. Provide drip pans fabricated from corrosion resistant sheet metal with watertight joints, and with edges turned up 2-1/2 inches. Reinforce top, either by structural angles or by folding over according to size. Provide hole, gasket, and flange at low point for watertight joint and 1-inch drain line connection.

2.07 FIRE STOPPING

A. Refer to Specification Section 230680 for details.

2.08 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. General: Except as otherwise indicated, provide factory fabricated horizontal piping hangers and supports. Supports and hangers in conformance with the Building Code of New York State (latest edition), Chapter 16: seismic requirements shall be used. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper plated hangers and supports for copper piping systems. Provide spring hangers where piping is subject to vibration movement.

B. Adjustable steel clevises.

1. Material: Carbon steel, copper plated for copper piping.
2. Finish: Black or copper plated.
3. Adjustment: Hanger to be adjustable for vertical height of pipe without removing the pipe.

2.09 VERTICAL PIPING CLAMPS

A. Two bolt riser clamp.

1. Material: Carbon steel copper plated for copper piping.
2. Finish: Black or copper plated.

2.10 HANGER ROD AND SPACING

ROD SIZE AND SPACING SCHEDULE (In accordance with NYSBC 1621)

PIPE SIZE	ROD DIAMETER
2" and smaller	3/8"
2-1/2" thru 3-1/2"	1/2"
4" thru 5"	5/8"
6" and over	3/4"

TYPE	MAXIMUM SPACING
Steel	10’ -0"
Copper	6’- 0"

Note: Cast Iron - support at every hub or coupling 5 ft. maximum spacing.

2.11 BUILDING ATTACHMENTS

A. General: Except as otherwise indicated provide factory fabricated building attachments of one of the following types listed, selected by Installer to suit building substrate conditions. Select size of building attachments to suit hanger rods. Provide copper plated building attachments for copper piping systems. Provide the following where approved by Building Code of New York State (latest edition), Chapter 16:

B. On Structural Steel:

1. For pipes 2" and smaller: C clamps with lock nuts similar to Grinnell figure 86.
2. For pipes 5" and larger: Use beam clamps similar to Grinnell figure 228 or 292.

C. On New Masonry:

1. Use concrete inserts similar to Grinnell figure 281.

D. On Existing Concrete:

1. Use expansion case similar to Grinnell figure 117.

E. On Wood:

1. Use coach screw rods Grinnell figure 111. Ceiling flanges Grinnell figure 153, or fabricated angle clips. Use wood drive screws or lag bolts as fasteners.

2.12 SHIELDS AND SADDLES (Where approved by the Building Code of New York State (latest edition), Chapter 16:)

A. General: For insulated piping.

B. Shields: 16 gauge galvanized metal.

Unsul Coustic Corp. "Insul-Shield"

C. Protection saddles:

1. Hardwood block
2. Steel saddle Grinnell 160 series

2.13 FLASHING MATERIALS

A. General: Provide flashings for each penetration of mechanical systems through roofs or waterproof membranes.

B. Molded Pipe Flashing: Compatible with single ply membranes with which it is used and manufactured by membrane manufacturer.

C. Copper flashing: Provide cold-rolled sheet copper (ANSI/ASTM B 370), of proper temper for applications shown and required forming, coated on one side with not less than 0.06 lbs. per sq. ft. of antimony (ANSI/ASTM B 101, Type I, Class A), weighing 1.06 lbs. per sq. ft., except as otherwise indicated.

D. Bituminous coating: FS TT-C-494, or MIL-C-18480, or SSPC-Paint 12, cold applied solvent type bituminous mastic coating for application in dry film thickness of 15 mils per coat.

2.14 MISCELLANEOUS MATERIALS

A. Metal framing: Provide products complying with NEMA STD ML 1.

B. Steel plates, shapes and bars: Provide products complying with ANSI/ASTM A 36.

C. Heavy duty steel trapezes: Fabricate from steel shapes selected for loads required, weld steel in accordance with AWS standards.

D. Pipe guides: Provide factory fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of a bolted two section outer cylinder and base with a two section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

2.15 ANCHORS

A. Fabricate pipe anchors from 3 x 3 x 1/2" angle.

B. Use pipe protection saddles one size larger than piping.

PART 3 - EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

A. General: All piping systems, components and their installation shall be in conformance with the Building Code of New York State (latest edition), Chapter 16: for seismic requirements. Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 23 specify piping installation requirements unique to the piping system.

B. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing and other design considerations. Install piping as indicated, except where deviations to layout are approved on coordinate drawings.

C. Install piping at indicated slope.

D. Install components having pressure rating equal to or greater than system operating pressure.

E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.

F. Install piping free of sags and bends.

G. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, except where indicated.

H. Install piping tight to slabs, beams, joists, columns, walls and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.

I. Install piping to allow application of insulation plus 1-inch clearance around insulation.

J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

K. Install fittings for changes in direction and branch connections.

L. Install couplings according to manufacturer's printed instructions.

M. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wallboard partitions and suspended ceilings according to the following:

1. Chrome-Plated Piping: Cast-brass, one-piece, with set-screw and polished chrome-plated finish. Use split-casting escutcheons where required, for existing piping.
2. Uninsulated Piping Wall Escutcheons: Cast-brass or stamped-steel, with set-screw.
3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
4. Insulated Piping: Cast-brass or stamped-steel, with concealed hinge, spring clips and chrome-plated finish.
5. Piping in Utility Areas: Cast-brass or stamped-steel with set-screw or spring clips.

N. Sleeves are required for core drilled holes.

O. Permanent sleeves are not required for holes formed by PE plastic (removable) sleeves.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, concrete floor and roof slabs and where indicated.

1. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring where specified.

2. Build sleeves into new walls and slabs as work progresses.

3. Install large enough sleeves to provide 1/4 inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

    a. Steel Sheet-Metal Sleeves: For pipes 6 inches and larger, penetrating gypsum-board partitions.
    b. Cast-Iron Sleeve Fittings: For floors having membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Flashing is specified in Division 7 Section "Flashing and Sheet Metal".
    c. Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.

4. Except for below-grade wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants specified in Division 7 Section "Joint Sealants".

Q. Above Grade, Exterior Wall, Pipe Penetrations: Seal penetrations using sleeve and mechanical sleeve seals. Size sleeve for 1 inch annular clear space between pipe and sleeve for installation of mechanical seals.

1. Install steel pipe for sleeves smaller than 6 inches.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger.
3. Assemble and install mechanical seals according to manufacturer's printed instructions.

R. Below Grade, Exterior Wall, Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installation of mechanical seals.

S. Below Grade, Exterior Wall, Pipe Penetrations: Install ductile-iron wall penetration system sleeves according to manufacturer's printed installation instructions.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

V. Piping Joint Construction: Joint pipe and fittings as follows and as specifically required in individual piping system specification Sections.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Soldered Joints: Construct joints according to AWS "Soldering Manual", Chapter 22 "The Soldering of Pipe and Tube".
4. Brazed Joints: Construct joints according to AWS "Brazing Manual", Chapter 28 "Pipe and Tube".
5. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full inside diameter. Join pipe fittings and valves as follows:

    a. Note the internal length of threads in fittings or valve ends and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
    b. Apply appropriate tape or thread compound to external pipe threads (except where dry seal threading is specified).
    c. Align threads at point of assembly.
    d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
    e. Damaged Threads: Do not use pipe or pipe fittings having threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

W. Welded Joints: Construct joints according to AWS D10.12 "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe" using qualified processes and welding operators according to "Quality Assurance" article.

X. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

1. Fitting Heat-Fusion Joints: Prepare pipe and fittings and join with heat-fusion equipment, according to manufacturer's printed instructions.

    a. Plain-End Pipe and Socket-Type Fittings: Socket-joining.

Y. Piping Connections: Except as otherwise indicated, make piping connections as specified below.

1. Install unions, in piping 2 inches and smaller, adjacent to each valve and at final connection to each piece of equipment having 2 inches or smaller threaded pipe connection.
2. Install flanges, in piping 2 1/2 inches and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
3. Dry Piping Systems (Gas, Compressed Air, and Vacuum): Install dielectric unions and flanges to connect piping materials or dissimilar metals.
4. Wet Piping Systems (Water and Steam): Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.02 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to provide the maximum possible headroom, where mounting heights are not indicated. Equipment platforms, vibration isolation and restraints shall be provided and installed where described and shall be in conformance with Building Code of New York State (latest edition), Chapter 16:

B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Architect.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.

D. Install mechanical equipment to facilitate servicing, maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

E. Install equipment giving right-of-way to piping systems installed at a required slope.

3.03 LABELING AND IDENTIFYING

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

1. Plastic markers, with application systems. Install on pipe insulation segment where required for hot non-insulated pipes.

2. Locate pipe markers as follows wherever piping is exposed in finished spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

    a. Near each valve and control device.
    b. Near each branch, excluding short take-offs for fixtures and terminal units. Mark each pipe at branch, where flow pattern is not obvious.
    c. Near locations where pipes pass through walls, floors, ceilings, or enter non-accessible enclosures.
    d. At access doors, manholes and similar access points that permit view of concealed piping.
    e. Near major equipment items and other points of origination and termination.
    f. Spaced at a maximum of 50 feet intervals along each run. Reduce intervals to 25 feet in congested areas of piping and equipment.
    g. On piping above removable acoustical ceilings, except omit intermediately spaces markers.

3. During back-filling/top-soiling of each exterior underground piping systems, install continuous underground type plastic line marker, located directly over buried line at 6-inches to 8-inches below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16-inches, install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

B. Equipment: Install engraved plastic laminate sign or equipment marker on or near each major item of mechanical equipment.

1. Lettering Size: Minimum 1/4 inch high lettering for name of unit where viewing distance is less than 2 feet, 1/2 inch high for distance up to 6 feet, and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.

2. Text of Signs: Provide text to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to name of identified unit.

C. Duct Systems: Identify air supply, return, exhaust, intake and relief ducts with duct markers, or provide stenciled signs and arrows, showing duct system service and direction of flow.

1. Location: In each space where ducts are exposed or concealed by removable ceiling system, locate signs near points where ducts enter into space and at maximum intervals of 50 feet.

D. Adjusting: Relocate identifying devices which become visually blocked by work of this Division or other Divisions.

3.04 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Provide and install in conformance with the Building Code of New York State (latest edition), Chapter 16: Cut, fit and place miscellaneous metal supports accurately in location, alignment and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1 "Structural Welding Code - Steel".

3.05 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.06 GROUTING

A. Install nonmetallic, nonshrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's printed instructions.

B. Clean surfaces that will come into contact with grout.

C. Provide forms for placement of grout, as required.

D. Avoid air entrapment when placing grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases to provide a smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout according to manufacturer's printed instructions

3.07 DRIP PANS

A. Locate drip pans under piping passing over or within 3 ft. horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, and weld rods to

sides of drip pan. Brace to prevent sagging or swaying. Connect 1-inch drain line to drain connection, and run to nearest plumbing drain or elsewhere as indicated.

3.08 FIRESTOPPING

A. See section 230680 for additional fire stopping requirements.

3.09 INSTALLATION OF BUILDING ATTACHMENTS

A. Install building attachments at required locations in concrete, in wood or on structural steel for proper piping support. Space attachments within maximum piping span length indicated. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed, fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.

3.10 INSTALLATION OF HANGERS AND SUPPORTS

A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure. Supports / hangers shall conform to the requirements of the Building Code of New York State (latest edition), Chapter 16: Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Install hangers and supports of same type and style for grouped piping runs.

C. Support fire water piping independently of other piping.

D. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated.

E. Provisions for movement: Building Code of New York State (latest edition), Chapter 16:

1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
2. Load distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
3. Pipe slopes: Install hangers and supports to provide indicated pipe slopes.

F. Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.

3.11 SHIELDS AND SADDLES FOR INSULATED PIPING

A. 4" and below use 16 gauge x 12 inch long shield with oversized hanger outside insulation.

B. 6" and above use hardwood protection saddle with 16 gauge x 18 inch long shield with oversized hanger outside insulation.

C. 6" and above use steel protection saddle. Fill void between shield and pipe with insulation. Cover with vapor barrier. Protect barrier with 16 gauge x 18 inch long shield with oversized hanger outside assembly.

3.12 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

D. Anchor spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.13 FLASHINGS

A. Manufacturer's recommendations: Except as otherwise shown or specified, comply with recommendations and instructions of manufacturer of sheet metal being installed.

B. Coat back side of flashings where in contact with concrete and other cementitious substrates, by painting surface in area of contact with heavy application of bituminous coating, or by other permanent separation as recommended by manufacturer of metal.

C. On vertical surfaces, lap flashings minimum of 3".

D. On sloping surfaces, for slopes of not less than 6" in 12", lap unsealed flashings minimum of 6".

E. For embedment of metal flashing flanges in roofing or composition flashing or stripping, extend flanges minimum of 6" for embedment.

END OF SECTION

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

SECTION 230400 – PAINTING OF MECHANICAL WORK

PART 1 – GENERAL

1.01 SUMMARY OF ITEMS INCLUDED

A. Types of painting of mechanical related work specified in this section include the following:

1. Exposed piping systems.
2. Exposed ductwork systems.
3. Steel supports, hangers and rods.

B. The scope of painting to be applied as part of the work under Division 23 shall consist of the following:

1. Paint exposed mechanical work throughout entire project including piping, ductwork, and terminal HVAC equipment.
2. Paint uninsulated ductwork and equipment.
3. Paint exposed NON insulated pipe, black steel such as pipe hangers, supporting steel, tanks, and equipment having no prime or only a prime coat finish.

1.02 SUBMITTALS

A. Submit manufacturer's technical information, including analysis of ingredients and application instructions for products used in painting work.

B. Certification by the manufacturer that products supplied comply with State VOC Regulations

1.03 DELIVERY, STORAGE AND HANDLING

A. Deliver painting materials to job site in original, new and unopened containers bearing manufacturer's name and label showing the following information:

1. Name and title of material.
2. Manufacturer's stock number and date of manufacture.
3. Contents by volume, for major pigments and vehicles.
4. Thinning instructions.
5. Application instructions.
6. Color name and number.

B. Store materials in approved fire-safe location with adequate ventilation. Area must be kept clean.

1.04 PROJECT CONDITIONS

A. Comply with governing regulations concerning use of and conditions for application of paint. Comply with manufacturer's recommendations and instructions. Do not apply paint in unfavorable conditions of temperature, moisture (including humidity) or ambient contamination (dust and other pollutants).

PART 2 - PRODUCTS

2.01 GENERAL PAINTING PRODUCT REQUIREMENTS

A. Painting products based on a system by Rust-Oleum. Equivalent systems by Devoe and Pratt and Lambert are acceptable.

B. Steel surfaces - normal temperatures:

1. First Coat - Rust-Oleum or equal Red Primer.
2. Second Coat - Rust-Oleum or equal Zinc Chromate Rust-Inhibitive Primer.
3. Third Coat - Rust-Oleum industrial enamels, finish color as directed.

C. Steel surfaces - elevated temperatures above 150 deg. F.

1. First Coat - Rust-Oleum or equal heat resistant primer.
2. Second Coat - Rust-Oleum or equal heat resistant aluminum.
3. Machinery, equipment and apparatus having factory applied prime coat shall be painted as specified above except omit first coat.

D. Exposed canvas on pipe and equipment insulation:

1. First Coat - Primer, Rust-Oleum primer-sealer.
2. Second and third coats - Rust-Oleum Acrylic Series.
3. Colors as directed.

E. Vehicles and thinners: Comply with governing regulations and recognized safe practices in handling, use and drying of paint vehicles and thinners. Compatibility of paint products is the Contractor's exclusive responsibility. Select paint products to ensure freedom from problems relating to vehicles and thinners of type and within limits recommended by paint manufacturer.

PART 3 - EXECUTION

3.01 GENERAL

A. Clean surfaces before applying paint products. Remove oil and grease prior to mechanical cleaning. Comply with paint products manufacturer's instructions for surface cleaning and preparation.

B. Remove surface applied accessories which are not to be painted, and reinstall after completion of painting. Protect non-removable items not to be painted, by covering with paper or plastic film.

C. Ferrous metal surfaces: Remove mill scale and loose rust on surfaces which are not zinc coated or shop/factory prime coated.

1. Clean shop applied prime coats on metal surfaces, and repair (touch-up) prime coats wherever abraded or otherwise damaged, prior to application of paint system.

D. Zinc coated surfaces: Clean with non-petroleum based solvent. Wash with copper sulfate solution and flush with water, unless surface has been pre-treated, or unless treatment is not recommended by manufacturer of prime coat.

3.02 PAINT SYSTEM APPLICATION

A. Comply with manufacturer's recommendations for mixing or stirring paint products immediately before application.

B. Application limitations: Paint every accessible surface of each unit of work indicated to be painted, regardless of whether in location recognized as "concealed" or "exposed" except as otherwise indicated.

1. Omit painting of ductwork and insulated piping above removable ceilings, but apply paint system to pipe hangers, duct hangers and similar unprotected ferrous materials.
2. Omit painting on machined sliding surfaces and rotating shafts of equipment, and on nonferrous finished metals including chrome plate, stainless steel, special anodized aluminum, brass/bronze and copper, and on plastics and similar finished materials, except where specifically indicated to be color-coded by painting.
3. Omit painting on required name plates, labels, identification tags, signs, markers, printed instructions, performance ratings, flow diagrams and similar text and graphics, located within the scope of work indicated to receive paint application.
4. Omit specified prime coat of paint system for metal surfaces where surface has shop applied prime coat of equivalent quality. Apply prime coat on other surfaces to be painted, comply with paint manufacturer's instructions for prime coating where not otherwise indicated. Apply additional prime coats where suction spots or unsealed areas appear.

C. Apply paint in accordance with manufacturer's directions. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance.

D. Apply paint at edges, corners, joints, welds and exposed fasteners in manner which will ensure dry-film thickness equal to that of flat surfaces. Allow sufficient time between successive coats for proper drying (comply with manufacturer's drying instructions).

1. Number of coats: Number indicated is minimum number, apply as many coats as are necessary to cover.
2. Coating thickness: Apply paint in uniform coats without thinning in application thickness recommended by manufacturer for each coat.
3. Apply paint in smooth finish without noticeable texture, cloudiness, spotting, holidays, laps, brush marks, runs, sags, ripples, ropiness and other surface imperfections.

3.03 CLEAN UP AND PROTECTION, PAINTING

A. During progress of work, remove from site discarded paint materials, rubbish, cans and rags at end of each work day. Do not leave in paint storage area.

B. Spattered surfaces: Upon completion of painting work, clean paint spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

C. Protection: Protect work of other trades, whether to be painted or not, against damage by painting work. Correct damage by cleaning, repairing or replacing and repainting as directed. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrappings installed for protection of work not to be painted, after completion of painting operations. At completion of work by other trades, touch up and restore damaged or defaced painted surfaces.

END OF SECTION

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

SECTION 230513 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

A. Internal electrical control devices that operate starters, controllers, etc. shall be furnished, installed, and wired under Division 23. Such devices shall be included but not necessarily limited to, devices connected to ducts, damper switches, float switches, electric thermostats, safety devices, limit switches, relays, push button controllers, selector switches, pilot lights, extra interlock contacts, etc.

B. Equipment starters and disconnects shall be provided by the mechanical contractor completely mounted and wired to internal controls and shall be wired to incoming and outgoing control connections. Should integral equipment starters, disconnects or control panels be shipped separately, the mechanical contractor shall be responsible for the proper installation and connections from equipment to same. Incoming and outgoing (line and load) power wiring to starters / disconnect switches shall be performed by the electrical contractor.

C. The integration of the existing temperature control system wiring and controls shall be the responsibility of the Contractor under Division 15. The Contractor shall be fully responsible for the satisfactory operation of new equipment with the temperature control system.

D. All control transformers, control devices, starters, and control wiring furnished shall be properly protected with fuse cutouts and fuses or circuit breakers to conform to the National Electric Code, latest edition. All work shall be performed by a licensed electrician.

E. Each piece of equipment shall be provided with permanent type laminated, black finish, white core, phenolic nameplate. Nameplates should indicate the name and number of the unit, voltage, and any interlock reference. Each starter furnished by the Contractor shall be provided with a permanent type laminated, black finish, white core phenolic nameplate. Nameplate shall indicate the name of the unit controlled and the voltage rating. Nameplate shall be secured with adhesives. Plastic tape type labels will not be accepted.

F. All equipment shall be provided with disconnect means (by Mechanical Contractor).

G. All wiring furnished and installed by the mechanical contractor shall be in strict accordance with the latest edition of the National Electrical Code and all State and Municipal Agencies having jurisdiction. Except as specified otherwise, minimum size wire shall be #14 AWG (control) and #12 AWG (power) and shall be run in rigid galvanized steel conduit except as noted hereinafter. All wire shall be Type THHN or as required by code. All conduit connections to motors shall be made with short lengths of neoprene jacketed galvanized flexible metallic conduit (liquitite).

H. All wire and cable shall be new, manufactured of soft drawn copper of not less than 98% conductivity, conforming to ASTM Specifications and the latest requirements of N.E.C. Wire, and cable shall have 600 volt insulation (unless otherwise noted or specified) of the type specified and shall be of the standard AWG sizes as called for on Drawings or specified.

I. The Contractor shall furnish all labor and material required for the installation of the systems. A brief description of the work is as follows:

   1. Furnish all electrical control wiring for the new equipment and controls.

   2. Contractor shall apply final finish to insure uniformity.

   3. All cutting, patching, and painting as required.

   4. All controls for units as hereinbefore specified and disconnect switches.

5. Testing of all mechanical contractor installed wiring as directed.

6. Contractor shall perform all work as stated on the documents for fire alarm fan shutdown for all new applicable equipment, unless noted otherwise.

7. Contractor shall obtain an approved independent electrical inspection certificate, covering all work performed by an electrical inspection agency serving the locality of the project.

END OF SECTION

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

SECTION 230516 – EXPANSION COMPENSATION

PART 1 – GENERAL

1.01 SUMMARY OF ITEMS INCLUDED

A. Expansion compensation products required for this project shall be provided and installed in accordance with section 1621 of the New York State Building Code.

B. Expansion compensation products specified in this section include:

1. Fabricated Expansion Loops.

2. Flexible Ball Pipe Joints.

3. Expansion Compensators.

1.02 QUALITY ASSURANCE

A. Refer to Division 01, for requirements pertaining to substitute materials and equipment.

B. Comply with standards of the Expansion Joint Manufacturer's Association (EJMA).

1.03 SUBMITTALS

A. Product Data: Submit catalog cuts, specifications, installation instructions, and dimensioned drawings for each type of expansion compensation product. Submit schedule showing manufacturer's figure number, size, and location on project.

B. Shop Drawings: Submit shop drawings for fabricated expansion loops indicating location, dimensions, pipe sizes and location and method of attachment of anchors.

C. Maintenance Data: Submit maintenance data and spare parts list for each type of expansion compensation product. Include this data in Maintenance Manual.

PART 2 - PRODUCTS

2.01 EXPANSION LOOPS

A. General: Fabricate expansion loops as dimensioned and located on the Drawings and elsewhere as determined by installer to provide for adequate control of expansion of the installed piping system. Cold spring the loop prior to connecting to the anchored piping.

2.02 FLEXIBLE BALL PIPE JOINTS

A. General: Provide flexible ball pipe joints where indicated for piping systems, with materials and pressure/temperature ratings selected by Installer to suit intended service. Design joints for 360 degree rotation and with minimum of 30 degree angular flexing movement for sizes 1/4" to 6", 15 degrees for sizes 8" to 30". Provide 2 composition gaskets for each joint.

B. Certify carbon steel joints for environmental shock testing in accordance with MIL-S-4456 or MIL-S-901C.

C. Comply with Section II of ASME Boiler and Pressure Vessel Code and ANSI B31.1 Power Piping for materials and design of pressure containing parts and bolting.

D. Test each assembly with steam at working pressure of piping system for zero leaks before shipment.

E. Manufacturer: Subject to compliance with requirements, provide flexible ball pipe joints of the following:

1. Gustin-Bacon Div., Aeroquip Corp.

2.03 EXPANSION COMPENSATORS

A. Low Pressure: 70 psi, 3/4 inch to 3 inch copper pipe, 2 ply phosphor bronze bellows, brass shroud, male copper tube end.

B. High Pressure: 150 psi, 3/4 inch to 3/ inch steel pipe, 2 ply seamless stainless steel bellows, steel shroud and male thread end or psi, 3/4 inch to 3 inch copper pipe all bronze construction male thread or sweat ends.

C. Manufacturer: Subject to compliance with requirements, provide expansion compensators of one of the following:

1. Flexonics Div., UOP, Inc.
2. Keflex, Mfg. Div.
3. Metraflex Co.
4. Vibration Mountings and Controls, Inc.

2.04 PIPE ALIGNMENT GUIDES

A. General: Provide pipe alignment guides on both sides of expansion joints and elsewhere as indicated. Construct with 3 or 4 finger spider traveling inside a guiding sleeve, with provision for anchoring to building substrate.

B. Manufacturer: Subject to compliance with requirements, provide pipe alignment guides of the following:

1. Flexonics Div., UOP, Inc.
2. Keflex Mfg. Div.
3. Metraflex Co.

2.05 PIPE ANCHORS

A. General: Fabricated anchor, coupling with steel angle clips, teflon lined clamp sleeve, or shaped anchor for welding to pipe.

B. Manufacturer: Subject to compliance with requirements, provide anchors of the following:

1. Flexonics Div., UOP, Inc.
2. Keflex Mfg. Div.

PART 3 - EXECUTION

3.01 EXPANSION LOOPS

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

3.02 EXPANSION COMPENSATION FOR RISERS AND TERMINALS

A. General: Install connection between piping mains and risers with at least 5 pipe fittings including tee in main. Install connections between piping risers and terminal units with at least 4 pipe fittings including tee in riser.

3.03 PIPE ALIGNMENT GUIDES AND ANCHORS

A. General: Install alignment guides on both sides of each expansion joint or loop. Provide anchors secured to building structure as required.

END OF SECTION

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

SECTION 230519 – METERS AND GAUGES FOR HVAC PIPING

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. Thermometers and gages specified in this section include the following:

1. Thermometers and fittings:
2. Pressure gages and fittings:

PART 2 - PRODUCTS

2.01 THERMOMETERS

A. Thermometers:

1. General: Provide and install adjustable, variable angle type thermometers of materials, capacities and ranges indicated.
2. Case: Die cast aluminum finished in baked epoxy enamel, glass front, 9 inches long.
3. Adjustable joint: 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, with locking device.
4. Tube and capillary: Blue liquid filled, magnifying lens, 1-percent scale range accuracy, shock mounted. (Mercury filled not acceptable).
5. Scale: Satin faced, non-reflective aluminum, permanently etched markings.
6. Stem: Copper plated steel, or brass, for separable socket.
7. Range: Conform to the following:

    a. Hot water: 30 to 240 degrees F with 2 degree F scale divisions.
    b. Chilled water: 30 to 180 degrees F with 2 degrees F scale divisions.

8. Manufacturer:

9. Wika
10. Trerice
11. Weiss
12. Or approved equal

B. Dial Thermometers:

1. General – Provide dial bimetal type adjustable angle thermometers of materials, capacities and ranges indicated, designed and constructed for use in service indicted.
2. Case – Type 300 series stainless steel hermetically sealed.
3. Dial – White finished aluminum with black and blue marking.
4. Pointer – balanced aluminum with black finish.
5. Stem – type 300 series stainless steel 1/4"o.d.internal bimetal coil silicone dampened.
6. Range – conform to the following:

    a. Hot water 20° to 240° F. scale divisions.

7. Manufacturer – subject to compliance with requirements, provide glass thermometers of one of the following:

a. Tel-Tru Mfg. Co.
b. Trerice (H.O.) Co.
c. Weiss Instrument Inc.

C. Thermometer wells:

1. General: Provide thermometer wells of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2 inch extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

2. Manufacturer: Same as thermometers.

2.02 PRESSURE GAGES AND FITTINGS

A. Pressure gages:

1. General: Provide "AA" industrial rated liquid filled pressure gages of capacities and ranges indicated, designed and constructed for use in service indicated. All pressure gauges shall be liquid filled unless otherwise specified. Provide gauge cocks for all pressure gauges.
2. Type: General use, 1/2 percent accuracy, ANSI B 40.1 grade A, phosphor bronze bourdon type, bottom connection.
3. Case: Aluminum or brass, glass lens, 4 1/2 inch diameter.
4. Connector: Brass with 1/4 inch male NPT. Provide protective syphon when used for steam service.
5. Scale: White coated aluminum, with permanently etched markings.
6. Range: Conform to the following:

a. Water - 0 - 100 psi.

7. Manufacturer - subject to compliance with requirements, provide pressure gages of one of the following:

a. Ametek, U.S. Gage Div.
b. Trerice
c. Weiss

B. Pressure gage accessories:

1. Gage cocks: Brass cock with 1/4 inch female NPT on each end, and "T" handle brass plug.
2. Syphon: 1/4 inch straight coil constructed of brass tubing with 1/4 inch male NPT on each end.
3. Snubber: 1/4 inch brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.
4. Manufacturer: Same as gages.

PART 3 - EXECUTION

3.01 INSTALLATION OF THERMOMETERS

A. General: Install temperature gages in vertical upright position, and tilted so as to be easily read by observer standing on floor.

B. Locations: Install in the following locations and elsewhere as indicated:

1. At inlet and outlet of each hydronic zone 3-way valve.
2. At inlet and outlet of each hydronic boiler and chiller.

3. At inlet and outlet of each hydronic coil in air handling units, and built-up central systems.
4. At inlet and outlet of each hydronic heat exchanger.
5. At inlet and outlet of each hydronic heat recovery unit.
6. At inlet and outlet of each thermal storage tank.
7. At outlet of domestic hot water heater.
8. Common boiler supply and return header.

C. Thermometer wells: Install in piping tee where indicated, in vertical upright position. Fill well with Thermal grease.

3.02 INSTALLATION OF PRESSURE GAGES

A. General: Install pressure gages in piping tee with pressure gage cock, located on pipe at most readable position.

B. Locations: Install in the following locations, and elsewhere as indicated:

1. At suction and discharge of each hydronic pump.
2. At discharge of each pressure reducing valve.
3. At water service outlet.
4. At inlet and outlet of water side for condensers, chillers, and cooling towers.
5. System makeup water line.
6. Accessible hihg point of hydronic piping systems.

C. Pressure gage cocks: Install in piping tee with snubber or syphon if steam.

END OF SECTION

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

SECTION 230523 – GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

A. Extent of valves required by this section is indicated on drawings and/or specified in other Division 23 sections.

B. Types of valves specified in this section include the following:

1. Gate valves.
2. Globe valves
3. Drain valves.
4. Ball valves.
5. Butterfly valves (where specifically approved by engineer only).
6. Check valves.

a. Wafer Check (where specifically approved by engineer only).

1.03 QUALITY ASSURANCE

A. Marking of valves - comply with MSS SP-25.

B. Valve dimensions - for face-to-face and end-to-end dimensions of flanged or welding end valve bodies, comply with ANSI B16.10.

C. ASME Compliance: ASME 1331.9 for Building Services Piping.

D. Valve types. Provide valves of same type by same manufacturer.

1.04 SUBMITTALS

A. Product data - submit catalog cuts, specifications, installation instructions, and dimensioned drawings for each type of valve. Include pressure drop curve or chart for each type and size of valve. Submit valve schedule showing manufacturer's figure number, size, location and valve features for each required valve.

B. Maintenance data - submit maintenance data and spare parts lists for each type of valve. Include this data in Maintenance Manual.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle valves and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged valves or components, replace with new.

B. Store valves and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide factory fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated, provide proper selection as determined by installer to comply with installation requirements. Provide sizes as indicated, and connections which properly mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is engineer's option.

B. Valve Features

1. Bypass- when shown provide manufacturer's standard bypass piping and valving.
2. Drain - when shown provide threaded pipe plugs complying with Division 15 "Hot & Chilled water piping" section.
3. Flanged - valve flanged complying with ANSI B16.1 (cast iron), ANSI B16.5, (steel), or ANSI B16.24 (bronze).
4. Threaded - valve ends complying with ANSI B2.1
5. Solder joint - valve ends complying with ANSI B16.18.
6. Trim - fabricate pressure containing components of valve, including stems (shafts) and seats from brass or bronze materials, of standard alloy recognized in valve manufacturing industry.
7. Renewable seat - design seat of valve with removable disc, and assemble valve so disc can be replaced when worn.
8. Extended stem - increase stem length 2" minimum, to accommodate insulation applied over valve.

C. Valve Definitions

1. Mechanical actuator - factory fabricated gears, gear enclosure, external chain attachment and chain designed to provide mechanical advantage in operating valve.
2. Bonnet - part of gate or globe valve through which stem passes to valve body, and attached to valve body by screws, bolts union, or welding.
3. Solid wedge - one piece tapered disc in gate valve, designed for contact on both sides.
4. Outside screw and yoke (OS&Y) - stem and handwheel designed to rise out of bonnet or yoke as valve is operated from closed to open position.
5. Inside screw, non-rising stem - stem and handwheel designed to rotate without rising when valve is operated from closed to open position.
6. Tight shutoff - butterfly valve designed for flow regulation, and manufactured to be tight in closed position.

2.02 GLOBE VALVES

A. Packing - select valves designed for repacking under pressure when fully opened, equipped with packing suitable for intended service. Select valves designed so back seating protects packing and stem threads from fluid when valve is fully opened, and equipped with gland follower.

B. Composition discs - where required, provide suitable material for intended service. For stem throttling service, fit composition disc valve with throttling nut. For metal seated globe valves, provide hardened stainless steel disc and seat ring.

C. Comply with the following standards:

1. Cast iron valves - MSS SP-85.
2. Bronze valves - MSS SP-80.
3. Steel valves - ANSI B16.34.

D. For HVAC hot and chilled water service:

1. Threaded ends 2" and smaller - Class 150, bronze body, union bonnet, rising stem, composition disc.
2. Soldered ends 2" and smaller - Class 125, bronze body, screwed bonnet, rising stem, composition disc.
3. Flanged ends 2 1/2" and larger - Class 125, iron body, bolted bonnet, rising stem, OS&Y, renewable seat and disc.

E. Manufacturer - subject to compliance with requirements, provide globe valves of one of the following:

1. Jenkins Bros, A Corp.
2. Kennedy Valve
3. Stockham Valves and Fittings, Inc.

2.03 DRAIN VALVES

A. For low pressure drainage service:

1. Threaded ends 2" and smaller - Class 125, bronze body, screwed bonnet, rising stem, composition disc, 3/4" hose outlet connection.
2. Soldered ends 2" and smaller - Class 125, bronze body, screwed bonnet, rising stem, composition disc, 3/4" hose outlet connection.

B. Manufacturer - subject to compliance with requirements, provide drain valves of one of the following:

1. NIBCO, Inc.
2. Watts

2.04 BALL VALVES

A. Comply with the following standards:

1. Cast iron valves - MSS SP-72.
2. Steel valves - ANSI B16.34.

B. For HVAC hot and chilled water service:

1. Threaded ends 2" and smaller - Class 125, bronze 2 piece body, full port, bronze ball, bronze stem.
2. Soldered ends 2" and smaller - Class 125, bronze 2 piece body, full port, bronze ball, bronze stem.

C. Manufacturer - subject to compliance with requirements, provide ball valves of one of the following:

1. Jenkins Bros.
2. Stockham Valves & Fittings
3. Watts

2.05 BUTTERFLY VALVES (only where specifically approved by the engineer)

A. General - comply with MSS SP-67. Valves to be tight shutoff. Where butterfly valves are used as shutoffs for terminal or equipment removal or repair, select lug type valves. Select wafer type valves for other applications. Provide gear operators on butterfly valves 8" and larger.

B. For HVAC hot and chilled water service:

1. Lug type 3" and larger - Class 150, ductile iron body, lever operated, cadmium plated ductile iron disc, Type 316 stainless steel stem, EPT or EPDM seat.

C. Manufacturer - subject to compliance with requirements, provide butterfly valves of one of the following:

1. Demco Inc.
2. Jenkins Bros., A Corp.
3. Mark Controls Corp., MCC Centerline.
4. Stockham Valves and Fittings, Inc.
5. Crane Co., Valve Division

2.06 WAFER CHECK VALVES (only where specifically approved by the engineer)

A. General - provide wafer style, butterfly type, spring actuated check valves designed to be installed with gaskets between two standard Class 125 flanges. Construct iron body valves with pressure containing parts of materials conforming to ANSI/ASTM A-126, Grade B. Support hanger pins on both ends by removable side plugs.

B. For water service:

1. 2" and larger - Class 125, cast iron body, stainless steel trim, bronze disc, Buna-N seal.

C. Manufacturer - subject to compliance with requirements, provide wafer check valves of one of the following:

1. Bell & Gossett, ITT Fluid Handling Div.
2. Metraflex Co.
3. NIBCO, Inc.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General - except as otherwise indicated, comply with the following requirements:

1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward for horizontal plane unless unavoidable. Install valve drains with hose end adapter for each valve that must be installed with stem below horizontal plane.

B. Insulation - where insulation is indicated, install extended stem valves, arranged in proper manner to receive insulation.

C. Applications subject to shock - install valves with bodies of metal other than cast iron where thermal or mechanical shock is indicated or can be expected to occur.

D. Applications subject to corrosion - do not install bronze valves and valve components in direct contact with steel, unless bronze and steel are separated by dielectric insulator. Install bronze valves in steam and condensate service and in other services where corrosion is indicated or can be expected to occur.

E. Mechanical actuators - install mechanical actuators with chain operators where indicated, and where valves 4" and larger are mounted more than 7'-0" above floor in mechanical rooms, boiler rooms, and where recommended by valve manufacturer because of valve size, pressure differential or other operating condition making manual operation difficult.

F. Selection of valve ends (pipe connections) - except as otherwise indicated, select and install valves with the following ends or types of pipe/tube connections.

1. Copper tube size 2" and smaller - soldered joint valves except ball valves used in plumbing systems.
2. Steel pipe, size 2" and smaller - threaded valves.
3. Pipe size 2 1/2" and larger - flanged valves.

G. Valve system - select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.

H. Non-metallic disc - limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.

I. Renewable seats - select and install valves with renewable seats, except where otherwise indicated.

J. Fluid control - except as otherwise indicated, install gate, ball, globe, and butterfly valves to comply with ANSI B31.1. Where throttling is indicated or recognized as principal reason for valve, install globe or butterfly valves.

K. Installation of Check valves: Wafer check valves – install between two flanges in horizontal or vertical position for proper direction of flow.

END OF SECTION

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

SECTION 230548 – VIBRATION ISOLATION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work specified in this section.

B. This section is a Division 23 Basic Materials and Methods section, and is a part of each Division 23 section making reference to vibration isolation products specified herein. Vibration isolation devices shall conform to the seismic requirements of the New York State Building Code. Isolators shall allow the amount of movement required by this code and shall be equipped with limit stops as required by this code.

1.02 DESCRIPTION OF WORK

A. Types of vibration isolation products specified in this section include the following:

1. Fiberglass Pad and Shapes
2. Neoprene Pads
3. Cork/Neoprene Pads
4. Equipment Rails
5. Fabricated Equipment Bases
6. Roof Curb Isolators
7. Isolation Hangers
8. Riser Isolators
9. Riser Support Isolators
10. Flexible Duct Connectors
11. Flexible Pipe Connectors

B. Vibration isolation products furnished as part of factory-fabricated equipment, are specified as part of the equipment assembly in other Division 23 sections.

C. Refer to other sections of these specifications for equipment foundations, hangers, sealants, gaskets and other work related to vibration isolation work.

1.03 QUALITY ASSURANCE

A. Product qualification - provide each type of vibration isolation unit produced by specialized manufacturer, with not less than 5 years successful experience in production of units similar to those required for this project.

1.04 SUBMITTALS

A. Product data - submit manufacturer's specifications, detailed drawings, performance characteristics data and installation instructions for each type of unit required.

1. Include data for each type and size of unit, showing isolation efficiency, stiffness, natural frequency and transmissibility at lowest operating speed of equipment.
2. Where required, include independent test agencies certified report of test results for each type of unit.

3. For spring units, show wire size, spring diameter, free height, solid-compression height, operating height, fatigue characteristics and ratio of horizontal to vertical stiffness.
4. For spring and pad type units, show basis of spring rate selection for range of loading weights.
5. Include performance certifications where required.

B. Shop drawings - submit shop drawings showing structural design and details of inertia bases, steel beam bases and other custom fabricated work not covered by manufacturer's submitted data.

1. Furnish templates to fabricators of equipment bases, foundations and other support systems, as needed for coordination of vibration isolation units with other work.

C. Submit shop drawings indicating scope of vibration isolation work and locations of units and flexible connections. Include support isolation points for piping and ductwork including risers, air housings and inertia bases.

1. Include schedule of units, showing size or manufacturer's part number, and weight supported and resulting deflection of each unit.

PART 2 - PRODUCTS

2.01 ISOLATION MATERIALS AND SUPPORT UNITS

A. Fiberglass pads and shapes - glass fiber of not more than 0.18 mil diameter, produced by multiple-flame attenuation process, molded with manufacturer's standard fillers and binders through 10 compression cycles at 3 times rated load bearing capacity, to achieve natural frequency of not more than 12 Hertz, in thicknesses and shapes required for use in vibration isolation units.

B. Neoprene pads - oil resistant neoprene sheets, of manufacturer's standard hardness and cross ribbed pattern, designed for neoprene in shear type vibration isolation, and in thicknesses required.

C. Cork/Neoprene pads - close grained composition cork sheet, laminated between 2 sheets of ribbed oil resistant neoprene, in thicknesses required.

D. Vibration isolation products furnished as part of factory-fabricated equipment, are specified as part of the equipment assembly in other Division 23 sections.

E. Refer to other sections of these specifications for equipment foundations, hangers, sealants, gaskets and other work related to vibration isolation work.

F. Equipment rails - where rails or beams are indicated for use with isolator units to support equipment, provide steel beams complying with ANSI/ASTM A36, with minimum depth of 6" or 0.08 x span of beam between isolators (whichever is greater). Provide welded bracket at each end of beams, and anchor each end to spring isolator unit. Provide bolt holes in beams matching anchor bolt holes in equipment. Provide beams of section modulus indicated or, if not indicated, selected for normal-weight equipment loading to limit static load stress to 16,000 psi.

1. Except as otherwise indicated, position equipment on equipment rails so that load will be equally supported by isolator units.

G. Fabricated equipment bases - where supplementary bases are indicated for use with isolator units to support equipment (base not integral with equipment), provide welded unit, fabricated of structural steel shapes, plates and bars complying with ANSI/ASTM A36, as shown. Provide welded support brackets at points indicated, and anchor base to spring isolator units.

H. Except as otherwise indicated, arrange brackets to result in the lowest possible mounting height for equipment. Provide bolt holes in base matching anchor bolt holes in equipment.

1. Where indicated, provide auxiliary steel base for support of motor, mounted on equipment base with slotted anchor bolt holes for adjustment of motor position.
2. Where sizes of base framing members are not indicated, fabricate base with depth of structure not less than 0.10 x longest span of base, rigidly braced to support equipment without deflections or distortions which would be detrimental to equipment or equipment performances.

I. Roof-curb isolators - fabricated frame units sized to match roof curbs as shown, formed with isolation springs between extruded aluminum upper and lower sections, which are shaped and positioned to prevent metal-to-metal contact. Provide continuous airtight and waterproof seal between upper and lower extrusions. Include provisions for anchorage of frame unit to roof curb, and for anchorage of equipment to unit.

J. Isolation hangers - hanger units formed with brackets and including manufacturer's standard compression isolators of type indicated. Design brackets for 5 times rated loading of units. Fabricate units to accept misalignment of suspension members, and for use with either rod or strap type members and including acoustical washers to prevent metal-to-metal contacts.

1. Provide vibration isolation spring with cap and pad type isolator, securely retained in unit.
2. Provide neoprene pad, securely retained in unit.
3. Provide fiberglass pad or shape, securely retained in unit, with threaded metal top plate.
4. Provide removable spacer in each unit, to limit deflection during installation to rated-load deflection.

K. Riser isolators - manufacturer's standard pad type isolator bonded to steel plate, formed for welding to pipe sleeve extension.

L. Riser support isolators - manufacturer's standard pad type isolator laminated between two formed steel plate members, one for welding to pipe sleeve extension and other for welding to pipe riser.

M. Flexible duct connectors - laminated flexible sheet of cotton duct and sheet elastomer (butyl, neoprene or vinyl), reinforced with steel wire mesh where required for strength to withstand duct pressure indicated. Form connectors with full faced flanges and accordian bellows to perform as flexible isolation unit, and of manufacturer's standard length for each size unless otherwise indicated. Equip each unit with galvanized steel retaining rings for airtight connection with ductwork.

N. Flexible pipe connectors:

1. For non-ferrous piping, provide bronze hose covered with bronze wire braid with copper tube ends or bronze flanged ends, brase-welded to hose.
2. For ferrous piping, provide stainless steel hose covered with stainless steel wire braid with NPT steel nipples or 150 psi ANSI flanges, welded to hose.
3. Rubber flexible pipe connectors - provide of rubber and butyl construction with integral full faced duck and butyl flanges, internally steel wire reinforced, and furnished complete with steel retaining rings. Select with temperature and pressure ratings to suit intended service.
4. Manufacturer - subject to compliance with requirements, provide vibration isolation products of one of the following:

a. Korfund Dynamics Corp.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
d. Vibration Mountings and Controls, Inc.

PART 3 - EXECUTION

3.01 PERFORMANCE OF ISOLATORS

A. General - comply with minimum static deflections recommended by the American Society of Heating, Refrigerating and Air Conditioning Engineers, including definitions of critical and noncritical locations, for selection and application of vibration isolation materials and units as indicated.

B. Manufacturer's recommendations - except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

3.02 APPLICATIONS

A. General - except as otherwise indicated, apply the following types of vibration isolators at indicated locations or for indicated items of equipment. Selection is Installer's option where more than one type is indicated.

B. Neoprene pad type isolators - install where the following equipment is indicated:

1. Floor mounted air handling units, in noncritical locations.
2. Rooftop units mounted on dunnage. (as well as internal spring isolator).

C. Equipment rails and spring isolators - install where the following floor mounted equipment is indicated:

1. Air handling units, 7 1/2 H.P. and larger.
2. Centrifugal fans, 7 1/2 H.P. and larger.

D. Fabricated equipment base and spring isolators - install where the following equipment is indicated:

1. Centrifugal fans.
2. Reciprocating refrigeration compressor, in noncritical locations.

E. Roof curb isolators - install where the following equipment is located on roof curbs over critical locations:

1. Air handling units.
2. Rooftop air conditioning units.
3. Fan or blower units, of more than 1.5 H.P.

F. Isolation hangers - install where the following suspended equipment is indicated:

1. Package air handling units.
2. Pipe over 1" pipe size, located in mechanical equipment rooms and each run connected to vibration isolation mounted equipment for a distance of 100 diameters but not less than 50' - 0".
3. Ductwork (except flexible ductwork), located in mechanical equipment rooms, and each run connected to vibration isolation mounted equipment for a distance of 50' - 0".
4. Sound traps in ductwork.
5. Ductwork, where air velocity is 3000 fpm or greater.

G. Riser isolators - install where the following risers pass through floors and roofs, provide support type where riser support is required:

1. Pipe risers.

2. Pipe risers, within 50' - 0" of connection with vibration isolation mounted equipment.
3. Pipe risers, in critical locations.
4. Pipe risers, 2" pipe size and larger, in critical locations.
5. Ductwork risers, in critical locations.
6. Ductwork risers, where air velocity is 3000 fpm or greater.
7. Ductwork risers, within 50' - 0" of connection with vibration isolation mounted equipment.

H. Flexible duct connectors - install at the following ductwork connections:

1. Connections with vibration isolation mounted air handling equipment.
2. Connections with fixed wall louvers for air intake and exhausts.
3. Where ductwork, 1.0 square foot and greater, changes directions in critical locations.

I. Flexible pipe connectors - install in piping systems at the following location:

1. Connections, 3/4" pipe size and larger, with vibration isolation mounted equipment.

3.03 INSTALLATION

A. General - except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration isolation materials and units. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading, and are not short circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary protection against overloading during installation.

B. Anchor and attach units to substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.

C. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.

D. Locate isolation hangers as near overhead support structure as possible.

E. Weld riser isolator units in place as required to prevent displacement from loading and operations.

F. Bond flanges of flexible duct connectors to ducts and housings to provide airtight connections. Seal seams and penetrations to prevent air leakage.

G. Flexible pipe connectors - install on equipment side of shutoff valves, horizontally and parallel to equipment shafts wherever possible.

3.04 DEFLECTION MEASUREMENTS

A. Upon completion of vibration isolation work, prepare report showing measured equipment deflections for each major item of equipment as indicated.

END OF SECTION

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

SECTION 230593 – HVAC TESTING, ADJUSTING AND BALANCING

PART 1 – GENERAL

1.01 SUMMARY OF ITEMS INCLUDED

A. Scope: Extent of HVAC testing, adjusting and balancing work required by this Section is indicated on the drawings, in schedules, and by the requirements of this Section.

B. Testing, Adjusting and Balancing (TAB) contractor to meet or exceed all uniform code testing requirements. (e.g. ASHRAE, ASME, IMC, Etc.)

C. Systems: Testing, adjusting and balancing specified in this Section includes the following systems:

1. Air systems including supply, return and exhaust.
2. Hydronic systems including heating, chilled water.

D. Related Sections: Refer to other Division 23 sections for:

1. Fans
2. Air Terminal Units
3. Pumps
4. Hydronic Piping Systems
5. Ductwork
6. Boilers
7. Chillers and Cooling Towers

1.02 QUALITY ASSURANCE

A. Agency Qualifications

1. The qualifications of the TAB contracting firms shall be submitted, within 30 days of notice to proceed. Recent projects shall be listed and described for the company. Names and telephone numbers of the project contractors and facility managers will be provided.

2. The Owner must approve in writing the qualifications of both the company and the lead technician.

3. Qualifications of TAB Firm Personnel:

a. A minimum of one professional engineer with current registration is required to be in the permanent employment of the firm for supervision and direction in the work performed. This engineer shall be totally responsible for developing job site data as required for test procedures.

b. All personnel used on job site shall be either professional engineer or technicians, who shall have been permanent, full-time employees of firm for a minimum of six (6) months prior to start of work for that specified project.

c. The qualifications of the TAB lead site technician who will remain on site during all TAB work, within 30 days of notice to proceed. Recent projects shall be listed and described for the company. Names and telephone numbers of the project contractors and facility managers will be provided.

d. The Owner must approve in writing the qualifications of both the company and the lead technician.

B. Tester's Qualifications: A specialist certified by the National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC) with at least 3 years of experience in those testing, adjusting and balancing requirements similar to those required for this project, who is not the installer of the system to be tested and is otherwise independent of the project.

C. Codes and Standards: Provide testing, adjusting and balancing conforming to American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), American National Standards Institute (ANSI), and either NEBB or AABC the following:

1. American National Standards Institute (ANSI): Comply with the following:

a. S1.4Specification For Sound Level Meters
b. S1.11Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters

2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): Comply with ASHRAE recommendations pertaining to measurements, instruments, and testing, adjusting, and balancing.

3. NEBB or AABC: Comply with NEBB'S "Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems" or comply with AABC MN-1 "National Standards," as applicable to mechanical air and hydronic distribution systems, and associated equipment and apparatus.

D. Calibration of Testing Instruments: All measurement instruments used for testing, adjusting, balancing, and commissioning shall be calibrated. The time between the most recent calibration data and the final test report date shall not be over 1 year.

1.03 SUBMITTALS

A. Test Reports: Provide certified test reports, signed by the test and balance supervisor who performed the work. The final reports shall include identification and types of instruments used, and their most recent calibration date and calibration date.

B. Standards: Deliver a copy of either NEBB or AABC standards for testing and balancing work associated with the project. This document shall serve as specific guidance to balancers as to minimum requirements.

C. Maintenance Data: Include, in maintenance manuals, copies of balance test reports and identification of instruments.

D. Qualifications: Submit the individual qualifications of all persons responsible for supervising and performing the actual work.

1.04 AGENDA

A. Agenda: A preliminary report and agenda shall be submitted and approved prior to the start of testing and balancing work.

1. Review Drawings and Specifications prior to installation of any of the affected systems, and submit a report indicating any deficiencies in the systems that would preclude the proper adjusting, balancing, and testing of the systems.

2. The agenda shall include a general description of each air and water system with its associated equipment and operation cycles for heating, intermediate, and cooling.

3. The agenda shall include a list of all air and water flow and air terminal measurements to be performed.

4. The agenda shall incorporate the proposed selection points for sound measurements, including typical spaces as well as sound sensitive areas.

5. The agenda shall also include specific test procedures and parameters for determining specified quantities (e.g. flow, drafts, sound levels) from the actual field measurements to establish compliance with contract requirements. Samples of forms showing application of procedures and calculations to typical systems shall be submitted.

6. Specific test procedures for measuring air quantities at terminals shall specify type of instrument to be used, method of instrument application (by sketch) and factors for:

    a. Air terminal configuration.
    b. Flow direction (supply or exhaust).
    c. Velocity corrections.
    d. Effective area applicable to each size and type of air terminal.
    e. Density corrections.

7. The agenda shall include identification and types of measurement instruments to be used, and their most recent calibration date and calibration date.

1.05 JOB CONDITIONS

A. General: Do not proceed with testing, adjusting and balancing work until the following conditions have been met.

1. Work has been completed and is operable. Ensure that there is no latent residual work yet to be completed on the tested equipment.

2. Work scheduled for testing, adjusting and balancing is clean and free from debris, dirt and discarded building materials.

3. All architectural openings (doors, windows, and other openings) which may affect the operation of the system to be tested, adjusted, and balanced shall at their normal states.

4. All related mechanical systems which may affect the operation of the system to be tested, adjusted, and balanced shall be at their normal operating conditions. Coordinate tests with Controls Contractor.

5. Air handling unit filters are not "loaded"; Mechanical Contractor shall replace, if required, prior to balancing.

PART 2 - PRODUCTS

2.01 PATCHING MATERIALS

A. Material: Seal, patch and repair ductwork, piping and equipment drilled or cut for testing purposes.

1. Plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.

2. Piping shall be capped with materials the same as the piping system.

3. Insulation shall be neatly hemmed with metal or plastic.

2.02 TEST INSTRUMENTS

A. Standards: Utilize instruments and equipment of type, precision, and capacity as recommended in the following standards:

1. NEBB "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

2. AABC Manual MN-1, "AABC National Standards".

B. Test Instruments: All instruments used for measurements shall be accurate and calibration histories for each instrument shall be available for examination. Each test instrument shall be calibrated by an approved laboratory or by the manufacturer. Owner's representative has the right to request instrument recalibration, or the use of other instruments and test methodology, where accuracy of readings is questionable.

C. Additional Instruments: Permanently installed measuring instruments, such as temperature and pressure gauges, shall be checked against transfer standard instruments. Any instrument which does not meet specification requirement shall be replaced or recalibrated.

D. Cone Instruments: Employ manufactured enclosure type cones, capable of air volume direct readings, for all diffuser air flow measurements. The readout meters shall meet calibration requirements.

PART 3 - EXECUTION

3.01 PROCEDURES AND INSTRUMENTS, GENERAL

A. Requirements: All systems and components thereof shall be adjusted to perform as required by drawings and specifications.

B. Test Duration: Operating tests of heating and cooling coils, fans, and other equipment shall be of not less than four hours duration after stabilized operating conditions have been established. Capacities shall be based on temperatures and air and water quantities measured during such tests.

C. Instrumentation: Method of application of instrumentation shall be in accordance with the approved agenda.

1. All instruments shall be applied in accordance with the manufacturer's certified instructions.

2. All labor, instruments, and appliances required shall be furnished by the balancer. Permanently installed instruments used for the tests (e.g., flow meters and Btu meters) shall not be installed until the entire system has been cleaned and ready for operation.

3.02 AIR SYSTEM PROCEDURES

A. Adjustments: Adjust all air handling systems to provide approximate design air quantity to or through, each component, and to maintain stable and comfortable interior temperatures, free of drafts or stagnant conditions. Adjusting and balancing of all systems shall be conducted during periods of the year approximating maximum seasonal operation. Verify operating parameters prior to start of balancing. Laboratory doors shall be closed and fume hood sashes full open, and all

other ancillary systems in simultaneous operation. Coordinate with automatic control system operation.

B. Balance: Flow adjusting (volume control) devices shall be used to balance air quantities (i.e., proportion flow between various terminals comprising system) to the extent that their adjustments do not create objectionable air motion or sound (i.e., in excess of specified limits).

1. Balancing between runs (submains, branch mains, and branches) generally shall be accomplished by flow regulating devices at, or in, the divided-flow fitting.

2. Restriction imposed by flow regulating devices in or at terminals shall be minimal. Final measurements of air quality shall be made after the air terminal has been adjusted to provide the optimum air patterns of diffusion.

C. Fan Adjustment: Total air system quantities, generally, shall be varied by adjustment of fan speeds or axial-flow fan wheel blade pitch. Damper restriction of a system's total flow may be used only for systems with direct-connected fans (without adjustable pitch blades), provided system pressure is less than 1/2-inch W.G. and sound level criteria is met.

D. Air Measurement: Where air quantity measuring devices are specified in other sections such systems shall be used as a cross-check of portable measuring equipment.

1. Except as specifically indicated herein, pitot tube traverses shall be made of each duct to measure air flow therein. Pitot tubes, associated instruments, traverses, and techniques shall conform to the ASHRAE "Handbook Fundamentals Inch Pound Edition."

2. For ducts serving modular office areas with movable partitions, which are subject to change, pitot tube traverses may be omitted provided the duct serves only a single room or space and its design volume is less than 2000 cfm. In lieu of pitot tube traverses, air flow in the duct shall be determined by totalling volume of individual terminals served, measured as described herein.

3. Where duct's design velocity and air quantity are both less than 1000 (fpm/cfm), air quantity may be determined by measurements at terminals served.

E. Test Holes: Test holes shall be in a straight duct, as far as possible downstream from elbows, bends, take-offs, and other turbulence generating devices, to optimize reliability of flow measurements.

F. Air Terminal Balancing: Generally, measurement of flow rates by means of velocity meters applied to individual terminals, with or without cones or other adapters, shall be used only for balancing. Measurement of air quantities at each type of air terminal (inlet and outlet) shall be determined by the method approved for the balancing agenda.

G. Air Motion: Air motion and distribution shall be as specified and indicated on Drawings.

3.03 WATER SYSTEM PROCEDURES

A. Adjustment: All heating, cooling and condensing water systems shall be adjusted to provide required quantity to or through each component. Verify operating parameters prior to start of balancing.

B. Metering: Water quantities and pressures shall be measured with calibrated meters.

1. Venturi tubes, orifices, or other metering fittings and pressure gauges shall be used to measure water flow rates and balance systems. Systems shall be adjusted to provide the approved

pressure drops through the heat transfer equipment (coils [except room units], converters, etc.) prior to the capacity testing.

2. Where flow metering fittings are not installed, in air/water type heat transfer equipment, flow balance shall be determined by measuring the air side energy differential across the heat transfer equipment. Measurement of water temperature differential shall be performed with the air system, adjusted as described herein, in operation.

C. Automatic Controls: Automatic control valves shall be positioned for full flow through the heat transfer equipment of the system during tests.

D. Flow: Flow through bypass circuits at three-way valves shall be adjusted to equal that through the supply circuit, when the valve is in the bypass position.

E. Distribution: Adjustment of distribution shall be effected by means of balancing devices (cocks, valves, and fittings) and automatic flow control valves as provided; service valves shall not be used.

1. Where automatic flow control valves are utilized in lieu of Venturi tubes, only pressure differential need be recorded, provided that the pressure is at least the minimum applicable to the tag rating.

F. Special Procedures: Where available pump capacity (as designed) is less than total flow requirements of individual heat transfer units of system served, full flow may be simulated by the temporary restriction of flow to portions of the system; specific procedures shall be delineated in the agenda.

3.04 HEAT EXCHANGER CAPACITY VERIFICATION

A. Air coil capacities shall be verified from air side measurement data. Capacities of coils shall be the difference of the energy carried by the air between the up stream and down stream of the coils.

B. The measured air flow rate for the fan may be used for air coil capacity calculations providing no ducted bypassing of coil is occurring.

C. Capacity verifications shall be performed after air and water systems have been balanced. Heat exchangers using steam as the exchange medium shall have the steam measured and adjusted to the specified pressure.

D. False load shall be applied if the upstream air or water does not meet the specified conditions at the time of test.

3.05 REPORTS

A. Submittals: Three copies of the reports described herein, covering air and water system performance, air motion (fpm), and sound pressure levels, shall be submitted prior to final tests and inspection.

B. Instrument Records: Types, serial numbers, and dates of calibration of all instruments shall be included.

C. Reports: Reports shall conspicuously identify items not conforming to contract requirements, or obvious malfunction and deficiencies.

3.06 AIR SYSTEM DATA

A. Report: The report shall include for each air handling system the data listed below.

1. Equipment (Fan or Factory Fabricated Station Unit):

    a. Installation data

        1) Manufacturer and model
        2) Size
        3) Arrangement, discharge and class
        4) Motor hp, voltage, phase, cycles, and full load amps
        5) Location and local identification data

    b. Design data

        1) Data listed in schedules on drawings and specifications.

    c. Fan recorded (test) data

        1) cfm
        2) Static pressure
        3) rpm
        4) Motor operating amps motor operating bhp

2. Duct Systems:

    a. Duct air quantities (maximum and minimum) - main, submains, branches, outdoor (outside) air, total air, and exhaust

        1) Duct size(s)
        2) Number of Pitot tube (pressure measurements)
        3) Sum of velocity measurements (Note: Do not add pressure measurements)
        4) Average velocity
        5) Recorded (test) cfm design cfm

    b. Individual air terminals

        1) Terminal identification supply or exhaust, location and number designation
        2) Type size, manufacturer and catalog identification applicable factor for application, velocity, area, etc., and designated area
        3) Design and recorded velocities- fpm (state "core," "inlet," etc., as applicable)
        4) Design and recorded quantities -cfm deflector vane or diffusion cone settings

3.07 WATER SYSTEM DATA

A. Report: The certified report for each water system shall include the data listed below.

1. Pumps:

    a. Installation data

        1) Manufacturer and model
        2) Size
        3) Type drive
        4) Motor hp, voltage, phase, and full load amps

    b. Design data

        1) gpm

2) Head
3) rpm, bhp, and amps

c. Recorded data

1) Discharge pressures (full-flow and no-flow)
2) Suction pressures (full-flow and no-flow) operating head
3) Operating gpm (from pump curves if metering is not provided) no-load amps (where possible)
4) Full-flow amps
5) No-flow amps

2. Air Heating and Cooling Equipment:

a. Design data

1) Load in Btu or MBh
2) gpm
3) Entering and leaving water temperature
4) Entering and leaving air conditions (DB and WB)

b. Recorded data

1) Type of equipment and identification (location or number designation)
2) Entering and leaving air conditions (DB and WB)
3) Entering and leaving water temperatures

3. Water Chilling Units:

a. Installation data

1) Manufacturer and model
2) Motor hp, voltage, cycles, phase, and full load amps
3) Part load amperes
4) gpm - chiller and condenser
5) Water pressure drop - chiller and condenser
6) Entering and leaving water temperature - chiller and condenser

b. Recorded data (chiller and condenser)

1) gpm
2) Water pressure drop
3) Entering and leaving water temperature
4) Amperes

3.08 FINAL COMMISSIONING TESTS, INSPECTIONS AND ACCEPTANCE

A. Scope: Test shall be made to demonstrate that capacities and performance of air and water systems comply with contract requirements.

1. At the time of final inspection, recheck random selection of data (water and air quantities, air motion, and sound levels) recorded in the balancing report. All laboratories shall be rechecked for satisfactory air flow and motion on vicinity of and through hoods.

2. Points and areas for recheck shall be selected by the Owner's Representative.

3. Measurement and test procedures shall be the same as approved for work forming basis of certified report.

4. Selections for recheck (specific plus random), in general, will not exceed 25 percent of the total number tabulated in the report, except that special air systems may require a complete recheck for safety reasons.

B. Retests: If random tests elicit a measured flow deviation of 10 percent or more from, or a sound level of 2 db or more greater than, that recorded in the report listings, as 10 percent or more of the rechecked selections, the report shall be automatically rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, new certified reports submitted, and new inspection tests made, all at no additional cost.

C. Marking of Settings: Following final acceptance of balance reports, the settings of all valves, splitters, dampers, and other adjustment devices shall be permanently marked so that adjustment can be restored if disturbed at any time. Devices shall not be marked until after final acceptance.

END OF SECTION

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

SECTION 230700 – HVAC INSULATION

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Duct Insulation.

B. Pipe Insulation.

C. Equipment and Specialties Insulation.

D. Acoustical Wrap.

1.02 RELATED WORK

A. Division 23 – Mechanical, General

B. Division 23 – Hangers and Supports

C. Division 23 – Sleeves and Seals

D. Division 23 – Pumps

E. Division 23 – Refrigerant Piping System

F. Division 23 – Ductwork

1.03 DEFINITIONS

A. R: Thermal resistance of insulation, in units of hr-sf-deg F/Btu.

B. Run-out: Piping not more than 12 feet long that runs to an individual unit.

C. Subject to Damage: Items installed exposed less than 8 feet above the walking surface (i.e., floor platform, roof, grade, etc.) adjacent to the item.

1.04 QUALITY ASSURANCE

A. All insulation and materials shall have a fire hazard rating not to exceed 25 for flame spread and 50 for smoke development, as tested by ASTM E 84, NFPA 255, and UL 723.

1.05 SUBMITTALS

A. All submittals shall comply with Section 230000.

B. Provide product data on all insulation materials to be used. Indicate thickness to be used.

1.06 GENERAL REQUIREMENTS

A. Code Compliance: Contractor shall insulate all systems with the materials and thicknesses as required by code, but in no case shall the insulation be less than that specified herein. In some cases the specified insulation exceeds code, and shall be provided as specified. Not all systems

requiring insulation by code are specified but shall be provided with insulation where required by code.

B. Insulation at Hangers: Insulation shall be continuous through hangers on all insulated systems (except ductwork). Inserts at hangers are specified in Section 230300 and are considered as part of the hanger and support system. Inserts are required to be installed at the time of pipe installation and are intended to be installed by the Contractor installing the pipe hanger/supports. See Section 230300.

C. All adhesives, sealants, mastics and similar materials shall be low-VOC type and comply with Section 230000 Low-VOC requirements.

1.07 REFERENCES

A. ASTM A 653: Standard Specification For Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.

B. ASTM B 209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

C. ASTM C 547: Standard Specification for Mineral Fiber Pipe Insulation.

D. ASTM C 1136: Standard Specifications for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.

E. ASTM C 1290: Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.

F. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials.

G. NCIIS: National Commercial & Industrial Insulation Standards, published by Midwest Insulation Contractors Association, 5th Edition.

H. NFPA 255: Standard Method of Test of Surface Burning Characteristics of Building Materials.

I. UL 723: Tests For Surface Burning of Building Materials.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Products shall comply with Section 230000.

B. Insulation: Johns Manville, Armacell, Owens-Corning, Knauf, Pittsburgh Corning, GLT, Halstead, Thermal Pipe Systems.

C. Accessories: Johns Manville, Armacell, Owens-Corning, Knauf, Pittsburgh Corning, GLT, Halstead, Duro Dyne, Gustin Bacon, Childers, RPR, Tee Cee, JPS, Buckaroos.

D. Acoustical Wrap: Kinetics Noise Control.

E. Fire Protection Duct Wrap: 3M.

2.02 DUCT INSULATION

A. Flexible Glass Fiber:

B. Material: Inorganic glass fibers, bonded with a thermosetting resin.

C. Jacket: All-purpose, factory-applied, laminated glass-fiber- reinforced, flame-retardant kraft paper and aluminum foil having self-sealing lap.

D. Board: ASTM C 612, Class 2, semi-rigid jacketed board.

1. Thermal Conductivity: 0.23 Btu x inch/h x sq. ft. x deg F average maximum at 75 deg F mean temperature.

2. Density: 3 pcf average maximum.

E. Blanket: ASTM C 553, Type II, Class F-1, jacketed flexible blankets. (maximum 25% compression installed)

1. Thermal Conductivity: 0.23 Btu x inch/h x sq. ft. x deg F average maximum at 75 deg F mean temperature.

F. Adhesive: Produced under the UL Classification and follow-up service.

1. Type: Non-flammable, water-based.
2. Service Temperature Range: Minus 20 to 180 deg F (Minus 29 to 82 deg C).

G. Vapor Barrier Coating: Waterproof coating recommended by insulation manufacturer for outside service.

2.03 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Woven glass fiber fabrics, plain weave, pre-sized a minimum of 8 ounces per sq. yd.

1. Tape Width: 4 inches
2. Cloth Standard: MIL-C-20079H, Type I.
3. Tape Standard: MIL-C-20079H, Type II.

B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:

1. Stainless Steel: Type 304, 0.020 inch thick.
2. Aluminum: 0.0070 inch thick.

C. Wire: 14-gauge nickel copper alloy, 16-gauge, soft-annealed stainless steel, or 16-gauge, soft annealed galvanized steel.

D. Corner Angles: 28-gauge (0.3 mm), 1 inch by 1 inch (25 mm by 25 mm) aluminum, adhered to 2 inches by 2 inches (51 mm by 51 mm) kraft paper.

E. Anchor Pins: Capable of supporting 20 pounds each. Provide anchor pins and speed washers of sizes and diameters as recommended by the manufacturer for insulation type and thickness.

2.04 SEALING COMPOUNDS

A. Vapor Barrier Compound: Water-based, fire-resistive composition.

1. Water Vapor Permeance: 0.08 perm maximum.
2. Temperature Range: Minus 20 to 180 deg F.

B. Weatherproof Sealant: Flexible-elastomer-based, vapor-barrier sealant designed to seal metal joints.

1. Water Vapor Permeance: 0.02 perm maximum.
2. Temperature Range: Minus 50 to 250 deg F.
3. Cooler: Aluminum.

C. Duct Insulation installed R values:

1. General: Provide insulation densities and thicknesses to achieve the following R values. R values are for the insulation only, in their installed thickness, considering installed duct wrap stretch and in accordance with code.

2. Lining: Where ducts have internal lining, the insulating properties of the lining may be credited toward meeting the required insulation R value.

3. Supply Air Ductwork:

a. Inside Building and within conditioned space: No insulation required.

b. Inside Building but not within conditioned space: R-6.

4. Return Air Ductwork:

a. Inside Building and within conditioned space: No insulation required.

b. Inside Building but not within conditioned space: R-6.

5. Outside Air Ductwork: Same insulation for ducts within conditioned space: R-8.

6. Exhaust and Relief Ductwork:

a. Inside Building and within conditioned space: No insulation required except ductwork from the system's backdraft damper (or motorized damper) to outside the building shall be insulated with R-8 insulation.

b. Inside Building but Not within conditioned space: R-6.

2.05 PIPE INSULATION

A. Glass Fiber:

1. Type: Rigid molded type, constructed of glass fibers bonded by a thermosetting resin, complying with ASTM C 1290, Type III. Insulation factory molded to match pipe size applied to. Johns Manville "Micro- Lok" (or approved).

2. Jacket: ASJ type, vapor proof, consisting of a white kraft paper cover reinforces with glass fiber and bonded to aluminum foil, with longitudinal self-sealing closure system. Provide with butt strips constructed of jacket material with adhesive to seal all joints. Water vapor permeance shall not exceed 0.02 perms.

3. Thermal Conductivity: Shall not exceed 0.24 Btu-in/hr-sq ft-deg F at 75° F.

4. Operating Temperature Limits: 0° F to 850° F.

B. Elastomeric Insulation:

1. Type: Flexible cellular elastomeric insulation, factory formed to match pipe sizes applied to, complying with ASTM C 534, Type 1. Armacell “AP/Armaflex SS”, Armaflex Shield (or approved equal).

2. Thermal Conductivity: Shall not exceed 0.27 Btu-in/hr-sq ft-deg F at 75° F.

3. Water Vapor Transmission: Water vapor permeance shall not exceed 0.08 perms.

4. Operating Temperature Limits: -20° F to 180° F.

5. Weather Protection: Where installed outdoors provide Zeston 2000 PVC cover.

C. Pipe Fittings:

1. Insulate with mitre cut or premolded fitting insulation of same material and thickness as pipe insulation.

D. Pipe Insulation Types:

1. Aboveground-Inside Building:

a. Hydronic Piping Systems: Glass fiber.

b. Cooling Coil Condensate: Glass fiber or elastomeric.

c. Refrigerant Piping: Elastomeric.

d. Other Systems: Glass fiber.

E. Pipe Insulation Thickness:

COLD SERVICE INSULATION MATERIAL SCHEDULE

TYPE	SERVICE AND TEMPERATURES	INSULATION MATERIAL	PIPE SIZES (INCHES)	MINIMUM (NOMINAL) INSULATION THICKNESS (INCHES)
A & B	Refrigerants, Brine, and Fluids below 40 F.	Flex. Elastomeric Foam	Less than 8 8 and Up	1 1-1/2
C	Chilled Water, domestic cold water, and other fluids 40 F to 80 F.	Flex. Elastomeric Foam or Fibrous Glass	All sizes	1

HOT SERVICE INSULATION MATERIAL SCHEDULE

	SERVICE AND TEMPERATURES	INSULATION MATERIAL	PIPE SIZES (INCHES)	MINIMUM (NOMINAL) INSULATION THICKNESS (INCHES)
D	Domestic Hot water, Domestic Hot Water recirculating, and other fluids 105 F to 140 F.	Flex. Elastomeric Foam or Fibrous Glass	Less than 1-1/2 1-1/2 &over	1 1-1/2
E	Heating hot water, and other fluids 141 F to 200 F.	Fibrous Glass	Less than 1-1/2 2 &over	1-1/2 2
F	Steam (LPS) to 15 psig 201 F-250 F	Fibrous Glass	Less than 4 4 & Up	2-1/2 3
G	Water and other fluids 251 F to 350 F.	Fibrous Glass	Less than 1 1 & Up	2 4-1/2
H	Water and other fluids Above 350 F.	Fibrous Glass	Less than 1 1 & Up	4-1/2 5

1. Provide minimum piping insulation thickness indicated, in inches.
2. Where a system operates over temperature ranges calling for different insulation thicknesses, the thicker insulation requirements shall be met.
3. Cooling system condensate piping (i.e., from a cooling coil) shall be considered to operate at 53° F.
4. Refrigerant piping (RG or RS piping) returning from an evaporator (i.e., cooling coil) to a compressor shall be considered to operate at 40° F.
5. Outdoor Piping: Piping exposed to outside air or located outside the building/thermal envelope, shall have insulation thickness increased by 0.5 inch from that indicated above.
6. Hydronic heat pump piping shall be considered to operate at 120° F (unless noted otherwise).
7. Cold water piping shall be considered to operate at 56° F (unless noted otherwise).

F. Underground piping:

1. Underground chilled water and hot water:

a. All underground pre-insulated pipe 1 1/2” – 12” shall be similar to thermal pipe systems, inc. heat-tite® piping with ring-tite joints.

b. Steel carrier pipe shall be black steel of the type, grade, and class specified by the design engineer. the pipe shall be suitable for use at maximum hydrostatic working pressure of 150 psi at 250ºf.

c. Each joint shall automatically provide for expansion and contraction through the ethylene propylene diene monomer (epdm) sealing rings in the grooves of the pre-insulated ductile iron coupling.

d. Casing pipe shall be [polyvinyl chloride (pvc) meeting the minimum classification requirements of astm d-1784] or [high density polyethylene (hdpe)]. the thickness shall be in accordance with the thermal pipe systems published data.

e. The insulation shall be polyurethane foam completely encapsulated on each end by a compression rubber end seal.

f. The rubber end seals shall be an ethylene propylene diene monomer (epdm) heat resistant compound.

g. Fittings may be uninsulated using welded steel or ductile iron class 150 fitting with a groove and rubber ring. fittings may also be pre-insulated by thermal pipe systems, inc. using the same carrier pipe, insulation thickness, and casing as the straight lengths of pipe.

h. After completion of hydrostatic testing, joints shall be closed using factory supplied 30 mil high temperature tape. it shall be applied circumferentially around the seam between the coupling and pipe casing.

2. Underground steam and steam condensate piping:

a. All underground pre-insulated steam and condensate pipe 3” – 12” shall be similar to thermal pipe systems, inc. super temp-tite® piping with ring-tite joints.

b. Steel carrier pipe shall meet the requirements of astm a-53 or a-106, grade b. each end of the carrier pipe shall be machined and metalized to provide a non-corrosive surface for the sealing rings. the metalizing shall be high nickel alloy applied to an excess thickness and then machined to the required outside diameter.

c. Each joint shall automatically provide for expansion and contraction through the sealing rings in the grooves of the bronze joining coupling. the sealing rings shall be stainless steel spring loaded molded and machined teflon. pipe must be assembled with the lubricant supplied by thermal pipe systems, inc.

d. Casing pipe shall be fiberglass reinforced thermosetting resin pipe (rtrp) manufactured by a filament winding process. the pipe shall be wound to meet astm d2310 classified rtrp-12e.

e. The composite insulation shall be a twocomponent system. the initial insulation shall be calcium silicate satisfactory for temperatures to 1200ºf and shall conform to astm c-533 and mil spec mil-1-2781. the secondary insulation shall be polyurethane foam completely filling the void between the calcium silicate and casing.

f. The rubber end seals shall be a highly saturated hitrile (hsn) or ethylene propylene diene monomer (epdm) heat resistant compound.

g. Fittings shall be pre-insulated by thermal pipe systems, inc. using the same carrier pipe, insulation thickness, and casing as the straight lengths of pipe.

2.06 EQUIPMENT AND SPECIALTIES INSULATION

A. Flexible Glass Fiber:

1. Type: Flexible blanket insulation, constructed of inorganic glass fibers bonded by a thermosetting resin, complying with ASTM C 553, Type III. Johns Manville “812 Spin-Glas” (or approved).

2. Jacket: FSK type, vapor proof, consisting of an aluminum foil cover reinforces with glass fiber mesh, and laminated to kraft. Water vapor permeance shall not exceed 0.05 perms. Provide with joint sealing tape constructed of jacket material with adhesive to seal all joints.

3. Thermal Conductivity: Shall not exceed 0.24 Btu-in/hr-sq ft-deg F at 75° F.

4. Operating Temperature Limits: 40° F to 450° F.

5. Density: 1.5 lb/cu ft.

B. Elastomeric:

1. Type: Flexible cellular elastomeric insulation, complying with ASTM C 534, Type II.

2. Thermal Conductivity: Shall not exceed 0.30 Btu-in/hr-sq ft-deg F at 75° F.

3. Water Vapor Transmission: Water vapor permeance shall not exceed 0.08 perms.

4. Operating Temperature Limits: -20° F to 220° F.

5. Weather Protection: Where installed outdoors provide with manufacturer’s weather proof coating to protect from UV and weather exposure.

C. Removable Insulation Blankets:

1. Type: Flexible blanket insulation pads, for insulating valves, unions, strainers, and similar items. Constructed of exterior fabric enclosure sewn around interior insulation, held in position with a closure system that allows for removal of the blanket. Contractor or factory fabricated.

2. Enclosure:

a. Hot Applications: Glass fiber mat, ¼ inch thick, noncombustible, service temperature up to 1200° F. JPS Glass Fabrics “Glastex 2025” (or approved).

b. Cold Application: Silicone impregnated glass fiber cloth, water resistant, ¼ inch thick. Claremont “Claretex SL” (or approved).

3. Insulation: Thermal insulating wool, 1-inch thick, complying with ASTM C 553. Maximum thermal conductivity 0.22 Btu-in/hr-sq ft-deg F at 75° F. Provide in layers to give equivalent R value to the adjacent insulated piping. Owens Corning “Fiberglass Brand TIW, Type II”.

4. Closure System: Steel lacing anchors with spindles and self-locking washers, fabricated of minimum 14 gauge stainless steel, with stainless steel wire ties. AGM Industries “Series NLA” (or approved).

D. Metal Jacket:

1. Steel: Minimum 24 gauge galvanized steel complying with ASTM A 653. Provide with longitudinal slip joints and 2-inch laps.

2. Aluminum: Minimum 0.020-inch thick aluminum, alloy 3003 or 5005, complying the ASTM B 209. Provide with longitudinal slip joints and 2- inch laps.

E. Equipment and Specialties Insulation Types and Thickness:

1. Unless a specific type of insulation is specified or noted, any of the insulation materials specified in this specification section may be used provided such application is in conformance with NCIIS.

2. Insulation Thickness: Insulation thickness shall be the same as that specified for the piping or ductwork connected to item, or as specified for the system the item is installed in (unless noted otherwise). Insulation thickness shall in no case be less than 1 inch thick.

3. Valves:

a. 2 inches and Smaller: Insulate with same material as piping system.

b. 2-1/2 inches and Larger: Removable blanket insulation.

4. Control Valves: Removable blanket insulation.

5. All equipment and specialties where access is required shall have removable insulation blankets; other removable insulation materials per NCIIS may be used where pre-approved by the Engineer. Items requiring such removable insulation include, but are not limited to, the following:

a. Strainers.

b. Pumps.

c. Balancing valves.

d. Pressure/temperature/flow measuring devices.

e. Pump suction diffusers.

f. Heat exchanger heads.

2.07 ACCESSORIES

A. Adhesive, Caulks, Mastics, and Coatings: As recommended by insulation material manufacturer and suited for the application.

B. Bands: ½ inch wide, of stainless steel, galvanized steel, or aluminum construction, to match with materials used with.

C. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor- discharge welding and galvanized speed washer. Pin length shall be as required for insulation thickness used with. Welded pin holding capacity 100 lb., for direct pull perpendicular to the attached surface. Style and type to suit application.

D. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness used with. Adhesive as recommended by the anchor pin manufacturer as appropriate for surface temperatures and materials used with, and to achieve a holding capacity of 100 lb for direct pull perpendicular to the adhered surface. Style and type to suit application.

2.08 ACOUSTICAL WRAP

A. Type: Composite material having an outer foil faced sound barrier wrap with an internal sound decoupling insulation. Kinetics Noise Control KNM-100ALQ (or equal).

B. Construction: Outer sound barrier material shall be flexible 1.10 inch think, 1 lb/sf (minimum) barium sulfate loaded limp vinyl sheet, bonded to an outside layer of aluminum foil. Interior sound decoupling insulation shall be 1-inch-thick fiberglass batting quilted to a non-woven porous scrim-coated glass cloth in a 4-inch diamond stitch pattern. Material shall be suitable for temperatures form 40 to 200 degrees F.

C. Acoustic Rating: STC (sound transmission coefficient) 28 (or better).

D. Vibration Damping Material: Kinetics Noise Control KDD or DKC-E-162.

PART 3 – EXECUTION

3.01 GENERAL

A. Pre-Insulation Review: No covering materials shall be applied until systems to be covered have had all tests satisfactorily completed, have had all required inspections, and have been satisfactorily reviewed by the Architect-Engineer. All systems shall be examined by the Contractor to confirm cleanliness and other conditions are appropriate to allow for insulation installation.

B. Insulation Work Review: No insulated items shall be concealed in the building structure or buried until the insulation work has been satisfactorily reviewed by the Architect-Engineer, and has had all required inspections.

C. Standards: Materials shall be installed in accordance with manufacturers' written instructions, NCIIS, and shall comply with materials and methods specified herein. The more stringent requirements govern.

D. Joints/Seams: Joints shall be staggered on multi layer insulation. Locate seams and joints in least visible location.

E. Insulation Protection: Insulation shall be kept clean and dry and shall be protected from dirt, damage, and moisture. Insulation that becomes dirty, damaged, or wet and cannot be restored to like new condition will be rejected, and shall immediately be removed from the jobsite.

F. Insulation Interruptions: Insulation shall be neatly finished at all supports, protrusions and interruptions. Provide adhesive and tape seal to maintain vapor barrier integrity.

G. Equipment and Floor Protection: Cover existing equipment and finished floors to protect such items from insulation fiber and dust. Keep all such existing areas in a "broom clean" condition at the end

of each day. Take precautions in these areas to prevent glass fiber and insulation dust from entering ventilation systems or areas adjacent to the work.

H. Glass Fiber Insulation – General:

1. Finish all insulation ends with joint sealing tape or vapor barrier mastic, no raw edges allowed.

2. Joints: Tightly butt adjacent insulation sections together without any voids. Provide overlap of jacket material over all joints.

I. Items To Be Insulated: Provide insulation on all ductwork, all piping, all items installed in these duct and piping systems, all air and liquid energy conveying systems and components, all air and liquid energy storage, all equipment, and all energy consuming devices specified as part of Division 15, except where such insulation has been specifically excluded.

J. Items Excluded From Being Insulated:

1. Fire Sprinkler piping (except where heat traced).

2. Sanitary sewer drain lines (except traps at handicap accessible fixtures).

3. Factory pre-insulated underground piping.

4. Stops and risers at plumbing fixtures (except at handicap accessible fixtures).

5. Factory insulated water heaters (except for base on electric water heaters).

6. Factory insulated tanks.

7. Electric motors.

8. Fans.

9. Factory insulated or factory lined air handler (heat pumps).

10. Overflow condensate drains.

11. Pumps.

12. Relief valves and associated drain piping.

13. Hose bibs (except where used as drains hot water systems).

14. Water meter.

15. Underground cold water piping and associated underground items.

16. Underground hydronic system piping, 5 feet beyond building foundation wall.

3.02 DUCT INSULATION INSTALLATION

A. Types and Thickness: Insulate all ducts with insulation type and thickness (to provide the required R value listed in this specification.

B. General: Insulation shall be firmly butted at all joints. All longitudinal seams for flexible insulation shall overlap a minimum of 2 inches. All joints and seams shall be finished with appropriate joint sealing tape.

C. Attachment: For rectangular ducts over 24 inches wide, duct insulation shall be additionally secured to the bottom of the ductwork with mechanical fasteners on 18 inch centers to reduce sagging. Washers shall be applied without compressing the insulation. Protruding ends of fasteners shall be cut off flush after washers are installed. All seams, joints, penetrations, and damage to the facing shall be sealed with joint sealing tape or vapor retardant mastic or appropriate joint sealing tape.

3.03 PIPE INSULATION INSTALLATION

A. Types and Thickness: Insulate all piping with insulation type and thickness as specified in “Part 2 – Products”. All piping shall be insulated except where specifically excluded.

B. General: All ends shall be firmly butted together and secured with joint sealing tape. All jacket laps and joint sealing tape shall be secured with outward clinch staples at 4 inch spacing, or by use of a suitable adhesive. Seal all jacket penetrations with vapor barrier mastic.

C. Elastomeric Pipe Insulation: Flexible elastomeric cellular insulation shall be installed with seams and joints sealed with rubberized contact adhesive. Insulation with pre-applied adhesive is not permitted. Insulation exposed to weather and not shown to have jacketing shall be protected with UV resistant PVC jacketing as recommended by the manufacturer after the adhesive is dry and cured. A brush coating of adhesive shall be applied to both butt ends to be joined and to both split surfaces to be sealed. The adhesive shall be allowed to set until dry to touch but tacky under slight pressure before joining the surfaces. Insulation seals at seams and joints shall not be capable of being pulled apart one (1) hour after application. Insulation that can be pulled apart one (1) hour after installation shall be replaced.

D. Pipe Hangers: Provide insulation tight up to pre-insulated pipe supports at pipe hangers; seal all joints with joint sealing tape.

E. Pipe Sleeves: Run insulation continuous full size through sleeve. Coordinate work with fire seal work and confirm fire sealant system is approved for use with insulated pipes; see Division 23.

3.04 EQUIPMENT AND SPECIALTIES INSTALLATION

A. Types and Thickness: All equipment and items installed in insulated duct and piping systems shall be insulated except where specifically noted not to be; reference paragraph 3.01. Insulation type and thickness shall be as specified in “Part 2 – Products”.

B. General: Apply insulation as close as possible to equipment by grooving, scoring, and beveling as necessary. As required, secure insulation to equipment with studs, pins, clips adhesive, wires or bands. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. Comply with NCIIS.

C. Removable: All equipment and specialties where access is required for maintenance, repair, service, or cleaning shall have insulation installed so that it can be easily removed and reinstalled without being damaged and without requiring new insulation.

D. Handicap Lavatories: Insulate P-trap and HW supplies below lavatory where exposed.

E. Nameplates: Do not insulate over nameplate or ASME stamps; bevel and seal insulation around.

F. Jacketing: Provide all equipment with vapor retardant jackets.

3.05 ACOUSTIC WRAP

A. Install in accordance with manufacturers written instruction and NCIIS.

B. On ductwork less than 20 gauge, apply vibration damping material on outside of duct before applying thermal insulation or acoustic wrap.

C. Overlap all interior sound insulation joints with a minimum 2 inch overlap of the exterior sound barrier.

D. Acoustical insulation shall not be compressed.

E. Where installed on ducts requiring thermal insulation, install thermal insulation over acoustic wrap.

END OF SECTION

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

SECTION 230800 – COMMISSIONING OF HVAC

PART 1 – GENERAL

1.01 DESCRIPTION

A. The purpose of this section is to specify Division 23 responsibilities in the commissioning process.

B. The systems to be commissioned are shown on the Drawings and noted in Section 230590 and Section 230593.

C. Commissioning requires the participation of Division 23 to ensure that all systems are operating in a manner consistent with the Contract Documents. Division 23 shall be familiar with all parts of Division 01 and the commissioning plan issued by the CA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

D. The commissioning process shall be performed in accordance with the latest Energy Code of New York State.

E. An approved agency or design professional shall perform the commissioning. The Commissioning Agent shall not be affiliated with the Contractor.

1.02 RESPONSIBILITIES

A. Mechanical, Controls and TAB Contractors. The commissioning responsibilities applicable to each of the mechanical, controls and TAB contractors of Division 23 are as follows (all references apply to commissioned equipment only):

1. Construction and Acceptance Phases

a. Include and itemize the cost of commissioning in the contract price.

b. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.

c. Attend a commissioning scoping meeting and other meetings necessary to facilitate the Cx process.

d. Contractors shall provide the CA with normal cut sheets and shop drawing submittals of commissioned equipment.

e. Provide additional requested documentation, prior to normal O&M manual submittals, to the CA for development of start-up and functional testing procedures.

1) Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent.

2) The Commissioning Agent may request further documentation necessary for the commissioning process.

3) This data request may be made prior to normal submittals.

f. Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the CA for review and approval.

g. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

h. Provide limited assistance to the CA in preparing the specific functional performance test procedures. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

i. Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the construction checklists from the CA for all commissioned equipment. Submit to CA for review and approval prior to startup. Refer to Section 230590 and Section 230593 for further details on start-up plan preparation.

j. During the startup and initial checkout process, execute the mechanical-related portions of the construction checklists for all commissioned equipment.

k. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CA.

l. Address current A/E punch list items before functional testing. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.

m. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

n. Provide skilled technicians to perform functional performance testing under the direction of the CA for specified equipment specified to be commissioned. Assist the CA in interpreting the monitoring data, as necessary.

o. Correct deficiencies (differences between specified and observed performance) as interpreted by the CA, OR and A/E and retest the equipment.

p. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

q. During construction, maintain as-built red-line drawings for all drawings and final CAD as-builts for contractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing).

r. Provide training of the Owner's operating staff using expert qualified personnel, as specified.

s. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

2. Warranty Period

    a. Execute seasonal or deferred functional performance testing, witnessed by the CA, according to the specifications.

    b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

B. Mechanical Contractor. The responsibilities of the HVAC mechanical contractor, during construction and acceptance phases in addition to those listed in (A) are:

1. Provide startup for all HVAC equipment, except for the building automation control system.

2. Assist and cooperate with the TAB contractor and CA by:

    a. Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.

    b. Including cost of sheaves and belts that may be required by TAB.

    c. Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Providing an approved plug.

    d. Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.

3. Install a P/T plug at each water sensor, which is an input point to the control system.

4. List and clearly identify on the as-built drawings the locations of all airflow stations.

5. Prepare a preliminary schedule for Division 23 pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CA. Update the schedule as appropriate.

6. Notify the OR or CA depending on protocol, when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the OR or CA, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the CA has the scheduling information needed to efficiently execute the commissioning process.

C. Temperature Controls Contractor. The commissioning responsibilities of the Temperature Controls Contractor, during construction and acceptance phases in addition to those listed in (A) are:

1. Sequences of Operation Submittals. The Temperature Controls Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:

    a. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.

    b. All interactions and interlocks with other systems.

c. Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.

d. Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative).

e. Start-up sequences.

f. Warm-up mode sequences.

g. Normal operating mode sequences.

h. Unoccupied mode sequences.

i. Shutdown sequences.

j. Capacity control sequences and equipment staging.

k. Temperature and pressure control: setbacks, setups, resets, etc.

l. Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.

m. Effects of power or equipment failure with all standby component functions.

n. Sequences for all alarms and emergency shut downs.

o. Seasonal operational differences and recommendations.

p. Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.

q. Schedules, if known.

r. To facilitate referencing in testing procedures, all sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered.

2. Control Drawings Submittal

a. The control drawings shall have a key to all abbreviations.

b. The control drawings shall contain graphic schematic depictions of the systems and each component.

c. The schematics will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.

d. Provide a full points list with at least the following included for each point:

1) Controlled system
2) Point abbreviation

3) Point description
4) Display unit
5) Control point or setpoint (Yes / No)
6) Monitoring point (Yes / No)
7) Intermediate point (Yes / No)
8) Calculated point (Yes / No)

a) Key:
b) Point Description: DB temp, airflow, etc.
c) Control or Setpoint: Point that control equipment and can have its setpoint changed (OSA, SAT, etc.)
d) Intermediate Point: Point whose value is used to make a calculation which then controls equipment (space temperatures that are averaged to a virtual point to control reset).
e) Monitoring Point: Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification.
f) Calculated Point: "Virtual" point generated from calculations of other point values.

The Temperature Controls Contractor shall keep the CA informed of all changes to this list during programming and setup.

3. An updated as-built version of the control drawings and sequences of operation shall be included in the final controls O&M manual submittal.

4. Assist and cooperate with the TAB contractor in the following manner:

   a. Meet with the TAB contractor prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB. Provide the TAB any needed unique instruments for setting terminal unit boxes and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.).

   b. For a given area, have all required construction checklists, calibrations, startup and selected functional tests of the system completed and approved by the CA prior to TAB.

   c. Provide a qualified technician to operate the controls to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.

5. Assist and cooperate with the CA in the following manner:

   a. Using a skilled technician who is familiar with this building, execute the functional testing of the controls system. Assist in the functional testing of all equipment. Provide two-way radios during the testing.

   b. Execute all control system trend logs.

6. The Temperature Controls Contractor shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to functional performance. At minimum, the plan shall include for each type of equipment controlled by the automatic controls:

   a. System name.

   b. List of devices.

   c. Step-by-step procedures for testing each controller after installation, including:

1) Process of verifying proper hardware and wiring installation.

2) Process of downloading programs to local controllers and verifying that they are addressed correctly.

3) Process of performing operational checks of each controlled component.

4) Plan and process for calibrating valve and damper actuators and all sensors.

5) A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.

d. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has "passed" and is operating within the contract parameters.

e. A description of the instrumentation required for testing.

f. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the CA and TAB contractor for this determination.

7. Provide a signed and dated certification to the CA and OR upon completion of the checkout of each controlled device, equipment and system prior to functional testing for each piece of equipment or system, that all system programming is complete as to all respects of the Contract Documents, except functional testing requirements.

8. Beyond the control points necessary to execute all documented control sequences, provide monitoring, control and virtual points as specified in Section 230900.

9. List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air, water and building pressure).

D. TAB Contractor. The duties of the TAB contractor, in addition to those listed in (A) are:

1. Six weeks prior to starting TAB, submit to the OR the qualifications of the site technician for the project, including the name of the contractors and facility managers of recent projects the technician on which was lead. The Owner will approve the site technician's qualifications for this project.

2. Submit the outline of the TAB plan and approach for each system and component to the CA, OR and the Temperature Controls Contractor six weeks prior to starting the TAB. This plan will be developed after the TAB has some familiarity with the control system.

3. The submitted plan will include:

a. Certification that the TAB contractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system.

b. An explanation of the intended use of the building control system. The Temperature Controls Contractor will comment on feasibility of the plan.

c. All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.

d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.

e. Final test report forms to be used.

f. Detailed step-by-step procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch / submain proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow straighteners or relocating flow stations and sensors will be discussed. Provide the analogous explanations for the water side.

g. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.

h. Details of how total flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic, etc.).

i. The identification and types of measurement instruments to be used and their most recent calibration date.

j. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.

k. Confirmation that TAB understands the outside air ventilation criteria under all conditions.

l. Details of whether and how minimum outside air cfm will be verified and set, and for what level (total building, zone, etc.).

m. Details of how building static and exhaust fan / relief damper capacity will be checked.

n. Proposed selection points for sound measurements and sound measurement methods.

o. Details of methods for making any specified coil or other system plant capacity measurements.

p. Details of any TAB work to be done in phases (by floor, etc.), or of areas to be built out later.

q. Details regarding specified deferred or seasonal TAB work.

r. Details of any specified false loading of systems to complete TAB work.

s. Details of all exhaust fan balancing and capacity verifications, including any required room pressure differentials.

t. Details of any required interstitial cavity differential pressure measurements and calculations.

u. Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).

v. Plan for formal progress reports (scope and frequency).

w. Plan for formal deficiency reports (scope, frequency and distribution).

4. A running log of events and issues shall be kept by the TAB field technicians. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CA and OR at least twice a week.

5. Communicate in writing to the Temperature Controls Contractor all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.

6. Provide a draft TAB report within two weeks of completion. A copy will be provided to the CA. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC, NEBB or ASHRAE Standard 111.

7. Provide the CA with any requested data, gathered, but not shown on the draft reports.

8. Provide a final TAB report for the CA with details, as in the draft.

9. Conduct functional performance tests and checks on the original TAB.

E. Commissioning Team: The commissioning process will require cooperation of the Contractor, sub-contractors, vendors, Architect/ Engineer, Commissioning Agent, LEED Consultant (if applicable) and Owner.

1. The commissioning team shall be comprised of the following:

a. Contractor

1) Project Manager
2) Test Engineer

b. Subcontractors: As appropriate to product or system being commissioned.

c. Commissioning Agent

1) Project Manager
2) Project Engineers

d. Owner’s Representative(s)

e. LEED Consultant (if applicable)

f. Architect/ Engineer

1) Architect
2) MEP Engineers

PART 2 - PRODUCTS

2.01 TEST EQUIPMENT

A. Division 23 shall provide all test equipment necessary to fulfill the testing requirements of this Division.

PART 3 - EXECUTION

3.01 SUBMITTALS

A. Division 23 shall provide submittal documentation relative to commissioning as required in this Section Part 1, Section 013300.

3.02 STARTUP

A. The HVAC mechanical and Temperature Controls Contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in Section 230590 and Section 230593. Division 23 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning agent or Owner.

B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CA and OR. Beginning system testing before full completion, does not relieve the Contractor from fully completing the system, including all construction checklists as soon as possible.

3.03 TAB

A. Refer to the TAB responsibilities in Part 1.02 above.

3.04 PRE-FUNCTIONAL CHECKLIST

A. A list of items to inspect and elementary component tests to conduct to verify proper installation of equipment, provided by the Commissioning Agent to the contractor. Pre-functional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). However, some pre-functional checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three-phase pump motor of a chiller system). The word “pre-functional” refers to before functional testing. Pre-functional checklists augment and are combined with the manufacturer’s start-up checklist.

3.05 FUNCTIONAL PERFORMANCE TESTS

A. Test the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, etc. The systems are run through all the control system’s sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not functional testing, in the commissioning sense of the word. TAB’s primary work is setting up the system flows and pressures as specified, while functional testing is verifying that which has already been set up. The Commissioning Agent develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing contractor or vendor. Functional Performance Tests are performed after pre-functional checklists and startup are complete.

3.06 DEFICIENCY REPORT AND RESOLUTION RECORD

A. Deficiency Report and Resolution Record: Document items of non-compliance in materials, installation, or operation.

B. Non-Conformance. Non-conformance and deficiencies observed shall be addressed immediately, in terms of notification to responsible parties, and providing recommended actions to correct deficiencies.

1. Corrections of minor deficiencies identified may be made during the tests at the discretion of the Commissioning Agent. In such cases the deficiency and resolution shall be documented on the procedure form.

2. For identified deficiencies:

a. If there is no dispute on the deficiency and the responsibility to correct it:
   1) The Commissioning Agent documents the deficiency and the adjustments or alterations required to correct it. The contractor corrects the deficiency and notifies the Commissioning Agent that the equipment is ready to be retested.
   2) The Commissioning Agent reschedules the test and the test is repeated.

b. If there is a dispute about a deficiency or who is responsible:
   1) The deficiency is documented on the non-compliance form and a copy given to the Consultant.
   2) Resolutions are made at the lowest management level possible. Additional parties are brought into the discussions as needed. Contractor shall have responsibility for resolving construction deficiencies. If a design revision is deemed necessary and approved by Owner, Architect/Engineer shall have responsibility for providing design revision.
   3) The Commissioning Agent documents the resolution process.
   4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency and notifies the Commissioning Agent that the equipment is ready to be retested. The Commissioning Agent reschedules the test and the test is repeated until satisfactory performance is achieved.

3. Cost of Retesting: Costs for retesting shall be charged to the Contractor.

3.07 FINAL COMMISSIONING REPORTS

A. Two copies of the final commissioning reports must be provided to the engineer of record and owner.

B. Division 23 shall compile and prepare documentation for all equipment and systems covered in the O&M manuals, according to this section prior to the training of owner personnel.

C. The components of the Commissioning Report shall include the following and are defined as follows:

1. Executive summary of process and results of commissioning – including observations, conclusions and outstanding items.
2. History of any system deficiencies and how resolved.
   a. Include outstanding deficiencies and plans for resolution.
   b. Include plans for seasonal testing scheduled for a later date.
3. System performance test results and evaluations.
4. Summary of training completed and scheduled.
5. Attach commissioning process documents.

a. Commissioning Plan
b. OPR – Owner's Project Goals
c. BOD – Basis of Design
d. Executed installation checklists
e. Executed functional performance test compliance documents.
f. Recommendations for end-of-warranty review activities.

3.08 OPERATION AND MAINTENANCE (O&M) MANUALS

A. The following O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications.

B. Division 23 shall compile and prepare documentation for all equipment and systems covered in Division 23 and deliver this documentation to the GC for inclusion in the O&M manuals, according to this section.

C. The CA shall receive a copy of the O&M manuals for review.

D. Special Control System O&M Manual Requirements. In addition to documentation that may be specified elsewhere, the Temperature Controls Contractor shall compile and organize at minimum the following data on the control system in labeled 3-ring binders with indexed tabs.

1. Four copies of the controls training manuals in a separate manual from the O&M manuals.

2. Operation and Maintenance Manuals containing:

a. Specific instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. These instructions shall be step-by-step. Indexes and clear tables of contents shall be included. The detailed technical manual for programming and customizing control loops and algorithms shall be included.

b. Full as-built set of control drawings (refer to Submittal section above for details).

c. Full as-built sequence of operations for each piece of equipment.

d. Full points list. In addition to the updated points list required in the original submittals (Part 1 of this section), a listing of all rooms shall be provided with the following information for each room:

1) Floor
2) Room number
3) Room name
4) Air handler unit ID
5) Reference drawing number
6) Air terminal unit tag ID
7) Heating and/or cooling valve tag ID
8) Minimum cfm
9) Maximum cfm

e. Full print out of all schedules and set points after testing and acceptance of the system.

f. Full as-built print out of software program.

g. Electronic copy on disk of the entire program for this facility.

h. Marking of all system sensors and thermostats on the as-built floor plan and mechanical drawings with their control system designations.

i. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.

j. Control equipment component submittals, parts lists, etc.

k. Warranty requirements.

l. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).

3. The manual shall be organized and subdivided with permanently labeled tabs for each of the following data in the given order:

a. Sequences of operation
b. Control drawings
c. Points lists
d. Controller / module data
e. Thermostats and timers
f. Sensors and DP switches
g. Valves and valve actuators
h. Dampers and damper actuators
i. Program setups (software program printouts)

4. Field checkout sheets and trend logs should be provided to the CA for inclusion in the Commissioning Record Book.

E. Special TAB Documentation Requirements. The TAB will compile and submit the following with other documentation that may be specified elsewhere in the Specifications.

1. Final report containing an explanation of the methodology, assumptions, test conditions and the results in a clear format with designations of all uncommon abbreviations and column headings.

2. The TAB shall mark on the drawings where all traverse and other critical measurements were taken and cross reference the location in the TAB report.

F. Review and Approvals. Review of the commissioning related sections of the O&M manuals shall be made by the A/E and by the CA.

3.07 TRAINING OF OWNER PERSONNEL

A. Division 23 Contractor shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed.

B. The CA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment.

C. Mechanical Contractor. The mechanical contractor shall have the following training responsibilities:

1. Provide the CA with a training plan two weeks before the planned training.

2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC

equipment including, but not limited to, pumps, boilers, furnaces, chillers, heat rejection equipment, air conditioning units, air handling units, fans, terminal units, controls and water treatment systems, etc.

3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.

4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.

6. The Temperature Controls Contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

7. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.

8. Training shall include:

    a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.

    b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.

    c. Discussion of relevant health and safety issues and concerns.

    d. Discussion of warranties and guarantees.

    e. Common troubleshooting problems and solutions.

    f. Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.

    g. Discussion of any peculiarities of equipment installation or operation.

    h. The format and training agenda in The HVAC Commissioning Process, ASHRAE latest Guideline is recommended.

    i. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.

9. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.

10. The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.

11. Training shall occur after functional testing is complete, unless approved otherwise by the Project Manager.

12. Duration of Training. The mechanical contractor shall provide training on each piece of equipment according to the following schedule.

Hours	System
8	Chillers and System
8	Boilers and System
3	Piping Systems
4	Chemical Treatment
12	Air Handler Units
8	VRF Systems
12	Rooftop Units
4	Heat Exchangers
1	Spot Unit Heaters
2	Air Terminal Units
1	Central Exhaust Systems
2	Supplementary Fans
2	Pumps
16	Controls System
16	Control system Follow-up
4	Humidifiers

D. Temperature Controls Contractor. The Temperature Controls Contractor shall have the following training responsibilities:

1. Provide the Commissioning Agent, Architect/ Engineer and CM with a training plan four weeks before the planned training.

2. The Temperature Controls Contractor shall provide designated Owner personnel training on the control system in this facility. The intent is to clearly and completely instruct the Owner on all the capabilities of the control system.

3. Training manuals. The standard operating manual for the system and any special training manuals will be provided for each trainee, with three extra copies left for the O&M manuals. In addition, copies of the system technical manual will be demonstrated during training and three copies submitted with the O&M manuals. Manuals shall include detailed description of the subject matter for each session. The manuals will cover all control sequences and have a definitions section that fully describes all relevant words used in the manuals and in all software displays. Manuals will be approved by the CA. Copies of audiovisuals shall be delivered to the Owner.

4. The trainings will be tailored to the needs and skill-level of the trainees.

5. The trainers will be knowledgeable on the system and its use in buildings. For the on-site sessions, the most qualified trainer(s) will be used. The Owner shall approve the instructor prior to scheduling the training.

6. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

7. The Temperature Controls Contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

8. There shall be three training sessions:

   a. Training I. Control System. This training may be held on-site or in the supplier's facility. If held off-site, the training may occur prior to final completion of the system installation. Upon completion, each student, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.

   b. Training II. Building Systems. The second session shall be held on-site and will consist of actual hands-on training after the completion of system commissioning. The session shall include instruction on:

      1) Specific hardware configuration of installed systems in this building and specific instruction for operating the installed system, including HVAC systems, lighting controls and any interface with security and communication systems.

      2) Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing set points and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.

      3) All trending and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends. Trainees will actually set-up trends in the presence of the trainer.

      4) Every screen shall be completely discussed, allowing time for questions.

      5) Use of keypad or plug-in laptop computer at the zone level.

      6) Use of remote access to the system via phone lines or networks.

         a) Setting up and changing an air terminal unit controller.
         b) Graphics generation
         c) Point database entry and modifications
         d) Understanding DDC field panel operating programming (when applicable)

   c. Training III. The third training (Follow-up Training) will be conducted on-site six months after occupancy. The session will be structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system.

E. TAB The TAB contractor shall have the following training responsibilities:

1. TAB shall meet for 2 hours with facility staff after completion of TAB and instruct them on the following:

   a. Go over the final TAB report, explaining the layout and meanings of each data type.

   b. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.

c. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.

d. Discuss any temporary settings and steps to finalize them for any areas that are not finished.

e. Other salient information that may be useful for facility operations, relative to TAB.

3.08 DEFERRED TESTING

A. Unforeseen Deferred Tests:

1. If a test cannot be completed due to the building structure, required occupancy condition, of other deficiency, the functional testing may be delayed upon recommendation of the Commissioning Agent and the approval of the Owner. These tests are conducted in the same manner as the seasonal tests as soon as possible.

B. Seasonal Testing:

1. Schedule, coordinate, observe and document additional testing for seasonal variation in operations and control strategies during the opposite season to verify performance of the HVAC system and controls. Complete testing during the warranty period to fully test all sequences of operation.

C. Update O&M manuals and Record Documents as necessary due to testing.

3.09 WRITTEN WORK PRODUCTS

A. Written work products of Contractors will consist of the start-up and initial checkout plan and the filled out start-up, initial checkout and construction checklists.

END OF SECTION

Division 15 - Mechanical

Section 23 09 23 - AUTOMATIC TEMPERATURE CONTROL SYSTEMS

PART 1 - GENERAL

1.01 GENERAL

A. Furnish and install all temperature controls including all devices and accessories required for the installation / modification to a "Johnson" Metasys energy management and control system. All required work is to be performed by an authorized Johnson Metasys installer.

B. There is an existing Johnson Metasys DDC front-end system, currently serviced by the local factory Johnson branch. All new controls shall be Johnson Controls, Inc. DDC, as a seamless extension of the existing BMS. The controls contractor will provide all network wiring between the existing BMS and the new controls, and will provide all graphics, front-end programming to map up the new controls. The contractor will include all licenses as necessary to accommodate the new controls.

C. All new controls shall be of the DDC type unless specified otherwise. All DDC controls shall be manufactured by Johnson Controls Inc. The design make for the web-based front-end controller and all local DDC controllers is Johnson Controls Inc.

D. The ATC contractor shall be authorized by the system manufacturer and shall submit training certificates and current proof that the contractor is a *certified Johnson Controls Inc. Metasys installer / integrator*.

E. Control systems shall be complete in all respects, including all labor, materials, equipment and service necessary. The controls shall be of the DDC type unless otherwise specified.

F. Systems shall include, but not be limited to, all application specific controllers, transducers, transformers, cabinets, valves and operators, dampers and operators, relays, sensors, switches, wiring and terminals.

G. Installation shall include all control components, installation of all control wiring and pneumatic tubing. All wiring required for interlocking and interfacing controls with the equipment to be controlled, whether low voltage or line voltage; calibration and adjustment of all controls, dampers, linkages, etc. is part of this contract. 120v power wiring to controls is to be included under this contract.

H. All control wiring concealed in walls or run in open areas of machine rooms shall be in conduit. In other locations, plenum rated cable shall be used.

I. The ATC Contractor shall provide PDF submittal showing how he proposes to complete the work specified herein. In this book, the ATC Contractor shall submit description of operation and schematic drawings, produced in AutoCAD, showing the wiring and pneumatic tubing (if applicable) of the entire control system to the District for review before starting any work. Bulletins describing each item of control equipment or component shall be included.

J. Upon completion of his work, the ATC Contractor shall provide PDF Operation & Maintenance Manuals showing exactly how each component of the system was installed, specifically noting any changes from the submittal book, and who authorized the change. Schematic drawings, sequences of operation and technical literature must be provided for all components of the system.

K. All automatic temperature control work completed under this Contract shall be covered under a one (1) year warranty and service contract effective on date of acceptance. Scheduled maintenance service shall be provided to attend to the normal maintenance required for proper system operation in the building.

L. It is the Contractor's responsibility to inspect the buildings, their existing systems and the project drawings to verify exact quantities of devices and controls required for the systems specified. No allowance will be made if the Contractor fails to make such an examination.

M. Provide nameplates on all devices, whether mounted on the face of the central and local control panels. In occupied areas, nameplates shall be concealed beneath covers of room type instruments, to describe functions.

N. All control panels shall include wire markers for each wire, with an identifying wiring diagram.

O. The Control Contractor shall provide a minimum of two (2) one-hour training classes on the system operation and maintenance. This is to include both classroom and on-site training to ensure that the District’s custodial and maintenance personnel have adequate knowledge of the control system’s features as well as operation and maintenance requirements. The Contractor will provide printed documentation to all persons attending the training sessions.

1.02. **VALVES**

1. All automatic control valves shall be fully proportioning unless otherwise specified, quiet in operation, and shall be arranged to fail-safe in either a normally open or normally closed position in the event of power failure. The open or closed position shall be as specified or as required to suit job conditions. Valves shall be capable of operating at varying rates of speed to correspond to the exact dictates of the controller and variable load requirements. Provisions shall be made for valves operating in sequence with other valves or damper operators to have adjustable operating ranges and starting points to provide flexibility of adjustment, sequencing and throttling range.

2. Valves shall be sized by the ATC Contractor and guaranteed to meet the heating or cooling requirements as specified, and as indicated on the drawings. Unless otherwise specified, control valves shall have 125 psig cast iron bodies with flanged connections on valves 2 1/2" or larger. Unless otherwise specified, valve bodies shall have the same pressure characteristics as the piping in which they are installed.

3. No single valve, except zone valves, shall be larger than 2" in size. Where the capacity of equipment to be controlled requires a valve larger

than 2", two (2) valves shall be installed in parallel with the smaller valve sized for a maximum of 1/3 of the total capacity.

4. All control valves, unless otherwise noted, shall be of the globe valve type.

5. Actuators shall be electronic. They shall be mechanically fail-safe. **Capacitor-based fail-safe actuators are not acceptable.**

1.03. **CONTROL PANELS**

1. All control panels for this project will meet the following requirements **as a minimum**:

    1. The control panel shall be a fully enclosed cabinet, of baked enamel, steel or aluminum material construction and shall meet the requirements of NEMA 1 enclosures.
    2. The panel will have a hinged door with a locking latch.
    3. Each component on the front panel shall have an appropriate engraved nameplate fabricated from .062" or .125" thick phenolic material, with engraved permanent lettering. **Stick-on labels are not acceptable.**

1.04. **DDC SYSTEM WIRING**

A. All conduit, wiring, accessories and wiring connections required for the installation of the Building Automation System, as herein specified, shall be provided by the Controls Contractor unless specifically shown on the Electrical Drawings under Division 26 Electrical. The contractor shall provide, install and wire all repeaters, terminators as recommended by the BMS manufacturer. Power wiring for DDC control panels and other line voltage devices shall be included under the Mechanical / Temperature control contract.

B. All wiring shall comply with the requirements of applicable portions of Division 26 and all local and national electric codes, unless specified otherwise in this section.

C. All control wiring materials and installation methods shall comply with DDC system manufacturer's recommendations.

D. The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the Controls Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the Controls Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.

1.05. **QUALITY ASSURANCE**

A. There is an extensive installation of Johnson Controls Inc. Metasys DDC controls in the District and in this building. The District must have assurance that the Mechanical contractor has solicited a quote for all controls work from an authorized Johnson Metasys branch.

Section 2 –Sequences of Operation.

A. **Johnson Metasys DDC Front-end**

a. Furnish and install all temperature controls including all devices and accessories required for the installation of a complete Johnson Metasys web-based energy management and control system for the new chillers. The contractor shall network and map up all new DDC controls to the existing Johnson Controls BMS system. The contractor will expand the existing system as necessary, including all hardware, software, licenses, and additional Controllers/Servers as necessary to provide the sequences and points lists specified.

b. This contractor will furnish and install as many master controllers as required to accommodate all new equipment, and maintain a free Java heap of at least 10MB, with 25% spare capacity for future expansion. If the controller cannot accommodate the new controls while still maintaining 10% expansion capability and at least 10MB free heap, an additional controller and dedicated Server with Server PC shall be provided at no additional cost to the owner. ***The contractor will be required to demonstrate this front-end capacity during training and in the O&M documentation.***

c. The existing front-end is networked to a districtwide energy monitoring Server. The Controls Contract will ensure that all new controls added to this project, including any master controllers, will be compatible with the existing Server and all new trends added to this project will be mapped up to the existing Server to match existing trend recording cycles.

d. The Controls Contractor will provide schedules for all equipment, zoned by different areas of the building as designated by the Owner. Providing a separate dedicated schedule for each piece of equipment is not acceptable unless specifically directed by the Owner.

e. This contractor will modify the BMS floor plan of the entire building, with links to all DDC controlled equipment. Upon completion of this project, all DDC controlled equipment will be one seamless DDC front-end with graphical interface for each piece of equipment. Simply putting hyperlinks or data tables to represent the new controls is not acceptable. Graphics shall match existing graphics in all respects.

f. The controls subcontractor will provide all network wiring and will provide all graphics, front-end programming to map up the new controls. The contractor will include all additional licenses as necessary to accommodate the new controls.

g. Override and offline Indication: All overridden points/setpoints will be displayed on the graphic in the same color background as the existing graphics, with text to match the existing graphics. All points operating under normal control logic will be in colors to match existing. All points that are offline will be indicated similar to existing.

h. Alarm Indication: Alarms shall be programmed to display on a customized graphical alarm screen indicating when any alarm occurs

at any of the new chillers.. An Alarm notification image will indicate on the home page and on every graphical page indicating an unacknowledged alarm condition. The flashing alarm notification will disappear once the user has acknowledged the alarm, but the alarm will remain in the alarm history database.

i. All DDC points indicated in the points list to be trended will be recorded at 1-hour intervals (or change of value).

j. Optimal Start: An adaptive optimal start algorithm shall be used to enable the new equipment to cool the space prior to occupancy time, necessary to achieve zone occupied temperature setpoints by the start of scheduled occupied period. The learning adaptive algorithm shall compare the zone temperature to its setpoint at beginning of scheduled occupied period and shall automatically adapt the cooling response time for the next unoccupied period. The maximum cool down start time will be adjustable at the DDC front-end. At no later than the scheduled occupancy time, the units will transition to occupied mode. When the unit comes on during optimal start and/or cool down mode, the central plant will be indexed to day mode settings to ensure the pumps, control valves are in day mode to allow optimal start/cool down sequence to occur.

B. Software

a. All controllers shall be programmed using licensed original software. Supervisory controllers shall be programmed using manufacturer's software, and controllers shall be programmed with manufacturer's software. All software shall be at current versions compatible with the hardware, including all patches and updates.

C. New Air Cooled Chillers, High School & Middle School Sections

a. Cooling, Unoccupied: During the unoccupied mode, the chillers may be programmed to be locked out or to operate at a higher discharge water temperature, depending upon owner preference.

b. Cooling, Occupied: During the occupied cycle, chillers shall be enabled based upon a programmable outdoor air setpoint. If the outdoor air is warmer than setpoint, the chillers will be enabled and each chiller's respective chilled water pump shall be started. Flow shall be proven. If flow is not proven, the chiller(s) shall be locked out and an alarm sent to the head end describing the nature of the lockout. Once chilled water flow has been established, the chillers shall be controlled by each chillers on-board controller to satisfy leaving chilled water temperature. Provide for a chilled water reset schedule to automatically adjust leaving chilled water temperature based upon outdoor air temperature. Each chiller shall modulate it's own compressor(s) in response to delta T between supply and return water.

All functions of each chiller controller shall be mapped up to the BMS. Alarms to be mapped up as read-only points with full descriptions as to the nature of the alarm. Chilled water supply setpoints / chilled water reset schedules shall be mapped up to each chiller as read – write points.

Section 3 – Dynamic Color Graphics Requirements

The color graphics that the user will see to operate the system shall be resident in the web-based front-end controller. PC-based systems are not acceptable. The main graphic shall be a three-dimensional floor plan of the building with links to each room and its HVAC system. The display will provide links to all DDC equipment in the building. Links to data trends and schedules shall be located on each system's graphic screen. The minimum point information that is to be mapped to the front-end panel and shown in the color graphic screens is as follows:

New Air Cooled Chillers				
Description	**Point**	**History**	**Alarm**	**Totalize**
Chiller Enable / Disable	Bin.	X	X	
Chilled Water Pump Enable	Bin.	X	X	
Chilled Water Flow	Ana.	X	X	
Leaving Chilled Water Temperature	Ana.	X		
Chilled Water Return Temperature	Ana.	X		
Chilled Water Supply Pressure	Ana.	X	X	
Chilled Water Return Pressure	Ana.	X	X	
Chilled Water Pump Flow Alarm / Lockout	Bin.	X	X	
Chilled Water Reset Schedule Value	Ana.	X		
Chiller Compressor Operation %	Ana.	X		
Chiller Low Side Pressure Value	Ana.	X	X	
Chiller High Side Pressure Value	Ana.	X	X	
Chiller Run Status	Bin.	X	X	
Chiller Occupied / Unoccupied Status	Bin.	X		

VRF Equipment: Show all space setpoints, H&V unit status, valve positions, damper positions, VRF interlock status, VRF indoor unit status, VRF unit mode.

Section 4 – Historical Data Trending Requirements

All the points listed will be trended in the Metasys front-end to record historical data for a period of 7 days, trended once per hour, and archived at the Server daily. The District intends to track these data for improving efficiency and occupancy conditions.

Section 5 – Hardware requirements:

A. General Description:

1. The Building Automation System (BAS) shall use an open architecture and where applicable support a multi-vendor environment. To accomplish this effectively, the BAS shall not be limited to a single open communication protocol standard, but to also integrate third-party devices and applications via additional protocol and through the latest software standards. The system configuration shall be available for use

on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.

2. The Building Automation System shall consist of the following:
   a. DDC Controllers (HVAC, etc.)
   b. Input, Output Modules
   c. Local Display Devices
   d. Portable Operator's Terminals – Portable PC's
   e. Distributed User Interfaces
   f. Network processing, data storage and communications equipment
   g. Other components required for a complete and working BAS.
3. The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
4. The system architectural design shall eliminate dependence upon any single device for alarm generation and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
5. Acceptable Systems

   Johnson Controls Inc. Metasys

B. BAS Architecture – Automation Network

1. The automation network shall be configured as a Client/Server network with a web server operating on the Client's LAN/WAN. The web browser interface is extended over the LAN/WAN. Monitoring and control of the BAS is available using the web browser interface.
2. The automation network shall include the option of a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.
3. The BAS shall network multiple user interface clients, system controllers and systems supervisors as required for systems operation.
4. The automation network option shall be capable of operating at a communication speed of 100 Mbps.
5. The automation network option will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

C. BAS Architecture – Control Network

1. Network Automation Controllers, (NAC) shall provide management over the control network(s) and shall support the following communications protocols:

   BACnet® Standard (ANSI/ASHRAE Standard 135-) MS/TP master.

   LonWorks® enabled devices using the free topology transceiver (FTT-1x).

   Modbus RTU and Modbus TCP.
2. The NAC shall be BTL (BACnet Testing Laboratories) listed as B-BC (BACnet Building Controller) and support the following data link options:

   BACnet Internet Protocol (IP) (Annex J).

   BACnet IP (Annex J) Foreign.

ISO 8802-3, Ethernet (Clause 7).

3. Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.
4. Digital Controllers shall reside on the control network.
5. A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
6. The PICS shall be submitted 10 days prior to bidding.

D. User Interface – Browser Based Interface

1. The system shall be capable of supporting an unlimited number of clients using standard Web browser such as Internet Explorer™ or Mozilla Firefox™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.
2. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the Building Automation System (BAS), shall not be acceptable.
3. The Web browser client shall support at a minimum, the following functions:
    a. User log-on identification and password shall be required. If an unauthorized user attempts access, notice of access failure shall be displayed. Security using authentication and encryption techniques to prevent unauthorized access shall be implemented.
    b. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
    c. Storage of the graphical screens shall be in the Network Automation Controller (NAC) or the server, without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
    d. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
    e. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
    f. Modify common application objects, such as schedules and setpoints in a graphical manner.
    g. Commands binary objects to start and stop.
    h. View logs and charts.
    i. View alarms.
4. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

E. User Interface – Alarms

1. Alarm feature shall allow user configuration of criteria to create, route, and manage alarms and events. It shall be possible for specific alarms from specific points to be routed to specific alarm recipients.

The alarm management portion of the user interface shall, at the minimum, provide the following functions:

a. Allow configuration to generate alarms on any numeric, binary, or data point in the system.
b. Generate alarm records that contain a minimum of a timestamp, original state, acknowledged state, alarm class and priority.
c. Allow the establishment of alarm classes that provide the routing of alarms with similar characteristics to common recipients.
d. Allow a user, with the appropriate security level, to manage alarms - including sorting, acknowledging, and tagging alarms.

F. User Interface – Reports and Summaries

1. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
   a. All points in the BAS
   b. All points in each BAS application
   c. All points in a specific controller
   d. All points in a user-defined group of points
   e. All points currently in alarm
   f. All BAS schedules
   g. All user defined and adjustable variables, schedules, interlocks and the like.
2. Reports shall be exportable to .pdf, .txt, or .csv formats.
3. The system shall allow for the creation of custom reports and queries.

G. User Interface – Schedules

1. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
   a. Regular schedules
   b. Repeating schedules
   c. Exception Schedules
2. Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
3. It shall be possible to define one or more exception schedules for each schedule including references to calendars.
4. Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days. Holidays and special days shall be user-selected with the pointing device or keyboard.

H. User Interface - Passwords

1. Multiple-level password access protection shall be provided to allow the system manager to assign user interface control, display, and database manipulation capabilities deemed appropriate for each user based on an assigned password.
2. Each user shall have the following: a username, a password, and access levels.
3. The system shall provide the capability to require a password of minimum length and require a combination of characters and numerical or special characters.
4. When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.

5. The system shall provide unlimited flexibility with access rights. A minimum of four levels of access shall be provided along with the ability to customize the system to provide additional levels.
6. A minimum of 100 unique passwords shall be supported.
7. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
8. The system shall automatically generate a report of log-on/log-off and system activity for each user.
9. All log data shall be available in .pdf, .txt, and .csv formats.

I. User Interface – Dynamic Color Graphics

1. The graphics application program shall be supplied as an integral part of the User Interface.
2. The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed.
3. The graphics shall be able to display real-time data that is acquired, derived, or entered.
4. Graphics runtime functions –Each graphic application shall be capable of the following functions:
5. All graphics shall be fully scalable.
6. The graphics shall support a maintained aspect ratio.
7. Multiple fonts shall be supported.
8. Unique background shall be assignable on a per graphic basis.
9. Operation from graphics – It shall be possible to change values (setpoints) and states in systems-controlled equipment within the Web browser interface.
10. Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all runtime binding.

J. Historical Data Collection

1. All numeric, binary or data points in the system database shall allow their values to be logged over time (trend log). Each historical record shall include the point’s name, a time stamp including time zone, and the point’s value.
2. The configuration of the historical data collection shall allow for recording data based on change of value or on a user-defined time interval.
3. The configuration of the historical data collection shall allow for the collection process to stop or rollover when capacity has been reached.
4. A historical data viewing utility shall be provided with access to all history records. This utility shall allow historical data to be viewed in a table or chart format.
5. The history data table view shall allow the user to hide/show columns and to filter data based on time and date. The history data table shall allow exporting to .txt, .csv, or .pdf file formats.
6. The historical data chart view shall allow different point histories to be displayed simultaneously and provide panning and zooming capabilities.

K. Audit Log

1. For each log entry, provide the following data:
    a. Time and date
    b. User ID
    c. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

L. Network Automation Controller (NAC)

The NAC must provide the following hardware features as a minimum:

1. Communications
    a. Two 10/100 Mb Ethernet Port – RJ-45 connections
    b. One RS-485 port (up to 57,600 baud)
    c. Expandable communications ports including LON, RS485, Modem, Wireless Terminal Equipment Control
    d. All required protocol drivers as required by the sequence of operation.
2. Battery Backup
    a. Battery backup provided for all on board functions including I/O
    b. Battery is monitored and trickle charged
    c. Battery maintains processor operation through power failures for a pre-determined interval, and then writes all data to flash memory, shuts the processor down, and maintains the clock for three months.
3. Environment
    a. Must be capable of operation over a temperature range of 0 °C to 50 °C (32 °F to 122 °F).
    b. Must be capable of withstanding storage temperatures of between 0 °C and 60 °C (32 °F to 140 °F).
    c. Must be capable of operation over a humidity range of 5% to 95% RH, non-condensing.

4. The Network Automation Controller (NAC) shall be a fully user-programmable device capable of providing all the capability described in Section 2.3 Part A.
5. Automation network – The Network Automation Controller (NAC) shall reside on the automation network. Each NAC shall support one or more sub-networks of controllers.
6. The Network Automation Controller shall have the capability to communicate directly with Modbus without the use of an additional gateway.
7. The Network Automation Controller shall have the capability to provide secure communications via SSL (Secure Socket Layer).
8. User Interface – Each Network Automation Controller (NAC) shall have the ability to deliver a web-based user interface as previously described. All computers connected physically or virtually to the automation network shall have access to the web-based UI.
9. Power Failure – In the event of the loss of normal power, The Network Automation Controller (NAC) shall continue to operate for a defined period after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software. Flash memory shall be incorporated for all critical controller configuration data.

10. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions.
11. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
12. Certification – All controllers shall be listed by Underwriters Laboratories (UL).

M. Input Device Characteristics

a. General Requirements: Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.
b. Temperature Sensors: Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations. The temperature sensor shall be of the resistance type and shall be either two-wire 1000-ohm nickel RTD, or two-wire 1000-ohm platinum RTD.
c. Room Temperature Sensors: Room sensors shall be constructed for either surface or wall box mounting.
d. Thermo wells: When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting. Thermo wells shall be pressure rated and constructed in accordance with the system working pressure. Thermo wells and sensors shall be mounted in a threadolet or ½-inch NFT saddle and allow easy access to the sensor for repair or replacement. Thermo wells shall be constructed of 316 stainless steel.
e. Outside Air Sensors: Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
f. Control Relays: Control pilot relays shall be of a modular plug-in design with retaining springs or clips. Mounting bases shall be snap-mount. DPDT, 3PDT, or 4PDT relays shall be provided as appropriate for application. Contacts shall be rated for 10 amps at 120 VAC. Relays shall have an integral indicator light and check button. Acceptable manufacturers: Idec, Functional Devices
g. Electronic/Pneumatic Transducers: Electronic to Pneumatic transducers shall provide: Output: 3-15 psig,
h. Input: 4-20 mA or 0-10 VDC, manual output adjustment, pressure gauge external replaceable supply air filter. Acceptable manufacturers: Johnson Controls Inc., Mamac

N. APPLICATION SPECIFIC CONTROLLERS

1. General Purpose Programmable Controllers (PCG)

a) The General-Purpose Programmable Controller shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.
b) Controller shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
c) A BACnet Protocol Implementation Conformance Statement shall be provided for the controller.
d) The Conformance Statement shall be submitted 10 days prior to bidding.

e) The controller shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
f) The controller shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
g) The controller shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
h) The controller shall include a removable base to allow pre-wiring without the controller.
i) The controller shall include troubleshooting LED indicators to identify the following conditions:
    i. Power On
    ii. Power Off
    iii. Download or Startup in progress, not ready for normal operation
    iv. No Faults
    v. Device Fault
    vi. Field Controller Bus - Normal Data Transmission
    vii. Field Controller Bus - No Data Transmission
    viii. Field Controller Bus - No Communication
    ix. Sensor-Actuator Bus - Normal Data Transmission
    x. Sensor-Actuator Bus - No Data Transmission
    xi. Sensor-Actuator Bus - No Communication
j) The controller shall accommodate the direct wiring of analog and binary I/O field points.
k) The controller shall support the following types of inputs and outputs:
l) Universal Inputs - shall be configured to monitor any of the following:
    i. Analog Input, Voltage Mode
    ii. Analog Input, Current Mode
    iii. Analog Input, Resistive Mode
    iv. Binary Input, Dry Contact Maintained Mode
m) Binary Inputs - shall be configured to monitor either of the following:
    i. Dry Contact Maintained Mode
    ii. Pulse Counter Mode
n) Analog Outputs - shall be configured to output either of the following:
    i. Analog Output, Voltage Mode
o) Analog Output, current Mode
p) Binary Outputs - shall output the following:
    i. 24 VAC Triac
q) Configurable Outputs - shall be capable of the following:
    i. Analog Output, Voltage Mode
    ii. Binary Output Mode
r) The controller shall have the ability to reside on a Field Controller Bus (FC Bus).
    i. The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
    ii. The FC Bus shall support communications between the controllers and the Supervisory Controller.
    iii. The FC Bus shall also support Expansion I/O (PCX) communications with the field controllers and with the Supervisory Controller.
s) The FC Bus shall operate at a maximum distance of 15,000 Ft. between the field controllers and the furthest connected device.

t) The field controllers shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
   a) The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard Protocol SSPC-135, Clause 9.
   b) The SA Bus shall support up to 10 devices per trunk.
   c) The SA Bus shall operate at a maximum distance of 1,200 Ft. between the PCG and the furthest connected device.

u) The field controllers shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.

2. The field controllers shall support, but not be limited to, the following:
   a) Chilled water/central plant automation applications including but not limited to:
      i) the selection and sequencing of up to 8 chillers of different sizes
      ii) the selection and sequencing of up to 8 (each) primary and secondary chilled water pumps of varying pump capacities
      iii) the selection and sequencing of up to 8 condenser water pumps
      iv) the selection and sequencing of cooling towers and bypass valve, including single speed, multi-speed, and Vernier control.
      v) a proven and documented central cooling plant optimization program that incorporates custom equipment efficiency profiles, without rewriting software code, in order to meet the building load using the least amount of energy as calculated.
      vi) the use of advanced control algorithms that apply equipment specific parameters, including operational limits and efficiency profiles, in order to determine equipment, start and runtime preferences.
      vii) the identification of the most efficient equipment combination and automatic control of state and speed of all necessary equipment to balance runtime, optimize timing and sequencing and ensure the efficiency and stability of the central cooling plant.
      viii) the control definition for the chiller plant in a single controller, as supported by available memory and point Input/Output (I/O), or capable of being split across multiple controllers.
         a) Heating central plant applications
         b) Built-up air handling units for special applications
   1. Terminal and packaged units
   2. Special programs as required for systems control.

2. Programmable Controller Expansion I/O Modules

   a) The Programmable Controller Expansion I/O Module provides additional inputs and outputs for use in the field controllers.
   b) The I/O module shall communicate with the field controllers over the FC Bus or the SA Bus.
   c) The I/O module shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
   d) A BACnet Protocol Implementation Conformance Statement shall be provided for the field controllers.
   e) The Conformance Statement shall be submitted 10 days prior to bidding.
   f) The I/O module shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
   g) The I/O module shall have a minimum of 4 points to a maximum of 17 points.
   h) The I/O module shall support the following types of inputs and outputs:

i. Universal Inputs - shall be configured to monitor any of the following:
   (i) Analog Input, Voltage Mode
   (ii) Analog Input, Current Mode
ii. Analog Input, Resistive Mode
iii. Binary Input, Dry Contact Maintained Mode
iv. Binary Inputs - shall be configured to monitor either of the following:
   (i) Dry Contact Maintained Mode
   (ii) Pulse Counter Mode
v. Analog Outputs - shall be configured to output either of the following:
   (i) Analog Output, Voltage Mode
   (ii) Analog Output, current Mode
vi. Binary Outputs - shall output the following:
   (i) 24 VAC Triac
vii. Configurable Outputs - shall be capable of the following:
   (i) Analog Output, Voltage Mode
   (ii) Binary Output Mode

3. The I/O module shall include troubleshooting LED indicators to identify the following conditions:
   (i) Power On
   (ii) Power Off
   (iii) Download or Startup in progress, not ready for normal operation.
   (iv) No Faults
   (v) Device Fault
   (vi) Normal Data Transmission
   (vii) No Data Transmission
   (viii) No Communication

(END OF SECTION)

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

SECTION 232113 – HYDRONIC PIPING

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

A. Extent of hot and / or chilled water piping systems work is indicated on drawings and schedules, and by requirements of this section.

B. Applications for hot/chilled water piping systems include the following:

1. Hot/chilled water piping systems for hot/chilled water heating/cooling terminal units.

2. Hot/chilled water piping systems for hot/chilled water coils in air handling units.

C. Refer to appropriate Division 23 sections for insulation required in connection with hot/chilled water piping systems.

1.03 QUALITY ASSURANCE

A. ANSI Compliance: Comply with applicable American National Standards pertaining to products and installation of hot/chilled water piping systems.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's data for hot/chilled water piping systems, materials and products.

B. Shop Drawings: Submit scaled layout drawings of installed hot/chilled water pipe and fittings including, but not necessarily limited to, pipe sizes, locations, elevations and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between piping and proximate equipment.

PART 2 - PRODUCTS

2.01 HOT/CHILLED WATER PIPING MATERIALS AND PRODUCTS

A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings and capacities as indicated. Where not indicated, provide proper selection as determined by engineer to comply with installation requirements.

B. Provide materials and products complying with ANSI B31.1 Code for Power Piping where applicable, base pressure rating on hot/chilled water piping systems maximum design pressures. Provide sizes and types matching piping and equipment materials used in hot/chilled water piping systems. Where more than one type of material or product is indicated, selection is engineer’s option.

2.02 BASIC IDENTIFICATION

A. General: Provide identification complying with Division 23 Basic Materials and Methods section "Mechanical Identification."

2.03 BASIC PIPE, TUBE AND FITTINGS

A. General: Provide pipe, tube and fittings complying with Division 15 Basic Materials and Methods section "Pipe, Tube and Fittings," in accordance with the following listing:

1. Hot/chilled water AND low pressure steam piping:

    a. Pipe size 2" and smaller: Black steel pipe.

        1) Pipe weight: Schedule 40.
        2) Fittings: Class 125 cast iron threaded.

2. Pipe size 2-1/2" and larger: Black steel pipe.

        1) Pipe weight: Schedule 40.
        2) Fittings: Wrought steel buttwelding.

2.04 BASIC PIPING SPECIALTIES

A. General: Provide piping specialties complying with Division 23 Basic Materials and Methods section "Piping Specialties."

2.05 BASIC SUPPORTS, ANCHORS AND SEALS

A. General: Provide supports, anchors and seals complying with Division 23 Basic Material and Methods section "Supports, Anchors, and Seals." Supports and anchors provided shall meet the requirements of section 1613 of the New York State Building Code; horizontal and vertical runs of pipe shall be securely supported in accordance with the New York State Building Code including seismic requirements.

2.06 BASIC VALVES

A. General: Provide valves complying with Division 23 Basic Materials and Methods section "Valves," in accordance with the following listings:

1. Sectional Valves:

    a. 2" and smaller: Ball valves (hot/chilled water only).
    b. 2-1/2” and larger: rising stem or O.S.&Y. type.
    c. 2-1/2: and larger: Butterfly valves

2. Shutoff Valves:

    a. 2" and smaller: Ball valves (hot/chilled water only)
    b. 2-1/2" and larger: Rising stem or O.S.&Y. valves. Butterfly valves may be used.

3. Heating/Cooling Terminal Outlet Valves:

    a. 2" and smaller: Balance valve (Globe type)(hot/chilled water only)
    b. 2-1/2" and larger: Rising Stem.(Globe type).

4. Drain Valves:

    a. 2" and smaller: Ball valves.

5. Check Valves:

    a. All sizes: Silent wafer type check valve, swing type check valve.

2.07 BASIC EXPANSION COMPENSATION

A. General: Provide expansion compensation products complying with Division 23 "Expansion Compensation," in accordance with the following listing:

1. Flexible ball pipe joints (hot/chilled water only) Use fabricated piping loops for low pressure steam or linear bellows type rated for steam service.
2. Pipe alignment guides and anchors.

2.08 BASIC THERMOMETERS AND GAUGES

A. General: Provide meters and gauges complying with Division 23 section "Thermometers and Gauges," in accordance with the following listing:

1. Temperature gauges and fittings.
2. Pressure gauges and fittings.
3. Flow measuring gauges.

2.09 HYDRONIC SPECIALTIES

A. General: Provide hydronic specialties complying with Division 23 section "Hydronic Specialties," in accordance with the following listing:

1. Balance valves.
2. Balance cocks.
3. Vent valves.
4. Flow control valves.
5. Diverting fittings.
6. Air separators.

2.10 UNDERGROUND PIPING

A. General:

1. All underground heating water lines shall be XTRU-THERM as manufactured by PERMA-PIPE. All straight sections shall be factory fabricated, insulated, and jacketed. The piping system design and manufacture shall be in strict conformance with ASME B31.1, latest edition. The piping manufacturer will be responsible for the design and thermal expansion of the system. Installation of the piping system shall be in accordance with the manufacturer’s instructions. Factory trained field technical assistance shall be provided for critical periods of installation, unloading, field joint instruction and testing.

B. Service Pipe:

1. The service pipe shall be ASTM A53 Schedule 40 Grade B Carbon Steel. Straight sections shall be supplied in 20 or 40-foot lengths with piping exposed at each end for field joint fabrication.

C. Insulation:

1. The service pipe insulation shall be polyurethane foam with 2 lb/ft^3 minimum density, 90% minimum closed cell content, minimum compressive strength of 40 psi and initial thermal conductivity of 0.18 Btu-in/hr/ft^2/^{O}F. The insulation shall completely fill the annular space between the service pipe and jacket and-shall be bonded to both. Systems using open cell insulation or a non- bonded design shall not be allowed. The polyurethane foam insulation shall be tested by the manufacturer for mechanical and thermal s to assure compliance with the above values. All test samples will be taken from production material, identified, tagged and tested in accordance with the table below. Test reports showing results will be furnished to the engineer for approval. Data supplied by the polyurethane foam chemical supplier is not acceptable.

Attribute	ASTM STD	Sample Frequency	Requirement
Insulation Density	D 1622	Once per shift	$\geq$ 2 lb/ft^3
Insulation Compression Strength	D 1621	Once per shift	$\geq$ 40 psi
Insulation Closed Cell Content	D 2856	Once per shift	$\geq$ 90%
Insulation Thermal Conductivity	C 518	Once per shift	< 0.18 Btu-in/hr/ft^2/°F

The insulation shall be provided to the minimum thickness specified below:

Pipe Size (in.)	Minimum Insulation Thickness (in.)	
	Chilled Water	Glycol Water
1 to 12	1.5	1.5

D. Insulation Jacket:

1. The outer protective insulation jacket shall be seamless high-density polyethylene (HDPE) in accordance with ASTM D3350, minimum cell classification PE345444C. PVC or tape materials are not allowed. The end of each straight section of pipe will have the jacket tapered down over the insulation and bonded to the service pipe. No mastic is allowed. The minimum thickness of the HDPE jacket shall be as follows:

Jacket OD (in.)	Minimum Jacket Thickness (in.)
OD < 12	0.120

E. Fittings:

1. All fittings shall be factory prefabricated and pre-insulated. Straight tangent lengths shall be added to all ends so that all field joints are at straight sections of pipe. Elbow jackets shall be molded HDPE. Tee jackets shall be extrusion welded or butt fusion welded HDPE. Gluing, taping or hot air welding shall not be allowed.

F. Field Joints:

1. The service pipe shall be hydrostatically tested to 150 psig or 1 1/2 times the design pressures whichever is greater. Insulation shall then be poured in place into the field joint area. All field-applied insulation shall be placed only in straight sections of pipe. The installer shall seal the field joint area with a heat shrinkable adhesive backed sleeve. Backfilling shall not begin until the heat shrink sleeve has cooled. All insulation and jacketing materials for the field joint shall be furnished by PERMA-PIPE.

G. Field Service:

1. The piping manufacturer will provide a factory field service technician to be present during critical periods of the installation. The factory field service technician will be employed by the piping manufacturer and will not be a sales representative.

H. Backfill:

1. A 4-inch layer of sand or fine gravel shall be placed and tamped in the trench to provide a uniform bedding for the pipe. The entire trench width shall be evenly backfilled with a similar material as the bedding in 6 inch compacted layers to a minimum height of 6 inches above the top of the insulated pipe. The remaining trench shall be evenly and continuously backfilled and compacted in uniform layers with suitable excavated soil.

PART 3 - EXECUTION

3.01 INSTALLATION OF BASIC IDENTIFICATION

A. General: Install mechanical identification in accordance with Division 23 Basic Materials and Methods section "Mechanical Identification."

3.02 INSTALLATION OF HOT/CHILLED WATER WATER DISTRIBUTION PIPING

A. General: Install water distribution piping in accordance with Division 23 Basic Materials and Methods section "Pipe, Tube and Fittings."

B. Install concentric reducers where pipe is reduced in size in direction of flow, with tops of both pipes and reducer flush.

C. Install piping with 1" minimum rise in 40' pipe run (0.2%) in direction of flow.

D. Connect branch feed piping to mains at horizontal center line of mains, connect run-out piping to branches at horizontal center line of branches.

E. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

3.03 INSTALLATION OF PIPING SPECIALTIES

A. Install piping specialties in accordance with Division 23 section "Hydronic Specialties."

3.04 INSTALLATION OF SUPPORTS, ANCHORS AND SEALS

A. Install supports, anchors and seals in accordance with Division 15 Basic Materials and Methods and project drawings and details.

3.05 INSTALLATION OF VALVES

A. Install valves in accordance with Division 23 section "Valves."

B. Sectional valves: Install on each branch and riser, close to main, where branch or riser serves two or more heating terminals or equipment connections and elsewhere as indicated.

C. Shutoff valves: Install on inlet and outlet of each mechanical equipment item and on inlet of each heating/cooling terminal and elsewhere as indicated.

D. Heating/cooling terminal outlet valves: Install on outlet of each heating/cooling terminal and elsewhere as indicated.

E. Drain valves: Install on each mechanical equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system and elsewhere where indicated or required to completely drain hot/chilled water piping system.

F. Check valves: Install on discharge side of each pump and elsewhere as indicated.

3.06 INSTALLATION OF EXPANSION COMPENSATION PRODUCTS

A. Install expansion compensation products in accordance with Division 23 section "Expansion Compensation."

3.07 INSTALLATION OF THERMOMETERS AND GAUGES

A. Install thermometers and gauges in accordance with Division 23 section "Thermometers and Gauges."

3.08 INSTALLATION OF HYDRONIC SPECIALTIES

A. General: Install hydronic specialties in accordance with Division 23 "Hydronic Specialties" section.

3.09 EQUIPMENT CONNECTIONS

A. General: Connect hot/chilled water piping system to mechanical equipment as indicated and comply with equipment manufacturer's instructions where not otherwise indicated. Install shutoff valve and union on supply and return, drain valve on drain connection.

B. Hot/chilled water terminals: Install hot/chilled water terminals with heating/cooling terminal outlet valve and union on outlet, union, shutoff valve on inlet. Install automatic air vent valve on element in accordance with manufacturer's instructions. Locate valves and balancing cocks behind valve access doors for ease of maintenance. Where indicated, install automatic temperature control valve with unions between all ports of the control valve.

3.10 CLEANING, FLUSHING AND INSPECTING

A. General: Include coils, etc. See Division 23 Basic Materials & Methods.

3.11 TESTING AND BALANCING

A. General: See Division 23 "Testing, Adjusting and Balancing.

END OF SECTION

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

SECTION 232116 – HYDRONIC SPECIALTIES

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

A. Extent of hydronic specialties required by this section is indicated on drawings, and/or specified in other Division 23 hydronic piping system sections.

B. Types of hydronic specialties specified in this section include the following:

1. Balance valves.
2. Vent valves.
3. Flow control valves.
4. Diverting fittings.
5. Air separators.
6. Compression tanks.
7. Pump discharge valves.
8. Shot feeders.
9. Water relief valves.
10. Pressure reducing valves.
11. RPZ – Backflow Preventer

1.03 QUALITY ASSURANCE

A. Materials and equipment shall be provided by one of the manufactures listed in Part 2 - Products. Materials and equipment from other manufacturers may be accepted if proven equal to those specified. This contractor is liable for and shall pay for all architectural and engineering review and redesign costs for substitute materials and equipment. This contractor also is liable for all costs of changes in the work required by substitute equipment.

B. The length of time the manufacturer has been in business, the location and capability of complete repair facilities, availability of repair parts and annual maintenance contracts all will be considered in determining equality. Refer to requirements pertaining to substitute materials and equipment.

1.04 SUBMITTALS

A. Product data - submit catalog cuts, specifications, installation instructions and dimensioned drawings for each type of manufactured hydronic specialty. Include pressure drop curve or chart for each type and size of hydronic specialty.

B. Shop drawings - submit for fabricated specialties, indicating details of fabrication, materials and method of support.

C. Maintenance data - submit maintenance data and spare parts lists for each type of manufactured hydronic specialty. Include this data in maintenance manual.

D. Hydronic specialty types - provide hydronic specialties of same type by same manufacturer.

PART 2 - PRODUCTS

2.01 MANUFACTURED HYDRONIC SPECIALTIES

A. General - provide factory fabricated hydronic specialties recommended by manufacturer for use in service indicated. Provide hydronic specialties of types and pressure ratings indicated for each service, or if not indicated, provide proper selection as determined by the engineer to comply with installation requirements. Provide sizes as indicated and connections which properly mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is the engineers' option, but more than one type cannot be used on project.

B. Balance valves:

1. General - provide balance valves as indicated, of one of the following types:

   a. Threaded ends 2" and smaller - Class 125, bronze body, ball valve with memory stop.
   b. Soldered ends 2" and smaller - Class 125, bronze body, ball valve with memory stop.
   c. Threaded, soldered, of flanged end globe style providing three (3) functions:

      1) Precise flow measurement
      2) Precision flow balancing
      3) Positive shut-off, no drip seat, Teflon disk, 1-1/2" to 2" size - drain connection with protective cap.
      4) Vernier-type setting with "hidden memory" feature to program valve for tamper-proof setting. Balance meter, valved connections. Manufacturer: Armstrong Pumps, Type CBV.

C. Vent valves:

1. Manual vent valves - provide manual vent valves designed to be operated manually with screwdriver or thumbscrew, 1/8" N.P.T. connection.

2. Automatic vent valves - provide automatic vent valves designed to vent automatically with float principle, stainless steel float and mechanisms, cast iron body, pressure rated for 125 psi, 1/2" N.P.T. inlet and outlet connections.

3. Manufacturer - subject to compliance with requirements, provide vent valves of one of the following:

   a. Bell & Gossett, ITT Fluid Handling Div.
   b. Taco, Inc.
   c. Armstrong Co.

D. Flow control valves:

1. General - provide flow control valves pressure rated for 125 psi, containing lift check assembly which will automatically open by means of pump flow pressure, and automatically close when pump is not operating. Provide with means to manually open in case of pump failure.

   a. Threaded ends 2" and smaller - cast iron body, bronze check mechanism, screw-in bonnet, straight or angle pattern.
   b. Soldered ends 1 1/4" and smaller - cast bronze body, bronze check mechanism, screw in bonnet, straight or angle pattern.
   c. Threaded ends 2 1/2" through 4" - cast iron body, bronze check mechanism, screw in bonnet, straight or angle pattern.

2. Manufacturer - subject to compliance with requirements, provide flow control valves of one of the following:

    a. Bell & Gossett, ITT Fluid Handling Div.
    b. Taco, Inc.
    c. Armstrong Pump Co.

E. Diverting fittings:

1. General - provide diverting fittings as indicated for one pipe hydronic piping systems. Construct fittings of cast iron with threaded ends or wrought copper with solder ends, pressure rated for 125 psi. Provide indication on fitting of direction of flow for supply or return applications. Furnish flow and pressure drop curves based on manufacturer's testing with submittal.

2. Manufacturer - subject to compliance with requirements, provide diverting fittings of one of the following:

    a. Armstrong Pumps, Inc.
    b. Bell & Gossett, ITT Fluid Handling Div.

F. Air Separators:

1. General – provide air separators pressure rated for 125 psi. Select capacity based on total system gpm.

2. Dip tube fittings – provide dip tube fittings in boilers as indicated to prevent free air collected in boiler from rising into system.

3. In-Line air separators – provide in-line air separators as indicated. Construct sizes 1 1/2” and smaller of cast iron, and sizes 2” and larger of steel complying with ASME Boiler and Pressure Vessel Code and stamped with” U” symbol. Furnish National board Form U-1 denoting compliance.

4. Combination separator/strainer – provide external combination air separators/strainers as indicated. Construct of steel complying with ASME Boiler and Pressure Vessel Code and stamped with “U” symbol. Furnish National Board Form U-1 denoting compliance. Provide galvanized steel integral strainer with 3/16” perforations and free area of not less than 5 times cross sectional area of connecting lines. Provide tangential inlet and outlet connections and internal stainless steel air collector tube designed to direct released air into compression tank. Provide blowdown connections.

5. Manufacturer – subject to compliance with requirements, provide air separators of one of the following:

    a. Armstrong Pumps, Inc.
    b. Bell & Gosett, ITT Fluid Handling Div.
    c. Taco, Inc.

G. Compression tank:

1. General – provide compression tanks of size and number as indicated. Construct of steel for 125 psi pressure rating complying with ASME Boiler and pressure Vessel Code and stamped with” U” symbol. Furnish National Board Form U-1 denoting compliance. Provide tappings in bottom of tank for tank fitting.

a. Tank fittings – provide tank fittings for compression tanks as indicated, sized for compression tank diameter. Design tank fittings for 125 psi pressure rating and include manual vent to establish proper air volume in tank on initial fill.

2. Manufacturer – subject to compliance with requirements, provide compression tanks and tank fittings of one of the following:

   a. Armstrong Pumps, Inc.
   b. Bell & Gossett, ITT Fluid Handling Div.
   c. Taco, Inc.

H. Diaphragm type compression tanks:

1. General – provide diaphragm compression tanks of size and number as indicated. Construct tank of welded steel, constructed, tested and stamped in accordance with Section VII of the ASME Boiler and Pressure Vessel Code for a working pressure of 125 psi. Furnish National Board Form U-1 denoting compliance. Support vertical tanks with steel legs or base, support horizontal tanks with steel saddles. Provide specially compounded flexible diaphragm securely sealed into tank to permanently separate air charge from system water, to maintain design expansion capacity. Provide pressure gauge and air charging fitting.

2. Manufacturer – subject to compliance with requirements, provide diaphragm type compression tanks of the following:

   a. Bell & Gossett, ITT Fluid Handling Div.
   b. Armstrong Pumps, Inc.

I. Pump discharge valves:

1. General – provide pump discharge valves as indicated. Provide Non-slam check valve with spring loaded disc and calibrated adjustment feature permitting regulation of pump discharge flow and shutoff. Provide flanged cast iron valve body, pressure rated for 175 psi, maximum operating temperature of 300 degrees F. Provide straight or angle pattern as required.

2. Manufacturer – subject to compliance with requirements, provide Pump discharge valves of one of the following:

   a. Armstrong Pumps, Inc.
   b. Bell & Gossett, ITT Fluid Handling Div.

J. Shot feeders:

1. General – provide shot feeders of 5 gallon capacity or otherwise as indicated, constructed of cast iron or steel, for introducing chemicals in hydronic system. Provide funnel and valve on top for loading drain valve in bottom, and recirculating valves on side. Construct for pressure rating of 125 psi.

2. Manufacturer – subject to compliance with requirements, provide shot feeders of one of the following:

   a. Culligan USA
   b. Laboratories, Subsidiary of Clow Corp.
   c. Mougul Div., The Dexter Corp.

K. Water relief valves:

1. General – provide water relief valves as indicated, of size and capacity as selected by Installer for proper relieving capacity, in accordance with ASME Boiler and Pressure Vessel Code.

   a. Combined pressure temperature relief valves – bronze body, test lever, thermostat, complying with ANSI Z21.22 listing requirements for temperature discharge capacity. Provide temperature relief at 210 degrees F (99 C) and pressure relief as indicated on drawing.
   b. Pressure relief valves – bronze body, test lever, ASME rated. Provide pressure relief at as indicated on drawing.

2. Manufacturer – subject to compliance with requirements, provide water relief valves of one of the following:

   a. Bell & Gossett, ITT Fluid Handling Div.
   b. Taco, Inc.
   c. Armstrong Pump Co.

L. Pressure Reducing Valves:

1. General – provide pressure reducing valves as indicated, of size and capacity as selected by Installer to maintain operating pressure on boiler system.

2. Construction – brass body, low inlet pressure check valve, inlet strainer removable without system shutdown, non-corrosive valve seat and stem, factory set at operating pressure.

3. Manufacturer – subject to compliance with requirements, provide pressure reducing valves of one of the following:

   a. Bell & Gossett, ITT Fluid Handling Div.
   b. Taco, Inc.
   c. Armstrong Pumps, Inc.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Balance valves:

1. General - Install on each hydronic terminal and elsewhere as indicated.

B. Vent valves:

1. Manual vent valves - install manual vent valves on each hydronic terminal at highest point, and on each hydronic piping drop in direction of low for mains, branches and runouts and elsewhere as indicated.

2. Automatic vent valves - install automatic vent valves at top of each hydronic riser and elsewhere as indicated. Install shutoff valve between riser and vent valve, pipe outlet to suitable plumbing drain, or as indicated.

C. Flow control valves:

1. General - install flow control valves on discharge of each pump serving a hot water heating system or zone and elsewhere as indicated. Install in upright position in a horizontal line with adequate clearance for service and replacement. Adjust flow sensitivity for automatic operation.

D. Diverting fittings:

1. General - install diverting fittings as indicated and in accordance with manufacturer's instructions. Position fittings on supply and return mains with proper orientation for flow.

E. Air separators:

1. Dip tube fittings – install dip tube fittings in boiler outlet in accordance with manufacturer's instructions. Run piping to compression tank pitched towards tank at 1" rise in 5' runs (1.7%).

2. In-Line air separators – install in-line air separators in pump suction lines. Connect inlet and outlet piping. Run piping to compression tank pitched towards tank at 1" rise in 5' run (1.7%). Install drain valve on units 2" and over.

3. Combination separator/strainer – install external combination separators/strainers in pump suction lines. Connect inlet and outlet piping. Run piping to compression tank pitched towards tank at 1" rise in 5' run (1.7%). Install blowdown valve and piping. Remove and clean strainer after 24 hours and again after 30 days of system operation.

F. Compression tanks:

1. General – install compression tanks on trapeze hangers sized for tank fully loaded, or otherwise as indicated. Install tank fitting and drain valve in tank bottom and charge tank in accordance with manufacturer's instructions.

G. Diaphragm type compression tanks:

1. General – install diaphragm type compression tanks on floor as indicated, in accordance with manufacturer's instructions. Vent and purge air from hydronic system, charge tank with proper air charge as recommended by manufacturer.

H. Pump discharge valves:

1. General – at engineers option, install pump discharge valves on each pump discharge line in lieu of separate shutoff valve, check valve, and balance cock. Install in horizontal or vertical position with stem in upward position, allow clearance above stem for check mechanism removal. After hydronic system has been completed, mark calibrated name plate with stripe of yellow lacquer to permanently mark final balanced position.

I. Shot feeders:

1. General – install shot feeders on each hydronic system at pump discharge and elsewhere as indicated. Install in upright position with top of funnel not more than 48" above floor. Install in pump discharge line as indicated.

J. Water relief valves:

1. General – Install on hot water generators and elsewhere as indicated. Pipe discharge to floor. Comply with ASME Boiler and Pressure Vessel Code. Cut discharge pipe at 45° angle.

K. Pressure reducing valves:

1. Install for each hot water boiler or heat exchanger as indicated, and in accordance with manufacturer's installation instructions.

END OF SECTION