Specifications
Volume 2 of 3

UCONN HEALTH

Building C Renovation
Farmington, CT

(UCONN Project # 901737)

BID DOCUMENTS
December 10, 2015

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SECTION 210500

BASIC FIRE PROTECTION MATERIALS AND METHODS

PART 1 GENERAL

1.01 PROVISIONS INCLUDED

A. Include General Conditions, Supplementary General Conditions Division 0 and applicable parts of Division 1 for conditions and Section 019100 Commissioning and requirements which may affect the work of this Section.

B. Examine all other Sections of the specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

C. Coordinate work with that of all other Trades affecting, or affected by work of this Section. Cooperate with such Trades to ensure the steady progress of all work under the Contract.

1.02 DEFINITIONS

A. Words in the singular shall also mean and include the plural, wherever the context so indicates and words in the plural shall mean the singular, wherever the context so indicates.

B. Wherever the terms "shown on drawings" are used in the specifications, they shall mean "noted", "indicated", "scheduled", "detailed", or any other diagrammatic or written reference made on the drawings.

C. Wherever the term "provide" is used in the specifications it will mean "furnish" and "install", "connect", "apply", "erect", "construct", or similar terms, unless otherwise indicated in the specifications.

D. Wherever the term "material" is used in the specifications it will mean any product", "equipment", "device", "assembly", or "item" required under the Contract, as indicated by trade or brand name, manufacturer's name, standard specification reference or other description.

E. The terms "approved" or "approval" shall mean the written approval of the Architect.

F. The term "specification" shall mean all information contained in the bound or unbound volume, including all "Contract Documents" defined therein, except for the drawings.

G. The terms "directed", "required", "permitted", "ordered", "designated", "prescribed" and similar words shall mean the direction, requirement, permission, order, designation or prescription of the Architect. The terms "approved", "acceptable", "satisfactory" and similar words shall mean approved by, acceptable or satisfactory to the Architect. The terms "necessary", "reasonable", "proper", "correct" and similar words shall mean necessary, reasonable, proper or correct in the judgment of the Architect.

H. "Piping" includes in addition to pipe or mains, all fittings, flanges, unions, valves, strainers, drains, hangers and other accessories relative to such piping.

I. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction or in crawl spaces.

J. "Exposed" means not installed underground or "concealed" as defined above.

K. "Invert Elevation" means the elevation of the inside bottom of the pipe.

L. "Fire Protection Contractor" shall refer to the Contractor (or his Subcontractors) responsible for furnishing and installation of all work indicated on the Fire Protection drawings and specifications, as applicable and or referenced to each Trade in the Architectural and/or Structural documents.

M. "Architect" shall refer to "Architectural Resources Cambridge (ARC)" and/or Engineer "Bard, Rao + Athanas Consulting Engineers, LLC" and/or Owner.

N. “Owner” shall refer to the designated representatives of the Project Owner.

O. “Commissioning Agent (CA)” shall refer to the party employed by the Facility to witness the demonstration of all systems according to the commissioning plan. Refer to Section 019100.

P. “General Contractor” shall refer to Contractor(s) performing work under other sections of the contract specifications.

Q. “Construction Manager” shall refer to the Construction Manager ”Fusco Corporation” (CM) for this project.

1.03 CODES, STANDARDS AND REFERENCES

A. All materials and workmanship shall comply with all applicable Codes, Specifications, Local and State Ordinances, Industry Standards and Utility Company Regulations, latest editions.

B. In case of difference between Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations and the Contract Documents, the Fire Protection Contractor, as applicable, shall promptly notify the Architect in writing of any such difference.

C. In case of conflict between the Contract Documents and the requirements of any Code or Authorities having jurisdiction, the most stringent requirements of the aforementioned shall govern for budgetary purposes. However, no work will proceed until the Architect determines the correct method of installation.

D. Should any Contractor, as applicable, perform any work that does not comply with the requirements of the applicable Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations, he shall bear all costs arising in correcting the deficiencies, as approved by the Architect.

E. Applicable Codes and Standards shall include all State Laws, Local Ordinances, Utility Company Regulations and the applicable requirements of the following accepted Codes and Standards, without limiting the number, as follows:

1. National Fire Protection Association (NFPA) Standards Nos.: 13, 14, 25, 45, 70, 72 and NFPA 101, Life Safety Code
2. Environmental Protection Agency (EPA)
3. National Electric Code (NEC) – 2005 Amendments to NFPA 70
4. Factory Mutual Data Sheets: 2-0, 2-8, 3-0, 3-26 and others as applicable.
5. State of Connecticut Building Code – 2005 Edition, including all adopted supplements

6. State of Connecticut Fire Prevention Regulations and Elevator Regulations, including all adopted supplements
7. Local Ordinances, Regulations of the Local Building Department and Fire Department
8. Underwriters Laboratories
9. State Fire Marshall
10. Local Ordinances, Regulations of Local Building Department and Fire Department

F. In these specifications, references made to the following Industry Standards and Code Bodies are intended to indicate the accepted volume or publication of the Standard. All equipment, materials and details of installation shall comply with the requirements and latest revisions of the following Bodies, as applicable:

1. ANSI American National Standards Institute
2. ASME American Society of Mechanical Engineers
3. ASTM American Society of Testing Materials
4. CS Commercial Standards, U.S. Department of Commerce
5. FMG Factory Mutual Global
6. FS Federal Specification, U.S. Government
7. MSS Manufacturers Standardization Society of the Valve and Fittings Industry
8. NEMA National Electrical Manufacturers Association
9. NFPA National Fire Protection Association
10. UL Underwriters' Laboratories, Inc.

G. The Fire Protection Contractor for the work under his charge, shall give all necessary notices, obtain and pay for all permits, pay all governmental taxes, fees and other costs in connection with his work; file for necessary approvals with the jurisdiction under which the work is to be performed. The Fire Protection Contractor shall obtain all required Certificates of Inspection for his work and deliver same to the Architect before request for acceptance of his portion of work and before final payment is made.

H. All equipment shall be installed per manufacturer's recommendations and requirements. The Fire Protection Contractor shall notify the Architect in writing when they intend to deviate from manufacturer's installation guidelines. The Architect shall advise if the installation is acceptable prior to installation.

1.04 SUBMITTALS

A. Submit detailed shop drawings or brochures for approval of equipment and material proposed to be used on this project. Furnish the number of copies required by the General Conditions.

B. The documents submitted shall show the following:

1. Principal dimensions and details of construction.
2. Operating and maintenance clearances.
3. Weights of principal parts and total weights with information required for the design of supports and foundations.
4. Sizes and location of piping and connections.
5. Performance data, including pump curves.
6. Data on electric motors, including brake horsepower of driven equipment, nameplate ratings and classes, sound data, starting and running full load currents, required starter size and recommended overload heater ratings.
7. Approval stamp of Underwriters' Laboratory, Factory Mutual and other authorities having jurisdiction of Contract Drawings requiring such approval.

8. Certified performance guarantees.
9. Minimum scale for fire protection plans shall be 1/4 inch equal 1 foot.

C. Submit brochures that contain only that information which is relative to the particular equipment or materials to be furnished. Do not submit catalogs that describe several different items other than those items to be used unless irrelevant information is marked out and relevant material is clearly marked.

D. Specifications Compliance Statement

1. The manufacturer shall submit a point by point statement of compliance with the specifications.
2. The statement of compliance shall consist of a list of all paragraphs (line by line).
3. Where the proposed system complies fully, such shall be indicated by placing the word “comply: opposite the paragraph number.
4. Where the proposed system does not comply, or accomplishes the stated function in a manner different from that described, a full description of the deviation shall be provided.
5. Where a full description of a deviation is not provided, it shall be assumed that the proposed system does not comply with the paragraph in question.
6. Submissions which do not include a point by point statement of compliance as specified shall be disqualified.

1.05 GUARANTEE/WARRANTIES

A. Attention is directed to provisions of the General Requirements and Supplementary General Conditions regarding guarantees and warranties for work under this Contract.

B. Manufacturers shall provide their standard guarantees for work under this Contract, unless specified otherwise. However, such guarantees shall be in addition to and not in lieu of all other liabilities which the manufacturer and Prime Contractor may have by Law or by other provisions of the Contract Documents. In any case, such guarantees and warranties shall commence when the Owner accepts the various systems, as applicable and as determined by the Architect. The guarantees and warranties will remain in effect for a minimum period of (1) year thereafter except where longer periods are specifically stated and specified.

C. All materials, items of equipment and workmanship furnished by the Fire Protection Contractor shall carry the warranty against all defects in material and workmanship. Any fault due to defective or improper material, equipment, workmanship or design which may develop shall be made good, forthwith, by and at the expense of the Fire Protection Contractor responsible, including all other damage done to areas, materials and other systems resulting from this failure.

D. The Fire Protection Contractor shall guarantee that all elements of the systems provided under his Contract, are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated on the drawings.

E. Upon receipt of notice from the Owner of failure of any part of the systems or equipment during the guarantee period, the affected part or parts shall be replaced by the responsible Contractor.

F. The Fire Protection Contractor shall furnish, before the final payment is made, a written guarantee covering the above requirements.

1.06 COMMISSIONING

A. The Fire Protection Contractor(s) must also include sufficient man-hours within their bids, for their participation with the Commissioning Team meetings and overall process and the rebalancing/readjusting/resetting all device setpoints, as described in Section 019100.

B. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Section 019100, Commissioning, for detailed commissioning requirements.

1.07 THE CONTRACTOR

A. The Fire Protection Contractor shall base his bid on site examinations performed by him. This requirement is mandatory. The Fire Protection Contractor shall visit the proposed site where work is scheduled to be performed and ascertain for himself the amount of work required to fulfill the intent of his Contract and the complexity of the installation. The Fire Protection Contractor shall not hold the Architect, his Consultants, agents or employees responsible for or bound by, any schedule, estimate or for any plan thereof. The Fire Protection Contractor shall study all Contract Documents (HVAC, Plumbing, Electrical, Architectural, Structural), etc., included under each Contract, to determine exactly the extent of work to be provided under each Section, and in installing new equipment and systems and coordinating the work with the other Trades and existing conditions.

B. The Fire Protection Contractor shall faithfully execute his work according to the terms and conditions of the Contract and specifications and shall take all responsibility for and bear all losses resulting to him in the execution of his work.

C. The Fire Protection Contractor shall be responsible for the location and performance of work provided under his Contract as indicated on the Contract Documents. All parties employed directly or indirectly by the Fire Protection Contractor shall perform their work according to all the conditions as set forth in these specifications.

D. The Fire Protection Contractor shall furnish all materials and perform all work in accordance with the project specifications and any supplementary documents provided by the Architect. The work shall include every item shown on the drawings and/or required by the specifications as interpreted by the Architect. All work and materials furnished and installed shall be new and of the best quality and workmanship. The Fire Protection Contractor shall cooperate with the Architect so that no error or discrepancy in the Contract Documents shall cause defective materials to be used or poor workmanship to be performed.

1.08 COORDINATION OF WORK

A. The Fire Protection Contractor shall compare his drawings and specifications with those of other Trades and report any discrepancies between them to the Architect and obtain from the Architect written instructions for changes necessary in the mechanical or electrical work, to ensure that all work is installed in coordination and cooperation with other Trades installing interrelated work.

Before installation, the Fire Protection Contractor shall make proper provisions to avoid interferences in a manner approved by the Architect. All changes required in the work of the Fire Protection Contractor caused by his negligence, shall be corrected by him at his own expense, to the Architect's satisfaction.

B. Locations of piping and equipment shall be adjusted to accommodate the new work with interferences anticipated and encountered during installation. The Fire Protection Contractor shall determine the exact routing and location of his systems prior to fabrication or installation of any system component. Accurate measurements and coordination drawings will have to be completed to verify dimensions and characteristics of the various systems' installations.

C. Lines which pitch shall have the right-of-way over those which do not pitch. For example, waste piping shall normally have the right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed.

D. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings. The Fire Protection Contractor shall provide drains as required for his work to affect these offsets, transitions and changes in direction, as applicable.

E. All work shall be installed in a way to permit access (without damage to other parts) of valves, connections and all other system components provided under this Contract requiring periodic replacement or maintenance. All piping shall be arranged in a manner to clear the openings of swinging overhead access doors, ceiling tiles and cleaning access doors in ductwork.

1. Fire rated access doors/panels with closers shall be provided for all rated assemblies.

F. The Contract Drawings are diagrammatic only intending to show general runs and locations of piping, valves, equipment and specialties and not necessarily showing all required offsets, details and accessories and equipment to be connected. All work shall be accurately laid out with other Trades to avoid conflicts and to obtain a neat and workmanlike installation which will afford maximum accessibility for operation, maintenance and headroom.

G. Where discrepancies in scope of work as to what Trade provides items, such as starters, disconnects, flow switches, electric control components, etc., exist, such conflicts shall be reported to the Architect prior to signing of the Contract. If such action is not taken, the Fire Protection Contractor, as applicable, shall furnish such items as part of his work, for complete and operable systems and equipment, as determined by the Architect.

H. Where drawing details, plans and/or specification requirements are in conflict and where pipe is shown to be different between plans and/or between plans and sections or details, the most stringent requirement will be included in the Contract. Fire Protection systems and equipment called for in the specification and/or shown on the drawings shall be provided under this Contract as if it were required by both the drawings and specifications. However, prior to ordering or installation of any portion of work which appears to be in conflict, such work shall be brought to Architect's attention for direction as to what is to be provided.

I. Final location of all sprinkler heads and devices shall be coordinated with the Architect’s reflected ceiling plans, elevation plans and/or other Architectural details, as applicable. Sprinkler head locations shall provide the specified coverage rating and water flow density and shall be in accordance with all applicable codes and be in full compliance with the requirements of the Owner’s insurance carrier.

Offsets of piping, added fittings, valves, elbows, flexible connections, etc., shall be provided as required to comply with the Architectural floor plans, elevation plans and/or installation details. Obtain approval of locations of all devices from Architect in the field, prior to installation.

1.09 COORDINATION DRAWINGS

A. Before materials are purchased, fabricated or work is begun, the Fire Protection Contractor shall prepare coordination drawings in cooperation with all trades for all floors/areas, including buried systems/services (all-Trade-composite at 1/4" scale), showing the size and location of his equipment and lines, in the manner described herein under General Requirements.

B. The HVAC Contractor shall take the lead in the coordination drawing process to produce the Architectural backgrounds. A detailed drawing schedule shall be produced to conform to the scale drawing requirements as herein listed and submitted for review. Coordination drawings are for the CM and Architects/Engineer use during construction and shall not be construed as shop drawings or as replacing any shop drawings. The coordination drawings, when corrected for actual "as-built" conditions, will be reviewed by the Architect, corrected and become the Record Drawings to be submitted to the Owner for his use.

C. The cost of producing and reproducing the drawings will be included under the Contract of each Trade, including the cost or preparation of the Architectural building outlines. This process may include multiple revisions to these drawings which will be included in the cost. The intent is to provide a fully coordinated set of documents between trades no matter how many times they may have to be redone. The HVAC Contractor shall take the lead to produce the Architectural backgrounds, show all ductwork, piping, etc., and circulate the drawings to any of his Subcontractors and the other Trades (Plumbing, Fire Protection, Electrical, etc.), so that they can indicate all their work as directed by the CM and Architect as required, to result in a fully coordinated installation.

D. In addition to the regular coordination drawing review, the fire protection work will also be reviewed by the Architect to ensure that the system and equipment arrangements are suitable to provide maintenance access and service as follows:

1. All sprinkler heads shall be coordinated utilizing the reflected ceiling plan.
2. All sprinkler heads shall be coordinated with all other trades.
3. Coordination of fire pump room with all equipment and piping including the fire pump, jockey pump and associated piping.
4. Valves shall be grouped where possible and positioned in accessible locations.

E. Prepare a complete set of computer based drawings:

1. Format shall be:

a. REVIT (Latest Version)

2. Scale not less than 1/4" scale equals 1'-0", showing basic layout for the structure and other information as needed for preparation of Coordination Drawings.
3. The drawings shall indicate the layout of all specialty tradework as indicated herein and shall be designated as Coordination Drawings.

4. Any drawing provided to assist the Contractor will require:

    a. A signed liability release form will be required from the Contractor prior to the release of the disk from the Engineer.

F. Highlight all fire rated partitions on the Coordination Drawings for appropriate coordination.

G. The main paths for the installation or removal of all MEP & FP equipment from mechanical and electrical rooms shall be clearly indicated on the Coordination Drawings.

H. Each of the specialty trades shall add its work to the base drawings with appropriate elevations and grid dimensions. Specialty trade information shall be required for mechanical rooms, crossovers and for spaces above ceilings where congestion of work may occur such as corridors and, where required, entire floors. Drawings shall indicate horizontal and vertical dimensions to avoid interference with structural framing, ceilings, partitions and other services. Indicate elevations relative to finish floor for bottom of piping. Sections shown in the contract drawings are diagrammatic only and all trades shall share and coordinate sectional views used.

1. Specialty Trade shall include:

    a. Plumbing system
    b. HVAC piping and associated control systems
    c. Electrical
    d. Sheet metal work
    e. Fire protection system
    f. Automatic temperature control
    g. Fire alarm
    h. Security
    i. Telecommunications
    j. Pneumatic tube
    k. Commissioning

I. Upon completing their portion of the Coordination Drawings, each specialty trade shall sign, date and submit the Coordination Drawings to the CM, Architect/Engineer for review.

J. Where conflicts occur with placement of materials of various trades, the CM shall be responsible to coordinate the available space to accommodate all trades. Any resulting adjustments shall be initialed and dated by the affected specialty trade Contractor. The CM shall then final date and sign each drawing.

K. Fabrication of materials shall not start until Coordinate Drawings have been signed, reviewed, and distributed to all parties as indicated herein.

L. Distribution of Coordination Drawings: (Modified for clarification)

1. The CM shall provide one print of each Coordination Drawing to:

    a. Each specialty trade Subcontractor.
    b. Owner.
    c. General Contractor.
    d. Architect (for record purposes).
    e. Engineer.

M. After Distribution

1. Resolve all interferences not previously identified.

N. Coordination Drawings shall include, but are not necessarily limited to:

1. Structure. (Beams, cross bracing, columns etc.).
2. Partition/room layout, including indication of smoke and fire resistance rated partitions.
3. Ceiling layout and heights.
4. Light fixtures.
5. Access panels.
6. Sheet metal, heating coils, heat pumps, grilles, diffusers, duct flanges, and pipe hanger/supports and pipe support steel, guides, expansion compensators, kitchen exhaust access doors, and take-offs from the duct risers, etc.
7. All heating piping and valves.
8. Smoke and fire dampers including access doors.
9. Soil, waste and vent piping.
10. Major water and gases.
11. Major electrical, fire alarm, and security conduit runs (All sizes), panelboards, feeder conduit and racks of branch conduit (All). Motor control centers, starters and disconnects including shaft coordination for larger conduit riser junction boxes to ensure access for JBs and JBs sized to access all cables, and access to splice cables.
12. Sprinkler piping and heads.
13. All equipment, including items in the Contract as well as O.F.C.I. and O.F.I. items.
14. Equipment located above finished ceiling requiring access for maintenance and service. In locations where acoustical lay-in ceilings occur indicate areas in which the required access area may be greater than the suspended grid systems.
15. Rainwater piping
16. Existing conditions, including but not limited to, Mechanical, Plumbing, Fire Protection and Electrical items.
17. ATC panels
18. Cable tray
19. Beam Penetrations

O. All shaft coordination drawings shall be detailed with the appropriate sizes for all ducts, HVAC pipe, conduits, fire protection piping & Plumbing waste, vent, water, gases, etc. Hanger support types, miscellaneous support steel shall be detailed to allow for proper clearances and appropriate insulation thickness. Shaft coordination drawings shall be submitted for review in plan and elevation views.

P. The Architect's response to all requests for information (RFI's) generated by the trade contractors shall be distributed to all other affected trades as if this information was contained in the original contract documents. In other words, the party that issues an RFI is responsible for distributing the information to all affected parties.

Q. The Fire Protection Contractor must include in his bid sufficient dollar amounts to coordinate the work of this Contract. This project is complex and will require additional time to coordinate all Trades and allow implementation of the Owners Standards and maintenance serviceability requirements. This requirement shall include, but not be limited to, producing the coordination drawings, as many times and as many drawings as required, to ensure serviceability of equipment, as approved by the Architect.

1.10 RECORD DRAWINGS

A. The Fire Protection Contractor shall maintain, current at the site, a set of Contract Drawings for his portion of the work on which he shall accurately show the actual installation of all work provided under his Contract indicating any variation from the Contract Drawings, in accordance with the General Conditions and Supplementary General Conditions. Changes whether resulting from formal change orders, requests for information, or other instructions issued by the Architect shall be recorded. Include changes in sizes, location and dimensions of piping, ducts, equipment, etc.

B. The Fire Protection Contractor shall indicate progress by coloring-in various pipes and associated appurtenances exactly as they are erected. This process shall incorporate both the changes noted above and all other deviations from the original drawings whether resulting from job conditions encountered or from any other causes.

C. The marked-up and colored-up prints will be used as a guide for determining the progress of the work installed. They shall be inspected periodically by the Architect and Owner's representatives and they shall be corrected if found either inaccurate or incomplete. This procedure is mandatory. Marked up drawings shall include all flow diagrams, schedules, details and control diagrams.

D. The Fire Protection Contractor shall meet at a minimum on a monthly basis, with the Owner's representative to transfer the information from his Fire Protection marked-up and colored-up prints to a set which will become the basis for preparation of as-built drawings.

E. Upon completion of the project, each Contractor shall submit his marked-up drawings to the Architect for review and comment. After the Architect reviews and comments on this set of documents, each Contractor shall prepare as-built drawings on CAD using the format specified for coordination drawings. When the work is completed, each Contractor shall provide 2 hard copies to the Architect for submittal to the Owner and disks with all documentation and a set of reproducible drawing plots marked "As-Built" drawings. The Contractor shall bear all costs of producing the CAD "As-Built" drawings, providing all necessary drawing changes and printing the reproducible drawings for the work under his charge.

1.11 GIVING INFORMATION

A. The Fire Protection Contractor shall keep himself fully informed as to the shape, size and position of all openings required for his apparatus and shall give information to the Architect and other Contractors **[or Subcontractors]** sufficiently in advance of the work so that all openings may be built in advance.

1.12 EQUIPMENT AND MATERIALS

A. Equipment and materials shall be delivered to the site and stored in original sealed containers, suitably sheltered from the elements, but readily accessible for inspection by the Architect until installed. All items subject to moisture damage such as controls, motors, etc., shall be stored in dry, heated spaces.

B. The Fire Protection Contractor shall have his equipment tightly covered and protected against dirt, water and chemical or mechanical injury and theft. At the completion of the work, equipment and materials shall be cleaned, polished thoroughly and turned over to the Owner in a condition satisfactory to the Architect. Damage or defects developing before acceptance of the work shall be made good at the Fire Protection Contractor's **[or Subcontractor's]** expense as applicable.

C. The Fire Protection Contractor shall make necessary field measurements to ascertain space requirements, for equipment and connections to be provided under his Trade and shall furnish and install such sizes and shapes of equipment to allow for the final installation to conform to the drawings and specifications.

D. Manufacturers' directions shall be followed completely in the delivery, storage, protection and installation of any equipment. Promptly notify the Architect in writing of any conflict between any requirements of the Contract Documents and the manufacturer's directions and obtain the Architect's written instructions before proceeding with the work. Should any Contractor perform any work that does not comply with the manufacturer's directions or written instructions from the Architect, he shall bear all costs arising in correcting any deficiencies that should arise.

E. The Fire Protection Contractor shall furnish and install all equipment, accessories, connections and incidental items necessary to fully complete the work under his Contract for use, occupancy and operation by the Owner.

F. Where equipment of the acceptable manufacturers requires different arrangement or connections from those shown, it shall be the responsibility of the Fire Protection Contractor to install the equipment to operate properly and in harmony with the original intent of the drawings and specifications. When directed by the Architect, the Fire Protection Contractor shall submit drawings showing the proposed installation. If the proposed installation is approved, the Fire Protection Contractor shall make all necessary changes in all effected related work provided under other Sections including location of roughing-in connections by other Trades, electrical requirements, piping, supports, insulation, etc. All changes shall be made at no increase in the Contract amount or additional cost to the other Trades and/or Owner.

G. All equipment and materials required for installation under these specifications shall be new and without blemish or defect. Equipment and materials shall be products which will meet with the acceptance of the Authorities having jurisdiction over the work and as specified hereinbefore. Where such acceptance is contingent upon having the products listed or labeled by FM, UL or other testing laboratories, the products shall be so listed or labeled. Where no specific indication as to the type or quality of material or equipment is indicated, a first class standard article shall be provided.

H. All equipment of one type (such as valves, sprinklers, etc.), shall be the product of one manufacturer.

I. Equipment pre-purchased on behalf of the Owner or by the Owner himself, if assigned to any of the Contractors, shall be received, inspected, installed, etc., as if it was purchased by the Contractors as applicable. All guarantees, service contracts, etc., shall be the same as for all other equipment provided under this Contract.

1.13 CUTTING AND PATCHING

A. The Fire Protection Contractor shall be responsible for all core drilling, as required for work under his Contract, but in no case shall he cut into any structural elements without the written approval of the Architect. For additional requirements, refer to Division One of the General Requirements.

B. All cutting, rough patching and finish patching, shall be provided under this Contract.

C. All concrete and masonry equipment bases and pads shall be provided under this Contract.

1.14 USE OF PREMISES

A. The Fire Protection Contractor shall confine all of his apparatus, storage of materials and construction to the limits indicated on the drawings and directed by the Architect and he shall not encumber the premises with his materials.

B. In storing materials within areas (structure or ground), or when used as a shop, the Fire Protection Contractor shall consult with the Prime Contractor and shall restrict his storage to space designated for such purposes. The Fire Protection Contractor will be held responsible for repairs, patching or cleaning arising from any unauthorized use of premises.

C. Notwithstanding any approvals or instructions which must be obtained by the Fire Protection Contractor from the Architect in connection with use of premises, the responsibility for the safe working conditions at the site shall remain the Fire Protection Contractor's. The Architect or Owner shall not be deemed to have any responsibility or liability in connection therewith.

1.15 PROTECTION

A. All materials such as valves, fittings, piping, etc. shall be properly protected and all piping openings shall be temporarily closed by the Fire Protection Contractor [or Subcontractor's] installing same, so to prevent obstruction and damage. The Fire Protection Contractor shall take precautions to protect his materials from damage and theft.

B. The Fire Protection Contractor shall furnish, place and maintain proper safety guards for the prevention of accidents that might be caused by the workmanship, materials, equipment or electrical systems provided under his Contract.

1.16 DAMAGE CORRECTION AND EXTRA WORK

A. The Fire Protection Contractor shall be held responsible and shall pay for all damages caused by his work to the new and existing building structures and new and existing equipment, piping, duct systems, etc., and all work and finishes installed under this Contract in the new or in existing building. Repair of such damage shall be done as herein before specified, at the expense of the Fire Protection Contractor and to the Architect's satisfaction.

B. The Fire Protection Contractor shall promptly correct all work provided under his Contract and rejected by the Architect as defective or as failing to conform to the Contract Documents whether observed before or after completion of work and whether or not fabricated, installed or completed. The Fire Protection Contractor shall bear all costs of correcting such rejected work.

C. No claim for extra work will be allowed unless it is authorized by the Architect in writing before commencement of the extra said work.

1.17 TOUCH-UP PAINTING

A. The Fire Protection Contractor shall thoroughly clean all equipment and systems provided under this Contract from rust, splatters and other foreign matter or discoloration, leaving every part of each system in an acceptable prime condition. The Fire Protection Contractor, for the work under his Contract, shall refinish and restore to the original condition all equipment and piping which has sustained damage to the manufacturer's prime and finish coats of paint and/or enamel.

1.18 HOUSEKEEPING PADS

A. The Fire Protection Contractor shall coordinate housekeeping pads for:

1. Fire pump, jockey pump and controllers
2. All floor supports or braces

B. Pads shall be 4" high above the finished floor.

C. Each pad shall be a minimum of 6" larger then the equipment, support or isolation base in all directions.

D. Pads shall be formed, poured with concrete, and tooled by the General Contractor.

E. Pads shall not be poured until after the M.E.P. coordination drawings are completed.

1.19 PIPE SLEEVES, PLATES AND ESCUTCHEONS, FIRESTOPPING AND SMOKEPROOFING

A. Where piping pass through masonry or concrete walls or floors, the Fire Protection Contractor shall provide and set individual sleeves for each pipe and all other work under his charge, as necessary for passage of all pipes. Sleeves shall be of sufficient size to provide 1/2" air space around the pipe passing through. All openings shall be sealed, smokeproofed and made tight. The Fire Protection Contractor shall be responsible for the exact location of sleeves provided under his Contract and shall coordinate all requirements for piping sleeves. In the event that failure to do so requires cutting and patching, it shall be done at this Contractor’s expense.

B. The Fire Protection Contractor, for work under his charge, shall determine the required inside diameter of each individual wall opening or sleeve before ordering, fabrication or installation.

C. Sleeves passing through lightproof or soundproof walls and floors and through firewalls shall be sealed and made tight using only approved materials and methods.

D. Sleeves and inserts shall not be used in any portions of the building, where their use would impair the strength or construction features of the building. Elimination of sleeves must be approved by the Architect.

E. Provide chrome plated brass escutcheons with set screw for exposed piping, in all areas except in mechanical rooms. In this area use plain brass or cast iron escutcheons suitable for painting. All escutcheons shall be sized to fit the bare pipe or insulation in a snug and neat manner.

They shall be of sufficient size to cover sleeved openings for the pipes and of sufficient depth to cover sleeves projecting above floors. Escutcheons shall be as manufactured by Beaton & Caldwell, Dearborn Brass, or Grinnell. All escutcheons shall be of one piece construction.

F. Pipe sleeves shall be made of Schedule 40 pipe, 20 gauge galvanized steel or 16 gauge steel as follows:

1. Sleeves on pipes passing through masonry or concrete construction shall be Schedule 40 pipe.
2. Sleeves on pipes passing through drywall construction shall be 20 gauge galvanized steel.
3. Sleeves on pipes passing through fire rated partitions shall be 16 gauge steel.

G. Pipe sleeves shall be set as follows:

1. Set sleeves 1" above finish floor, (except set sleeves, 6" above finish floor at penthouses or mechanical rooms and 6” above finished roof) and flush on each side of walls. Coordinate roof penetrations with roofing Contractor.
2. Sleeves shall be set securely in place before concrete is poured when placed in concrete construction.

H. The Fire Protection Contractor shall firestop or smoke stop the space between the sleeves provided under his Contract and piping as applicable, as follows:

1. See Specification Section 210584 – Through-Penetration Firestopping System

I. Except as otherwise specified, underground piping passing through exterior walls or foundation slabs on grade, shall have penetration closures of the modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Links shall be loosely assembled with bolts to form a continuous belt around the pipe and with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely watertight seal between the pipe and wall, reducing chances of cathodic reaction between these members. The Fire Protection Contractor for work under his charge shall determine the required inside diameter of each individual wall opening or sleeve before ordering, fabrication or installation. The inside diameter of the wall opening shall be sized to fit the pipe and ensure a watertight joint. Where applicable, when installing seals, take into account the pipe O.D. if non-standard due to coating or jacketing.

1.20 MISCELLANEOUS IRON AND STEEL

A. Each trade shall provide all primary and secondary steel supports and hangers as shown on the drawings and/or as required to support equipment, piping or any other materials provided under the work of this Section.

B. The work of this Section of designing, furnishing and installing all miscellaneous metal work associated with the system, and related items as indicated on the drawings and/or as specified herein, and includes, but is not limited to the items listed herein below.

C. The scope of work shall include:

1. Intermediate beams to hang piping from the roof. All piping must be hung from beam or supported from the floor.

2. Support of piping in shafts in addition to support provided by structure.
3. Pipe anchors in the building.
4. Hangers, brackets, angel irons or rods required for the support and protection of fire protection equipment.
5. Field prime painting of galvanized steel and field finish painting.

D. Shop Drawings for General Miscellaneous Items

1. Submit Shop Drawings of all miscellaneous metal items to Architect for approval, showing sizes and thickness of all members, types of materials, methods of connection and assembly, complete dimensions, clearances, anchorage, relationship to surrounding work by other Trades, shop paint, and other pertinent details of fabrication and installation.

E. Samples

1. Submit duplicate samples of all materials to be furnished under this Section if, and in size and form, requested by Architect.

F. Do not order materials or begin fabrication until Architect's approval of submittals has been obtained.

G. In addition to the governing laws and codes, the following Specifications and Codes form a part of this Specification:

1. American Iron and Steel Institute applicable standards.
2. American Institute of Steel Construction "Code of Standard Practice for Steel Buildings and Bridges" and "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings".
3. American Welding Society Code: Standard Code for Arc and Gas Welding in Building Construction.

H. All materials shall be new stock, free from defects impairing strength, durability or appearance and of best commercial quality for each intended purpose.

1. Unless otherwise specifically called for, work of this Section shall be fabricated of structural steel conforming to ASTM Specification A36.
2. Steel pipe shall be seamless steel pipe conforming to ASTM Specification A53, Schedule 40.
3. Steel tubing shall be seamless steel tubing conforming to ASTM Specifications A500 to A501.
4. Construction specialties such as slotted inserts, wedge inserts, etc., shall be as manufactured by Hohmann and Barnard, Gateway Erectors, Inc., Richmond Screw Anchor Co., or equal approved by Architect.
5. Non-ferrous metals shall be as specified under descriptions of specific items, herein below.

I. Provide all anchors, bolts, sockets, sleeves, and other parts required for securing each item of work of this Section to the construction, including furnishing to concrete workers all required insets and sleeves for use at concrete.

1. All exposed fastenings shall be of the same material and finish as the metal to which applied, unless otherwise noted.

2. Welding rods shall conform to AWS Standards and the recommendation of the welding rod manufacturer.
3. Shop primer for other ferrous surfaces shall be a high-quality, lead-free, rust-inhibitive primer, Tnemec No. 10-99 Metal Primer or equivalent by Devoe and Raynolds Co., Carboline or equal.

J. Metal surfaces shall be clean and free from mill scale, flake, rust and rust pitting. Metal work shall be well formed and finished to required shape and size, true to details, with straight, sharp lines and angles and smooth surfaces. Curved work shall be true radii. Exposed sheared edges shall be eased.

K. Weld all permanent connections. Welds shall be continuous on all exposed surfaces and where required for strength on concealed surfaces. Exposed welds shall be ground flush and smooth, with voids filled with metallic filling compound (metallic filling compound not permitted on surfaces to receive hot-dip galvanizing). Tack-welding will not be permitted unless specifically called for. Do not use screws or bolts where they can be avoided. Where used, heads shall be countersunk, screwed up tight, and threads nicked to prevent loosening.

L. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall give ample strength and stiffness. Joints exposed to weather shall be formed to exclude water.

M. Do all cutting, punching, drilling and tapping required for attachment of anchor bolts and other hardware and for attachment of work by other Trades. All such cutting, punching, drilling, etc., shall be done prior to hot-dip galvanizing of the various components.

N. Live loads shall be not less than the minimum required by law. Where specific live load are not set forth in the laws and codes applicable to this work, and are not given on the Drawings or in this Specification, designs shall be such as to support the live loads which may normally be imposed without failure, without deflection of more than 1/360 of length of any member, and without permanent deformation, all with a factor of safety of not less than 2 1/2 to 1.

O. Shop Painting

1. All ungalvanized ferrous metals under this Section shall be given a shop coat of rust inhibitive primer of type specified above.

   a. Immediately before shop painting, remove all rust, loose mill scale, dirt, weld flux, weld spatter, and other foreign material with wire brushes and/or steel scrapers. Power tool clean in accordance with SSPC SP-3 (Power Tool Cleaning). Remove all grease with oil by use of solvent recommended by paint manufacturer. Sandpaper exposed surfaces as required to produce smooth, even finishes.
   b. Apply paint by spray process in strict accordance with manufacturer's printed instructions to uniform thickness(es) recommended by manufacturer. Apply thoroughly and evenly and work well into corners and joints taking care to avoid sags and runs.
   c. Do not paint surfaces to be embedded in concrete, or to be welded in the field. After field welds are complete, grind smooth and flush, thoroughly clean and then apply specified primer over all unprimed in the field by brush roller.
   d. After erection, sand smooth and retouch all portions of the shop coats chipped or damaged during erection, and coat all field welds and connections with primer equivalent to that used for the shop coat.

P. Installation

1. All materials shall be carefully handled and stored under cover in manner to prevent deformation and damage to the materials and to shop finishes, and to prevent rusting and the accumulation of foreign matter on the metal work. All such work shall be repaired and cleaned prior to erection.
2. Work shall be erected square, plumb and true, accurately fitted, and with the tight joints and intersections. All anchors, inserts and other members to be set in concrete or masonry shall be furnished loose by this Trade to be built-into concrete and masonry and by those Trades as the work progresses. Later cutting or drilling shall be avoided wherever possible.
3. Where members, other than expansion bolts or inserts, are fastened into concrete, set such members in holes formed as specified below, and secure permanently in place by installation of proprietary-type expanding grout manufactured specifically for such purpose, used strictly in accordance with manufacturer's directions. Holes to receive members shall be formed with galvanized sheet metal sleeves, expanded polystyrene foam, or other approved method to provide at least 1/2 inch clearance around entire perimeter. At exposed applications, hold expanding grout back 1/2 inch from finish surface and fill voids with Portland cement grout to match color and texture of surrounding concrete surface.
4. Electrolytic Isolation

   a. Where dissimilar metals are to come into contact with one another, isolate by application of a heavy coating of bituminous paint on contact surfaces in addition to shop coat specified above. Do not permit the bituminous paint in any way to remain on surfaces to be exposed or to receive sealant.

Q. Piping supports shall be coordinated with the building structure and shall span between roof beams as required.

1.21 WATERPROOFING, FLASHING AND COUNTERFLASHING

A. Unless specifically indicated otherwise on the drawings, the Fire Protection Contractor shall provide all counterflashing and waterproofing of all piping, drains and equipment provided by him, which pierce roofs, walls and other weatherbarrier surfaces. All work under this paragraph shall be coordinated with the CM.

B. All work shall be performed in a workmanlike manner to ensure weatherproof installation. Any leaks developed due to the Fire Protection Contractor's work shall be repaired at his expense, to the Architect's satisfaction.

C. Pipes passing through slabs shall have the sleeve extended above floors as hereinbefore specified to retain any water and the space between the pipe and sleeve caulked waterproof fire stopping. The top and the bottom shall be sealed with monolastic caulking compound.

D. All flashing required for piping penetrations shall be provided by the CM.

1.22 IDENTIFICATION OF MATERIALS

A. See Division 211000.

1.23 VALVE TAGS, NAMEPLATES AND CHARTS

A. See Division 211000.

1.24 ELECTRICAL WORK, MOTORS AND MOTOR CONTROLLERS

A. See Division 26 for Electrical.

1.25 PARTS LIST AND INSTRUCTIONS FOR OPERATION AND MAINTENANCE

A. The Fire Protection Contractor shall thoroughly instruct the representative(s) of the Owner, to the complete satisfaction of the Architect, in the proper operation of all systems and equipment provided by him. The Fire Protection Contractor shall make arrangements, via the CM as to whom the instructions are to be given in the operation of the basic and auxiliary systems and the periods of time in which they are to be given. The Architect shall be completely satisfied that the representative of the Owner has been thoroughly and completely instructed in the proper operation of all systems and equipment before final payment is made. If the Architect determines that complete and thorough instructions have not been given by the Fire Protection Contractor to the Owner's representative, then the Fire Protection Contractor shall be directed by the Architect to provide whatever instructions are necessary until the intent of this paragraph of the specification has been complied with. All time required for Owner's instruction to satisfy the above requirements shall be included in this Contract. No extra compensation for such instructions will be allowed.

B. The Fire Protection Contractor shall provide operating and maintenance data in accordance with the Specification. All data and literature furnished shall be specific for the make and model of the equipment furnished. General non-specific catalog data will not be acceptable. Information shall indicate possible problems with equipment and suggested corrective action. The manuals shall be indexed for each type of equipment. Each section such as valves, fire pump, sprinklers, etc., shall be clearly divided from the other sections. A sub-index for each section shall also be provided. The methodology of setting-up the manuals shall be submitted to the Architect and Owner through the Prime Contractor for approval prior to final submission of manuals.

C. The instructions shall contain information deemed necessary by the Architect and shall include, but not be limited to, the following:

1. Instructional classes on equipment and systems operation for Owner's representative and maintenance personnel, by engineering staff of each Contractor. Minimum of 48 hours of instruction for minimum of (6) people. Instruction shall include:

   a. Explanation of manual and its use.
   b. Summary description of the Fire Protection systems.
   c. Purpose of systems.

2. System

   a. Detailed description of all systems.
   b. Illustrations, schematics, block diagrams, catalog cuts and other exhibits.

3. Operations

   a. Complete detailed, step-by-step, sequential description of all phases of operation for all portions of the systems, including start-up, shutdown, adjusting and balancing. Include all posted instruction charts.

4. Maintenance

   a. Parts list and part numbers.
   b. Maintenance, lubrication and replacement charts and manufacturer's recommendations for preventive maintenance, as applicable to his work.
   c. Troubleshooting charts for systems and components.
   d. Instructions for testing each type of part.
   e. Recommended list of on-hand spare parts.
   f. Complete calibration instructions for all parts and entire systems.
   g. Instruction for charging, filling, draining and purging, as applicable.
   h. General or miscellaneous maintenance notes.

5. Manufacturer's Literature

   a. Furnish complete listing for all parts required for models actually furnished.
   b. Names, addresses and telephone numbers of manufacturers and suppliers.
   c. Describe and operation of all models actually furnished.
   d. Furnish all and only pertinent brochures, illustrations, drawings, cuts, bulletins, technical data, certified performance charts and other literature with the model actually furnished to be clearly and conspicuously identified.
   e. Internal wiring diagrams and engineering data sheets for all items and/or equipment furnished under each Contract.
   f. Guarantee and warranty data.

6. Each Contractor shall furnish instructions for lubricating each piece of equipment installed by him. Instructions shall state type of lubricant, where and how frequently lubrication is required. Frame instructions under glass and hang in a location as directed by Architect.

1.26 MANUFACTURER'S REPRESENTATIVE AND START-UP OF SYSTEMS

A. The Fire Protection Contractor shall provide, at appropriate time or as directed by the Architect, the on-site services of a competent factory-trained Engineer or authorized representative of particular manufacturer of equipment provided under his Contract, such as for the sprinkler system, fire pumps, etc. provided under this Contract, to instruct the Owner, inspect, adjust and place in proper operating condition any item provided by him, as applicable.

B. The Fire Protection Contractor, as applicable, shall start up and set in operating condition all major equipment and systems, such as the fire pump, etc., in the presence of the applicable equipment manufacturer's representatives, and the Owner and Architect's representatives. In no case will major systems and equipment be commissioned by any of the Contractor's forces alone, without the assistance or presence of the equipment manufacturers.

C. A written report shall be issued by the particular equipment manufacturer and the Fire Protection Contractor summarizing the results of the start up and performance of each system for the Architect's record. No additional compensation will be allowed for any Contractor for such services.

D. The Fire Protection Contractor shall prepare and submit to the Architect for acceptance, a schedule of anticipated system commissioning. No system shall be commissioned without prior acceptance of the schedule by the Architect and Owner. No system shall be commissioned prior to submittal and acceptance of the operations and maintenance manuals.

1.27 CONNECTIONS TO EQUIPMENT

A. The Fire Protection Contractor shall provide all pipe connections, drains, relief valves, power connections, etc., to make equipment operable, as provided under other Sections of the specifications, as shown on the Architectural and/or each Trade's drawings and herein specified, including final connections to equipment to result in a complete system, fully operational. Coordinate location of all equipment with Architect. Obtain installation diagrams and methods of installation of all equipment from manufacturers. Follow instructions strictly. If additional information is required, obtain same from Architect. If equipment is indicated on the Architectural drawings, it shall also be construed and understood by the Fire Protection Contractor to be constructed as shown on the Fire Protection drawings and shall be fully serviced and connected at no extra cost to the Owner.

1.28 ELECTRICAL ROOM REQUIREMENTS

A. The Fire Protection Contractors shall not install any piping or equipment in or through electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms, unless piping or equipment is intended to serve these rooms. If any Contractor violates this requirement, he shall remove and/or relocate all items as required at his expense and to the satisfaction of the Architect.

1.29 HOISTING EQUIPMENT AND MACHINERY

A. All hoisting equipment and machinery required for the proper and expeditious prosecution and progress of the work under this Contract shall be furnished, installed, operated and maintained in safe condition by the Fire Protection Contractor for his material and/or equipment delivered to the designated hoisting area. All costs for hoisting operating services shall be borne by the Fire Protection Contractor for all equipment and work under his charge.

1.30 STAGING

A. All staging, exterior and interior, required to be over 8'-0" in height shall be furnished and erected by the Fire Protection Contractor for work under his charge and maintained in safe condition by him for proper execution of his work.

1.31 PHASING, DEMOLITION AND MAINTAINING EXISTING SERVICES

A. During the execution of the work, required relocation of existing equipment and systems in the existing areas where new work and connections are scheduled to be made shall be performed by the Fire Protection Contractor as indicated on the drawings, as required by the job conditions and as determined by the CM in close cooperation with the Architect and Owner's designated representative to facilitate the installation of the new systems and completion of this Contract. The Owner will require the continuous operation of all existing systems while demolition relocation work of new tie-ins is being performed. Outages required for construction purposes shall be scheduled for the shortest practical periods of time, in coordination with the Owner's designated representative for specific, mutually agreeable periods of time after each of which the interruption shall cease and service shall be restored. This procedure shall be repeated to suit the Owner's working schedule as many times as required until all work is completed.

B. Prior to any deactivation and relocation, capping, valving, tie-in or demolition work, consult the drawings and arrange a conference with the Architect and the Owner's representative in the field to inspect each of the items to be deactivated, removed or relocated. Care shall be taken to protect all equipment designated to be relocated and reused. Give notice to all parties, with a minimum of (10) working days in advance.

C. All draining of existing systems, filling and venting required to remove and relocate existing piping systems shall be included and provided under this Contract as required to perform the various equipment or piping relocations or new tie-ins.

D. Except as otherwise noted, all deactivation, safe capping, valving, etc., of systems designated to be demolished shall be provided by the Fire Protection Contractor, as applicable, and all demolition, removal and disposal of demolished materials shall be performed by the CM. All equipment scheduled to be removed shall be inspected by the Owner, and, if he decides that such equipment is to be salvaged, the Fire Protection Contractor shall deliver said equipment to an area within the site boundaries as determined by the Owner and Architect.

E. The phasing of the work shall be performed in strict accordance with the CM construction schedule. The new systems will be installed and completely commissioned prior to occupancy. Coordinate requirements for temporary heat or rerouting of existing services as required to accomplish the construction schedule.

F. The Fire Protection Contractor shall be responsible for shutting down, draining and demolition of the existing system as required. All work shall be done during the day and the system shall be placed back in operation prior to the end of the day. If system cannot be operational, then the Fire Protection Contractor shall be required to provide fire watch.

G. The Fire Protection Contractor shall follow the Owner's Shut-down Notification Procedures.

H. It shall be the responsibility of the Contractor and Sub-Contractor to provide temporary provisions related to maintaining MEP/FP/FA/LV services to support program areas that are to remain occupied and in use by the Owner during the phased construction. (Scope to be inclusive of temporary supplies to systems during interim conditions and ensuring building life safety code requirements are always maintained).

PART 2 PRODUCTS

2.01 NOT USED

PART 3 EXECUTION

3.01 NOT USED

END OF SECTION

SECTION 210510

3D BUILDING INFORMATION MODELING

1.01 OVERVIEW

A. Building Information Modeling (BIM) is the development and use of a 3-dimensional computer model to represent a virtual model of the facility and the process for constructing the facility. Once the model is developed, it can be used to simulate the construction process and to manage the operations of the facility. The Building Information Model can be created by combining many different 3D models from the designers and contractors into a composite model. From this composite model, views and data appropriate to various users' needs can be extracted and analyzed to generate information, to make decisions and to improve the process of delivering the building.

1.02 OUTCOME

A. The purpose of BIM is to create a model that may be used for coordination of all trades throughout the construction process, with the final product being an as-built model of the Project which contains all of the major elements of construction that could be used by the Owner for future operation and maintenance of the building.

1.03 REQUIRED DISCLAIMER

A. All users shall be required to sign a disclaimer as follows:

TERMS OF USE OF 3D COMPUTER MODEL FOR THE UCONN PROJECT ("Project")

This 3D Computer Model for the Project is provided by Architectural Resources Cambridge (ARC) (Architect) to user (individually, a "User", or collectively, "Users") at the User's request subject to the terms and conditions stated below (the "Terms of Use"):

The 3D Model is made available to User solely for his convenience and for informational purposes only. The User is not to rely upon the 3D Computer Model and the data and/or information contained therein in preparing any of the coordination documents for the Project. The User acknowledges that the 3D Computer Model is not a part of the Construction or Contract Documents for the Project and that the Architect makes no representations or warranties, express or implied, regarding the 3D Computer Model's, accuracy or completeness or the data and/or information contained therein.

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The User acknowledges and agrees that it is not in privity of contract with the Architect as of result of these Terms of Use with respect to any claims or causes of action related to or arising out of the Project. The User further agrees to obligate any contractor, consultant or other party who uses the 3D Computer Model to be bound by the terms and conditions contained herein. Any User's use of the 3D Computer Model and the information and/or data contained therein constitutes such User's acceptance of all the terms here specified.

ACCEPTED & AGREED:

Name: _____

Title: _____

Date: _____

1.04 SCOPE OF WORK

A. General Scope Requirements

1. In general, the BIM scope of work for the Project is to create a technically accurate and detailed 3D computer model of the architectural, structural, mechanical, plumbing and electrical systems.
2. The computer model (in plan view) shall extend to five feet beyond the exterior walls of the building. Vertically, the model shall extend from the lowest extent of the foundations up through and including the roof of the top-most floor. To the extent that the scope includes building systems, those systems will be included to the full horizontal and vertical extents of the model including underground utilities and roof mounted items.

3. The level of detail defined in the Specific Scope Requirements is the minimum level of detail required in the model. Greater detail than the minimum should be incorporated into the model where important details are necessary for communicating information about a system.
4. Each Trade Contractor shall provide shop drawings in both 2D and 3D model format.
5. The 3D model shall be located and oriented to the pre-determined world coordinates for the project to allow easy integration into the BIM for the project.
6. The 3D model shall include the project control grid. This grid should be visible when viewing the model in a true view along the X, Y or Z axis.
7. The 3D model shall be layered and constructed in a manner such that all elements of the model can be converted into a 2D dimensioned drawing for use in the field.
8. The 2d shop drawing scale should be 1'-0" = 3/8" unless specified otherwise or as required for full comprehensible and reviewable details.
9. Each drawing should include a key map referencing the location in the building.
10. In addition to the native file format, the Trade Contractor shall provide translation of the 3D model into a .DWG, CIS/2 or other agreed upon file format that can be viewed using NavisWorks Manager.
11. The following changes shall be promptly incorporated into the drawings and model, on a regular basis:

    a. RFIs, Bulletins and Owner changes
    b. Changes in the sequence of work
    c. Field modifications
    d. Shop drawing review comments
    e. Changes requested by the Design Build Contractor

12. All revised 3d model or 2D drawing submittals shall have a written narrative to define changes from previous submittals. Typical drafting techniques such as 'clouds' or 'bubbles' are acceptable means of tracking changes on the 2D drawings. [Layer control shall be used to define changes in the 3D model. All revisions shall be shown in both 2D and 3D formats].
13. The working 3D model will be shared with the Trade Contractors and design team at least once every two weeks. This will be performed by posting the model to the project FTP site or PrologWeb. The Trade Contractor will post the native file format and an agreed upon file format as defined in Item J above.
14. Pre-detailing meeting:

    a. Shall determine the lead trade.
    b. The order that coordination work will be added to the model.

15. The 3D modeling and layering conventions will be established at a pre-detailing meeting to be attended by:

    a. Concrete Contractor and detailer
    b. Steel Fabricator and detailer
    c. Mechanical Contractors and detailers
    d. Electrical Contractors and detailers
    e. Plumbing Contractors and detailers
    f. Fire protection Contractors and detailers
    g. Other trades.

16. Each Trade Contractor will submit its 3D modeling software and proposed file format(s) for approval prior to proceeding with detailing. The Trade Contractor will also provide a 3D mock-up of a specific portion of the project, to be agreed upon at a future time, in full detail in order to verify the compatibility of the file formats.
17. Each Trade Contractor shall provide viewer licenses only for its specific 3D software to the following:

    a. Owner
    b. Design Build Contractor
    c. Architect
    d. Engineer of Record

18. Each Trade Contractor and detailers shall have the capability to host and attend web meeting using Microsoft Live Meeting software.
19. Each Trade Contractor shall complete the drawings and model in a time frame capable of meeting the Project Schedule.
20. Each Trade Contractors are advised that the model shall be shared among all trades and shall be the basis of coordination and fabrication. Costs incurred for post-coordination changes caused by unauthorized deviations from the model shall be borne by the Trade Contractor that initially deviated from the model. This determination is at the sole discretion of the Design Build Contractor.
21. The base architectural BIM will be created using AutoDesk's Revit Building.
22. The 3D modeling effort is intended to augment and assist in the MEP coordination process. Before first submission shop drawings, the elements shall be first pass coordinated in the 3D model. The model is intended to find conflicts before shop drawings are reviewed and approved.
23. In addition to the requirements set forth in the contract documents, final models shall be submitted reflecting true "as-built" conditions.

B. Plumbing Technical Scope Requirements

1. All plumbing piping will be modeled. All plumbing equipment will be modeled to its overall height, width and depth. Pipes will be modeled to the outside diameter of the pipe or the pipe insulation, whichever is greater. Pipe slope will be incorporated in the model.
2. Pipe fittings and connections will not be modeled. All valves, clean outs and accessories will be modeled.
3. Each Trade Contractor to provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
4. Each Trade Contractor shall be prepared to attend weekly coordination meetings to resolve conflicts within the model.
5. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
6. The 3D model is to include access areas for equipment – included as a modeled element such that clash detection and coordination can be accommodated relating to access.
7. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
8. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
9. All items modeled shall have a level of intelligence associated with them, including, at a minimum, material type, size, insulation, etc.

10. All items located within mechanical rooms shall have a level of intelligence associated with them that includes, at a minimum, material type, size, insulation, manufacturer, product numbers, serial numbers, maintenance schedules, operation and maintenance data, etc.
11. All conduits shall be modeled.

C. Electrical Technical Scope Requirements

1. All electrical equipment including switchgear, transformers and panelboards will be modeled to its overall size. All necessary clearances for electrical equipment will be modeled as a separate volume. All conduits shall be modeled.
2. All light fixtures will be modeled as an overall volume require for that fixture.
3. Each Trade Contractor shall provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
4. Each Trade Contractor shall be prepared to attend weekly coordination meetings to resolve conflicts within the model.
5. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
6. The 3D model is to include access areas for equipment – included as a modeled element such that clash detection and coordination can be accommodated relating to access.
7. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
8. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
9. All panelboards modeled shall have a level of intelligence associated with them that accurately identifies at a minimum the panel schedule.
10. All items located within electrical rooms and closets shall have a level of intelligence associated with them that includes, at a minimum, material type, size, manufacturer, product numbers, serial numbers, maintenance schedules, operation and maintenance data, etc.

D. Fire Protection Technical Scope Requirements

1. All fire protection equipment including pipe, valves, heads, risers and drains will be modeled.
2. All light fixtures will be modeled as an overall volume require for that fixture.
3. Each Trade Contractor to provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
4. This Trade Contractor shall be prepared to attend weekly coordination meetings to resolve conflicts within the model.
5. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
6. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
7. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
8. All items modeled shall have a level of intelligence associated with them that accurately identifies at a minimum the material type, rating, model number, etc.

9. All conduits shall be modeled

E. Mechanical / Sheetmetal Technical Scope Requirements

1. All ducts and air handling equipment will be modeled. Ducts will be modeled to the outside face dimension. Equipment will be modeled to its overall height, width and depth. All piping associated with the mechanical system will be modeled. Pipes will be modeled to the outside diameter of the pipe or pipe insulation (whichever is greater).
2. Pipe hangers and hanger assemblies and dunnage will be modeled for clash detection and coordination. Fittings and connections will not be modeled. The intent of this model is to show the ductwork and piping, etc. in a true representation of the actual condition at construction completion.
3. Pipe fittings and connections will not be modeled. All valves, clean outs and accessories will be modeled.
4. Each Trade Contractor to provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
5. Each Trade Contractor shall be prepared to attend weekly coordination meetings to resolve conflicts within the model.
6. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
7. The 3D model is to include access areas for equipment – included as a modeled element such that clash detection and coordination can be accommodated relating to access.
8. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
9. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
10. All items modeled shall have a level of intelligence associated with them including, at a minimum, the material type, size, insulation, etc.
11. The Basement Level and Penthouse Mechanical Rooms shall have a level of intelligence associated with them that includes at a minimum material type, size, insulation, manufacturer, product numbers, serial numbers, maintenance schedules, operation and maintenance data, etc.
12. Each Trade Contractor shall include in their base bid BIM/Coordination facilities on site. The Design Build Contractor shall provide a Coordination Trailer for the Construction Team's use throughout the duration of the project. The HVAC Trade Contractor must provide a CAD workstation capable of running the Trade Contractor's CAD software as well as the following BIM software:

    a. NavisWorks Manager (current version)
    b. AutoCAD REVIT Architecture Suite (current version)
    c. AutoCAD REVIT MEP Suite (current version)

13. Each Trade Contractor shall turn over the above software complete with Licenses at Final Completion for the Owner's use.
14. All conduits shall be modeled.

F. Fire Alarm Technical Scope Requirements

1. All fire Alarm equipment including Fire Alarm conduit sizes/routing and Fire Alarm Panels and associated panels will be modeled.

2. Each Trade Contractor to provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
3. This Trade Contractor shall be prepared to attend weekly coordination meeting to resolve conflicts within the model.
4. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
5. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
6. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
7. All items modeled shall have a level of intelligence associated with them that accurately identifies at a minimum the material type, rating, model number, etc.
8. All conduits shall be modeled.

G. ATC Technical Scope Requirements

1. The ATC equipment including conduit and panels will be modeled.
2. Each Trade Contractor to provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
3. This Trade Contractor shall be prepared to attend weekly coordination meeting to resolve conflicts within the model.
4. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
5. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
6. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
7. All items modeled shall have a level of intelligence associated with them that accurately identifies at a minimum the material type, rating, model number, etc.
8. All conduits shall be modeled.

END OF SECTION

SECTION 210584

THROUGH-PENETRATION FIRESTOP SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 210500 and Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Through-penetration firestop systems for penetrations through the following fire-resistance-rated assemblies, including both empty openings and openings containing penetrating items:

1. Floors
2. Roofs
3. Walls and partitions
4. Smoke barriers
5. Construction enclosing compartmentalized areas.
6. Other rated assemblies.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1. Section 210500 – Basic Fire Protection Materials and Methods
2. Section 211000 – Fire Protection

1.04 REFERENCES

A. American Society for Testing and Materials Standards (ASTM):

1. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials
2. ASTM E814: Standard Test Methods for Fire Tests of Through-Penetration Firestops
3. ASTM E119: Standard Test Methods for Fire Tests of Building Construction Materials
4. ASTM E1399: Standard Test Methods for Cyclic Movement and Measuring of Joint Systems
5. ASTM E1725: Standard Test Methods for Fire Tests of Fire-Resistive Barrier Systems of Electrical Systems Components
6. ASTM E1966: Standard Test Methods for Fire Tests of Joints

B. Underwriters Laboratories, Inc. (UL):

1. UL 723 Surface Burning Characteristics of Building Materials
2. UL 1479 Fire Tests of Through-Penetration Firestops, including optional air leak test
3. UL 2079 Fire Test of Building Joint Firestop systems
4. UL Fire Resistance Directory (Component Listing Test Criterion)

C. National Fire Protection Agency (NFPA)

1. NFPA 80 Standard Fire Door and Window Assembly Tolerances
2. NFPA 252 Standard Fire Test for Fire Rated Doors (not specified for positive or negative furnace test pressure)
3. NFPA 257 Standard Fire Test for Fire Rated Windows (not specified for positive or negative furnace test pressure)
4. NFPA 101 Life Safety Code
5. NEC 70 National Electrical Code

1.05 PERFORMANCE REQUIREMENTS

A. General: For the following constructions, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly penetrated.

1. Fire-resistance-rated load-bearing walls, including partitions, with fire-protection-rated openings.
2. Fire-resistance-rated non-load-bearing walls, including partitions, with fire-protection-rated openings.
3. Fire-resistance-rated floor assemblies.
4. Fire-resistance-rated roof assemblies.

B. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.

C. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, as determined per ASTM E 814, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas.

1. Penetrations located outside wall cavities.
2. Penetrations located outside fire-resistive shaft enclosures.
3. Penetrations located in construction containing fire-protection rated openings.
4. Penetrating items larger than 4-inch diameter normal pipe or 16 sq. in. in overall cross-sectional area.

D. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide product that after curing do not deteriorate when exposed to these conditions both during and after construction.

1. For piping penetrations for wet pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
2. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved either by installing floor plates or by other means.

E. For through-penetration firestop systems exposed to view, provide products with flame-spread ratings of less than 25 and smoke-development ratings of less than 450, as determined per ASTM E 84.

1.06 SUBMITTALS

A. See Section 210500 and General Conditions for additional requirements.

B. Product Data: For each type through-penetration firestop system product indicated.

C. Shop Drawings: For each through-penetration firestop system show each kind of construction condition penetrated, relationships to adjoining construction, and kind of penetrating items. Include firestop design designation of testing and inspecting agency acceptable to authorities having, jurisdiction that evidences compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
2. Where Project conditions require modification of qualified testing and inspecting agency's illustration to suit a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer.

D. Submit complete plans indicating clearly where all seals are located and the type of seal to be used at that location

E. Qualification Data: For firms and persons specified to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

F. Product Certificates: Signed by manufacturers of through-penetration firestop system products certifying that products furnished comply with requirements.

G. Product Test Reports: From a qualified testing agency indicating through-penetration firestop system complies with requirements, based on comprehensive testing of current products.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed through-penetration firestop systems similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.

C. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in "Performance Requirements" Article:

1. Through-Penetration Firestop Systems tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, ITS, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
2. Through-penetration firestop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements:

a. Through-penetration firestop system products hear classification marking of qualified testing and inspecting agency.

b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:

1) UL in “Fire Resistance Directory.”
2) ITS in “Directory of Listed Products.”

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers’ labels identifying product and manufacturer, date of manufacture; lot number; shelf life, if applicable, qualified testing and inspecting agency’s classification marking applicable to Project; curing time; and mixing instructions for multicomponent materials.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.09 PROJECT CONDITIONS

A. Environmental Limitations: Do not install through-penetration fires top systems when ambient or substrate temperatures are outside limits permitted by through penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturer’s written instructions by natural means or, where this is inadequate, forced-air circulation.

1.10 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

C. Notify Owner’s inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.

D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until Owner’s inspecting agency and building inspector, if required by authorities having jurisdiction, have examined each installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable manufacturers subject to compliance with the specifications shall be one of following:

1. A/D Fire Protection Systems, Inc.
2. Hilti Construction Chemicals, Inc.
3. Nelson Firestop Products
4. RectorSeal Corporation (The)
5. Specified Technologies Inc.

6. 3M Fire Protection Products
7. Tremco
8. United Stated Gypsum Company

2.02 FIRESTOPPING GENERAL

A. Compatibility: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and fired experience.

B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with “Performance Requirements” Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:

1. Permanent forming/damming/backing materials, including the following:

   a. Slag-/rock-wool-fire insulation.
   b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
   c. Fire-rated form board

2. Temporary forming materials
3. Substrate primers
4. Collars
5. Steel sleeves

2.03 MIXING

A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer’s written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.

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

3.02 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop systems manufacturer and the following requirements:

1. Remove from surfaces of openings substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contactor by cleaning methods used to remove smears from firestop systems materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.03 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Install fill materials for firestop systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 FIELD-QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified independent inspecting agency to inspect through-penetration firestop systems and to prepare test reports.

1. Inspecting agency will state in each report whether inspected through-penetration firestop systems comply with or deviate from requirements.

B. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued.

C. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

3.05 IDENTIFICATION

A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels.

1. The words: “Warning-Through-Penetration Firestop System-Do Not Disturb. Notify Building Management of Any Damage.”
2. Contractor’s name, address, and phone number.
3. Through-penetration firestop systems designation of applicable testing and inspecting agency.
4. Date of installation.
5. Through-penetration firestop systems manufacturer’s name.
6. Installer’s name.

3.06 CLEANING AND PROTECTION

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

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

END OF SECTION

SECTION 211000

FIRE PROTECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification sections, apply to this section.

1.02 WORK INCLUDED

A. Code compliance, research, design, coordination, and installation of a complete and functional hydraulically calculated sprinkler system and combined riser standpipe system and fire pump, that meets the approval, and is in accordance with the requirements of Factory Mutual Guidelines (FMG), NFPA 101- Life Safety Code, Owner Standards, NFPA Fire Protection Standards, Underwriters Laboratory (UL), local and state regulation, and these specifications.

B. This is a performance specification. It requires performance of design work, preparation and submission of drawings, procurement of approvals, and provision of complete functional system of automatic sprinklers and/or standpipes. As a result, this section serves dual purpose of providing specifications and indicating design criteria for Contractor's use and guidance in designing systems and preparing sprinkler drawings for approval.

C. The location and sizes of existing building system, piping, fixtures, devices, outlets and equipment noted and drawing on these documents have been provided by the Owner. The Contractor shall be responsible for obtaining from the Construction Manager a set of the existing plans. The Contractor shall be responsible for verifying all existing conditions and coordinating with all new systems prior to commencing work.

D. Alarm system devices including alarm valves, flow switches/pressure switches, tamper switches and coordination with Division 28.

E. Shop drawings and calculations prepared and submitted in accordance with the requirements of the local fire department and the Owner's insurance underwriter.

F. Permits and approvals of the fire protection system.

G. Field acceptance testing and certification.

H. Coordination drawings.

I. Submittal drawings and working plans shall be prepared utilizing a computer generated system compatible with Owners' AutoCAD Drawing System.

J. Commissioning of systems.

K. Seismic bracing.

L. Complete automatic wet sprinkler system for the renovation areas.

M. Connections to existing systems, including draining, shut-downs and testing.

N. Automatic sprinkler heads.

O. Sprinkler accessories.

P. Inspectors test stations.

Q. Removal, relocation, modifications, connections to, and/or extensions of, existing sprinkler piping as required to coordinate with new and existing systems.

R. Fire department connections.

S. Existing fire pump test.

T. Escutcheons.

U. Core drilling of holes up to and including 12” diameter.

V. Sleeves, inserts and hangers.

W. Staging and planking up to and including 8 feet in height.

X. Record drawings.

Y. Operation and maintenance manuals.

Z. Valve tags and charts.

AA. Instructions.

BB. Hoisting, rigging and setting of all pipe and equipment.

CC. Fees, permit, royalties, guarantees.

DD. Piping and valves.

EE. Furnishing of access panels.

FF. Temporary fire protection systems and temporary supplies to existing fire protection systems.

GG. Phasing according to Architectural phase documents.

HH. Demolition of existing fire protection systems.

II. Performance of work in existing occupied areas.

JJ. Impairments and safeguarding plans.

1.03 RELATED SECTIONS

A. Examine drawings and criteria sheets and other Sections of the Specifications including, but not limited to, the following for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section. Coordinate all work with that of all other trades affecting or affected by work in this section.

1. Section 210500 – Basic Fire Protection Materials and Methods
2. Section 210510 – 3D Building Information Modeling
3. Section 210584 – Through-Penetration Firestop Systems
4. Section 019113 – Commissioning

1.04 REFERENCES

A. Refer to Section 210500.

1.05 SUBMITTALS

A. Refer to Section 210500.

1.06 DESIGN CRITERIA

A. Sprinkler systems and all components, piping, valves and head location, ratings, etc., shall be designed in accordance with NFPA 13, 14, 20, 24, State Building Code and Owner's Insurance Company, FM-Global, and other applicable NFPA pamphlets governing the installation of alarm valves, system drains, etc. The Fire Protection Subcontractor shall submit his shop drawings to Local Fire Department, Building Department, Owner's Insurance Company and all authorities having jurisdiction for approval prior to submission to Architect for approval.

B. The fire protection work is partially shown on the fire protection drawings. Each bidder for work under this Section of the specifications shall establish for himself, the exact quantity of sprinklers required. Refer to Architectural reflected ceiling plans for preferred sprinkler head locations. Additional heads shall be provided as part of this Contract, as required, to satisfy the code requirements for the hazard stated. Provide additional sprinklers as required per NFPA 13, in order to coordinate with any and all obstructions.

C. Each Bidder shall refer to the fire protection drawings and architectural reflected ceiling plans for major fire protection system's components, piping, head locations and which areas are to have fire department valves, hose cabinets, etc.

D. Provide a complete and operable fire suppression system in all areas that are a part of this Contract. Coordinate all sprinkler head locations with the architectural reflected ceiling plans.

E. Hydraulic calculations shall be based on flow characteristics specified herein for bid purposes only. Actual flow test must be performed or data must be obtained and verified as acceptable by all Authorities Having Jurisdiction by The Fire Protection Subcontractor. The Fire Protection Subcontractor shall perform his own up-to-date flow test and submit to Architect for his review; indication of test location, date, flow, residual and static pressure, etc., as outlined in NFPA #13, #20 and #25. The Fire Protection Subcontractor shall coordinate the flow test of the Owner and Construction Manager and pay all costs and fees associated with flow test at no additional cost to the Owner.

F. Sprinkler system design shall be based on the following information and in accordance with the Owner's Insurance Company requirements:

1. Sprinkler systems shall be provided throughout the renovated areas and shall by hydraulically calculated to provide the following densities and hose allowances as required.
2. Sprinkler systems at common areas, offices, lounges, Conference Rooms, exam rooms, dental clinics, corridors, lobbies and similar areas shall be designed for NFPA 13 Light Hazard and FM-Global Class HC-1, 0.10 gallons per minute per square foot over the hydraulically most remote 1500 square feet with a 250 GPM hose allowance and a maximum sprinkler spacing of 225 square foot per head.
3. Sprinkler systems at Mechanical Rooms, electrical, storage, utility rooms, gift shop, retail spaces, imaging areas, assembly area, pharmacy spaces and laboratory spaces shall be designed for NFPA 13 Ordinary Hazard Group I and FM-Global Hazard Class HC-2, 0.16 gallons per minute per square foot over the hydraulically most remote 3,000 square feet with a 250 GPM hose allowance and a maximum sprinkler spacing of 130 square foot per head. Sprinklers shall have a minimum K-factor of 5.6.
4. For dry pipe sprinkler systems, include an additional 30% of floor area over the wet system design criteria.

G. Sprinkler systems shall be modified as required, zoned by area, per floor. Existing floor control valve with tamper switch and flow switch. Modify existing zoning, as necessary, as shown on the drawings.

1. The sprinkler piping is typically dual-fed, and single and triple-fed in some areas, between risers. Piping arrangements shall be complete with control valves, tamper switches, flow switches, check valves and inspector test assemblies with drains as required by NFPA-13.

H. Inspector test valves assemblies are to be located at the remote end of each zone. Provide test assemblies with sight glasses and hard pipe express drains to hub drains.

I. Fire Pump Flow Test Data

1.	Fire Pump Rating:	1,250 GPM at 145 PSI
2.	Test Date:	May 3, 2013
3.	Agency:	Simplex Grinnell
4.	Static Pressure:	215 PSI
5.	Residual Pressure:	190 PSIG
6.	Flow Rate:	1,261 GPM
7.	Location:	Building A Basement
8.	Elevation:	Feet

J. The hydraulic calculations shall include the hydraulically most remote area for systems supplied by more than one combination riser. Hydraulic calculations shall show the remote areas being supplied solely from the hydraulically most remote combination riser.

K. Velocity shall not exceed 20 FPS.

L. All calculations shall assume 10 PSI deterioration in static and residual pressures in the hydrant flow test results.

1.07 WORKING PLANS

A. Prepare working plans according to the requirements of NFPA Standard 13 and 14. Working plans and hydraulic calculations shall be prepared by a NICET-Certified Level III or IV Automatic Sprinkler System Engineering Technician and stamped by a Professional Engineer registered in Connecticut. Working plans shall be provided in addition to the requirements for coordination drawings. Coordination drawings will not be accepted in lieu of working plans.

B. Deviation from the approved plans will require re-approval by the reviewing authorities.

C. Submit working plans and hydraulic calculations to the Owner's Representative. Plans submitted without review stamps or hydraulic calculations will be returned without review. Hydraulic calculations submitted without working plans will be returned without review.

D. Submittal drawings and working plans shall be prepared utilizing a computer generated system.

1.08 QUALITY ASSURANCE

A. Installer: Company specializing in performing work of the type specified in this Section, with documented experience.

B. Manufacturer: Company specializing in manufacturing products specified in this Section, with document experience.

C. Welders: Certify in accordance with ASME (BPV1X)

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. Materials and equipment provided under this Section to make a complete installation shall be U.L. listed and/or FMG-approved and in compliance with NFPA Standards.

2.02 PIPING, FITTINGS, AND JOINTS

A. Piping shall meet applicable ANSI or ASTM standards requirements and shall have manufacturer's name and standard marked on each length. Joints shall meet applicable ANSI and ASTM standards requirements. Where ANSI and ASTM standard does not exist, joints and fittings shall bear UL listing symbol.

B. Piping for sprinkler systems and standpipe systems 2-1/2" in size and larger may be Schedule 10 black steel conforming to ASTM 135. Piping for sprinklers 2" and smaller in size shall be Schedule 40 black steel conforming to ASTM A53. Should any authority require, standpipe and/or sprinkler risers shall be schedule 40 regardless of size.

C. Piping for use with hole-cut fittings shall have machine cut holes per manufacturer requirements at predetermined positions, on the centerline of the pipe, of a size to receive the housing locating collar. Hole cutting machine shall be supplied by the fitting manufacturer. Torch cutting shall not be utilized.

D. Piping for use with grooved end fittings shall be roll grooved without metal removal or as per manufacture requirements.

E. Flexible piping connections to sprinkler heads may be used for either suspended or sheetrock ceilings. All flexible piping systems shall be UL listed and FM approved and suitable for their intended use, similar to Flexhead Series 2000.

1. All flexible piping connections shall include a fully welded (non-mechanical fittings), braided, leak-tested sprinkler drop with a minimum internal corrugated hose diameter of 1”; and a one-piece multi-port ceiling bracket with removable attachment hub and self-securing integrated snap-on clip ends, for attachment to ceiling grid without the need for a screw fastener.

F. Fittings for Grooved End Steel Pipe shall be cast of ductile iron conforming to ASTM A-536 or forged steel conforming to ASTM A-234 (A-106, Gr. B), with grooved or shouldered ends for direct connection into grooved piping systems with steel pipe and shall be UL listed and FMG approved, rated for a minimum 300 psi maximum working pressure (MWP) and shall be of one manufacture Victaulic, Gruvlok or Grinnell.

G. Branch outlet fittings shall be UL listed and FMG approved, and rated for 300 psi (MWP) on piping 3" and larger, and 300 psi (MWP) on piping under 3" in size and shall be of one manufacture Victaulic, Gruvlok or Grinnell:

1. Mechanical tee branch, hole-cut type connections, with locating collar engaging into hole, with standard pressure responsive gaskets and black nuts and bolts similar to Victaulic Style 920/920N or
2. Outlet couplings, construction as hereinafter specified for couplings, with outlets grooved or threaded outlet ends with standard pressure responsive gaskets and black bolts and nuts similar to Victaulic Style 72.
3. No strap, snap and or one bolt outlet fittings will be permitted.

H. Standard black cast iron screwed fittings shall be used on piping 2" and smaller and may be used on larger sizes.

I. All grooved couplings, fittings and mechanical tee branch fittings shall be Victaulic, Gruvlok or Grinnell.

J. All pipe, fittings, valves, devices and associated appurtenances shall be rated for pressures that may be developed.

K. Bushings shall not be permitted where fittings of required sizes are manufactured. Care shall be taken in the design of this work to avoid piping arrangements that would require bushings.

L. Unless specified otherwise herein, all fittings shall be in accordance with NFPA standards and subject to approval by the Architect/Engineer. All fittings are to be UL listed and FMG approved.

M. All close and shoulder nipples shall be of corresponding materials as the pipe and shall be extra heavy pattern.

N. Pipe and fittings exposed to weather and piping between check valve and fire department pumper connection shall be galvanized.

O. Piping and fittings may be joined by mechanical grooved couplings. Grooved couplings shall be cast of ductile iron conforming to ASTM A-536 with bolts/nuts conforming to ASTM A-449. Standard gaskets to be used for systems under operating conditions within the range -30°F through +230°F for wet fire protection sprinkler service. Dry pipe system to be provided with "flush seal" type gaskets. All grooved couplings shall be 300 psi (CWP) as a minimum.

1. Rigid Type Couplings: Housings cast with offsetting, angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9. Couplings that require the use of torque wrenches for proper installation are not permitted similar to Victaulic Style 005.
2. Flexible Type Couplings: Use in locations where vibration attenuation and stress relief are required similar to Victaulic Style 75.
3. Flange Adapters: Flat face, for direct connection to ANSI Class 125 or 150 flanged components similar to Victaulic Style 744.

P. All piping for fire department connections shall be Schedule 40 piping with threaded galvanized.

Q. Dry sprinkler piping and fittings shall be galvanized steel with threaded galvanized steel fittings.

2.03 VALVES

A. All valves shall be UL listed and FMG approved similar to Mueller, Nibco or Victaulic. All valves that are installed as a part of this specification shall be provided with pressure ratings suitable for their intended service.

B. Shut-off and/or control valves shall be:

1. Outside screw and yoke valve. Cast iron body, bronze mounted, flanged or grooved ends, solid wedge, 2-1/2" in size and up. All bronze, solid wedge, threaded ends, 2" and under in size both to be electrically supervised, or
2. Bronze supervised slow close butterfly valve, threaded ends, stainless steel disc and stem, built-in supervisory switch, slow-close operator, up to 2-1/2" in size, or
3. Butterfly type indicating valves, grooved end, ductile iron body, elastomer encapsulated ductile iron disc with integral seating surface or bronze disc with rubber seat, gear operator, with built-in supervisory switch similar to Victaulic 705W. Wafer body style is not acceptable.
4. All equipment must be installed with isolation valves for service shut-off. The shut-off valves shall be screwed, grooved or flanged. If screwed ends are provided, a union or a coupling between equipment and valve shall be provided.

C. Check valves shall be:

1. Iron body, bronze mounted swing check with flanged ends, 2-1/2" in size up to 8" size; or
2. Iron body, spring actuated, wafer check, sizes 4" through 8"; or
3. Grooved end, ductile iron body, spring activated, sizes 2-1/2" through 12" similar to Victaulic Series 717.
4. All check valves up to 2" in size shall be all bronze with screwed ends.

D. Trim Valves: (for use on inspectors test set ups, alarm check valves, dry pipe valves, etc.)

1. Gate valves - all bronze, solid wedge, outside screw and yoke, rising stem, screwed ends.
2. Ball valves - all bronze, 400 lb. WWP, screwed ends.

3. Globe valves - all bronze, 200 lb. WWP, screwed ends.
4. Check valves - all bronze swing check, rubber disc, 200 lb. WWP, screwed ends.

2.04 SPRINKLER HEADS

A. All sprinkler heads shall be listed by U.L. and approved by FMG. All sprinklers shall be of single manufacturer. Heads shall be as manufactured by Reliable, Tyco, Viking or Victaulic.

B. Sprinkler heads shall be furnished and installed to conform with manufacturer's listing.

C. All sprinklers shall be coordinated with a final reflected ceiling plan to arrive at a suitable pattern consistent with proper sprinkler protection.

D. All sprinklers within 8'-0" of the floor in mechanical rooms shall have sprinkler guards, wire gage type.

E. Sprinklers shall be located in center of tiles.

F. Glass bulb type sprinklers shall not be installed in areas subject to freezing.

G. Quick response recessed sprinkler heads similar to Reliable F1FR shall be provided for all Light and Ordinary Hazard areas with ceilings and shall be Quick-response type, chrome-plated with 1/2" orifice, 155°F rated, FMG approved.

H. Quick response upright sprinkler heads similar to Reliable F1FR shall be provided in, unfinished areas such as mechanical rooms, without ceilings and shall be Quick-response type, brass, 1/2" orifice, 155°F rated, FMG approved.

I. Quick response upright or pendent heads in finished areas, without ceilings shall be similar to Reliable F1FR, chrome plated, Quick-response type, 1/2" orifice, 155°F rated, FM approved.

J. Cold rooms shall be provided with quick response dry type pendent sprinklers, chrome plated with 1/2" orifice 155°F rated.

K. Glazing requiring window protection shall be provided with pendent vertical sidewall or horizontal sidewall chrome plated heads similar to Tyco WS, 155°F rated, 1/2" orifice.

L. Intermediate and high temperature heads shall be provided as required by NFPA 13. Heads shall be chrome plated pendent style similar to Reliable F1FR.

M. Spare Heads: Provide 20-gauge steel sprinkler head cabinets with red enamel finish. Furnish the quantities of spare sprinkler heads for each type installed as required by NFPA Standard 13. Furnish sprinkler wrench for each head type installed. Mount in mechanical room or fire pump room.

2.05 PIPE HANGERS AND SUPPORTS

A. Acceptable products: Hanger materials shall match piping material as required for dielectric isolation. All support systems shall be UL listed and FMG approved and shall meet ASTM B633, SC1 and SC3.

B. Support all piping included in the Work of this Section with hangers and rods attached to the building structure. Hang piping in compliance with NFPA Standards and the requirements of this Section. Attach beam clamps before application of spray fire-proofing.

C. Piping 2-1/2" and smaller: Carbon steel, adjustable swivel.

D. Piping 3" and larger: Carbon steel, adjustable, clevis.

E. Hanger Attachments

1. Beam Clamps: Carbon steel hanger with lock nut and retaining strap or approved equal.
2. Expansion Shields: Hilti HDI or approved equal.
3. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods. Hilti HKD or approved equal.

F. Space hangers and supports for horizontal steel sprinkler piping according to the following schedule:

	Pipe Size:	Maximum Hanger Spacing:
1.	1-1/4" and smaller	8'-0"
2.	1-1/2" to 3"	10'-0"
3.	4" to 5"	12'-0"
4.	6" and larger	15'-0"

G. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded. Provide hanger rods sized according to the following schedule:

	Pipe Size:	Minimum Rod Diameter:
1.	4" and smaller	3/8"
2.	5", 6" and 8"	1/2"
3.	10” and 12”	5/8”

H. Hang standpipe and sprinkler piping to support the weight of the water filled pipe plus 250 pounds at the hanger.

I. Hang horizontal fire line piping to support the weight of five times the weight of the water filled pipe plus 250 pounds at the hanger.

J. Provide steel angle supports attached to the building structure to support piping below ductwork.

K. Riser Clamps: Carbon steel riser clamp, black or galvanized finish.

L. Floor Supports: Schedule 40 black steel adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

M. All vertical drops and run-out pipes shall be supported by split ring extension type hangers.

2.06 PIPE SLEEVES, PLATES AND ESCUTCHEONS, FIRESTOPPING AND SMOKEPROOFING

A. Refer to Section 210500.

2.07 FIRE DEPARTMENT PUMPER CONNECTIONS

A. Provide complete connection assemblies with body, identified face plate, snoots, caps and chains, with threads to suit Fire Department.

B. Fire Department Pumper Connections

1. Flush Mounted: Polished cast brass or polished chrome with escutcheon and two-way connection. Each inlet shall have a clapper valve, and plug and chain. Identify: "Auto-Spkr-Standpipe" or “Standpipe Connection”. Potter-Roemer Series 5500 Series 5740.

2.08 ALARM DEVICES

A. Water Flow Switches: Vane Type Switch for mounting horizontal or vertical, with two contacts rated 10 Amp at 120 volt AC, with adjustable 60 second time delay mechanism. Potter-Electric Model VSR-D, Notifier or System Sensor.

B. Water Pressure Switches

1. Supervisory: Potter-Electric Signal Co. Model PS40-2, or approved equal with two sets of double throw, single pole contacts with adequate pressure differential to prevent false operation.

C. Supervisory Tamper Switches

1. OS&Y Gate Valves: Tamper switch with two contacts rated 10 Amp at 120 volts AC. Potter-Electric Model OSYSU-A2 or approved equal.
2. Electrical alarm bell for weatherproof operation shall be 6”, Potter Electrical or approved equal.

D. Air Pressure Switch: For monitoring high/low pressure variations, 130 psi rated to detect system pressure from 3 to 90 psi.

2.09 SPRINKLER ACCESSORIES

A. Alarm Testers: In place of the assembled inspector's test assembly, the following manufactured alarm testers may be used: Victaulic 720 Test Master III or AGF Model 1000 Test and Drain. Test stations in systems over 175 PSI shall be equipped with relief valve as required.

B. Ball Drips: Grinnell Model F775, Reliable Model C, or Viking Model B-1.

C. Pressure Gages:

1. Water: 3-1/2 inch diameter, 0-300 psi. Reliable Model UA or approved equal. Provide at inlet and outlet of pumps and at top of all standpipes
2. Air: 3-1/2 inch diameter, 0-250 psi. Reliable Model UA or approved equal.

2.10 ELECTRICAL COMPONENTS

A. Provide all electrical components including, but not limited to motors, contactors, and controllers as required for all equipment included under the Work of this Section. Controllers shall be wired to require a single power supply provided under Division 26.

B. The Fire Protection Subcontractor shall prepare a typewritten list of all equipment to which the Electrical Subcontractor shall make connections. This list shall include all electrical characteristics of each piece of equipment. Submit list to Engineer and Electrical Contractor prior to purchasing any of this equipment.

2.11 EARTHQUAKE PROTECTION AND SEISMIC RESTRAINTS

A. The Fire Protection Subcontractor shall provide all necessary design and materials for seismic restraint and protection of piping and devices against damage where subject to earthquake as required for the entire fire protection system within the building. All isolation and seismic devices shall be the product of a single manufacturer. Products of other manufacturers are acceptable provided their systems strictly comply with this section of the specifications. Provide isolation materials and seismic restraints complete and as manufactured by Mason Industries, Tolco or approved equal.

1. The work under this section shall include the design, furnishing and installation of all restraint devices and systems as may be required for the fire protection system including, but not necessarily limited to, the following:

a. All fire protection equipment and devices such as pumps, air compressors, tanks, etc.
b. All fire protection system piping as required.
c. Piping penetrations through floors and walls.
d. Sleeves with clearances around the outside, as recommended.
e. Equipment isolation bases.
f. Piping flexible connectors.
g. Seismic restraints for isolated equipment.
h. Seismic restraints for non-isolated equipment.
i. Certification of seismic restraint designs.
j. Six (6) elbow swing joints at all building seismic separations as required by NFPA #13.

B. Submit ten (10) copies of descriptive data for all products and materials, including the following:

1. Catalog cuts and data sheets for the specific isolators, restrains and all other items to be utilized.
2. Details of methods of sleeving, fire protection, smokeproofing and isolation for pipes penetrating walls and slabs.
3. Specific details of seismic restraints and anchors, including number, size and locations for each piece of equipment.
4. Calculations to support seismic restraint designs.
5. All calculations, details and other submittal materials shall be sealed and signed by a Structural or Civil Engineer registered in the state and qualified to perform seismic design calculations.
6. A seismic design liability insurance certificate that must accompany all submittals.

C. Code and standard requirements shall include, but not be limited to:

1. Applicable Building Code with any additional state or local requirements.
2. NFPA 13, 14 and 24 and other applicable NFPA standards.
3. All state and local codes.

D. Manufacturers working in this section must provide a seismic design liability insurance certificate and certify their ability to provide engineering and design as required by this section. This certificate shall be submitted to the Architect for review prior to any submittals.

2.12 FIRE HOSE VALVES AND CABINETS

A. Provide Fire Hose Valves (FHV) and fire valve cabinets where noted on the contract drawings. Hose cabinets shall be complete with 1-1/2 inch valves and shall be fully recessed type. Fire Hose Valves shall be adjustable type so that no valve is set for greater than 100 psig at outlet. The Contractor shall be responsible for location of reducing/restricting valves based upon a certified fire pump curve and hydraulic calculations. Cabinets and valves shall be as manufactured by Croker, Potter-Roemer, Elkhart or Larsen, as follows:

1. Fire Hose Valves (FHV)

a. Fire Hose Valves shall be Croker #5064 or Potter Roemer #4085 or approved equal, 1-1/2” pressure restricting, female inlet by male outlet, chrome plated or rough brass finish, 300 psi working pressure, complete with 1-1/2" cap and chain.
b. This Contractor shall include in this bid proposal the cost to adjust all pressure restricting and/or reducing valves in accordance with NFPA 14 or Local Authorities. This work shall be accomplished by the Manufacturer's Authorized Representative and attested to in writing to the Architect by The Fire Protection Contractor.

2. Fire Hose Valve Cabinet (FHC)

a. Fire Hose Valve Cabinet (FHC) shall be Croker Figure No. 1700, Potter Roemer #1810 or approved equal steel cabinet recessed style with clear tempered safety glass door. Fire hose valve to be as outlined in item 1 above and shall have the threaded outlet of the valve facing the front of the cabinet.

PART 3 EXECUTION

3.01 GENERAL

A. This is a performance specification. It requires performance of design work, preparation and submission of drawings, procurement of approvals and provision of complete functional system of automatic sprinklers. As a result, this Section serves dual purposes of providing specifications and indicating design criteria for Contractor's use and guidance in designing systems and preparing sprinkler drawings for approvals.

B. The contract documents intend to show only the scope of the design, the Fire Protection Contractor shall be responsible for the correct installation of this work in a manner satisfactory to the best practices of his trade to complete the scope of this subcontract in all respects. No roughing work shall be accomplished until the pertinent manufacturer's shop drawings are approved.

C. The location of piping as indicated on the Drawings, unless otherwise noted, is diagrammatic only, and the exact locations shall be determined in the field. The run and arrangement of all pipes shall be approximately as shown on the Drawings, as directed during installation, in strict accordance with NFPA Pamphlets, and as straight and direct as possible, forming right angles or parallel lines with building walls and other pipes, and neatly spaced. All risers shall be erected true and plumb, parallel with walls and other pipes, and neatly spaced. All horizontal runs of piping, except where concealed in partitions, shall be kept as high as possible and close to walls. Where possible, adjacent pipe lines, both heating and plumbing, shall be grouped in the same vertical or horizontal planes. All piping shall be concealed and concealed piping shall have a minimum number of fittings. Piping shall not interfere with the operation or accessibility of doors, windows, access panels, valves, H & V unit access, air flow patterns, or equipment, and shall not encroach on aisles or passageways. All piping shall be installed to preserve access to all valves, drains and equipment. Pipe will not be permitted to pass through beams or ribs. Make such offsets and deviations from the Drawings as may become necessary to meet actual field conditions.

D. The Fire Protection Contractor shall be responsible for the correctness of field dimensions and shall check for himself all grades, lines, measurements, and other data in any way affecting his work. He shall refer to the project phasing schedule together with architectural and structural drawings of other Trades for a full comprehension of the extent of the work to be performed and to avoid interference, and shall not be entitled to any extra compensation for any additional work or expense arising from his failure to do so. In case interference develops the Architect shall decide which work is to be relocated, regardless of which was first installed. Work installed by the Fire Protection Contractor which is improperly located and/or interferes with or modifies either the phasing schedule or the architectural or structural design, shall be changed as directed by the Architect, and all costs incidental to such changes shall be paid by the Fire Protection Contractor.

E. The Fire Protection Contractor shall coordinate all his work with the work of all other Trades, and shall so arrange his work that there will be no delay in the proper installation and completion of any part or parts of each respective work wherein it may be interrelated with his, so that generally all construction work can proceed in its natural sequence without unnecessary delay, close coordination is also required with the HVAC, Plumbing and Electrical Contractors in areas serving these Trades. The Fire Protection Contractor shall also participate with all other Contractors in the process to prepare a complete set of coordination drawings prior to installation of any systems.

F. Contact between piping and dissimilar metals such as hangers, building structural work, or equipment shall be avoided to prevent galvanic action.

G. Pipe shall be cut accurately to measurements established at the site and shall be worked into place without springing or forcing. All pipe, regardless of how cut throughout the job, shall be reamed smooth and all burrs removed before being installed. Pipe shall not be split, bent, flattened, nor otherwise injured either before or during the installation. Full lengths of pipes shall be used wherever possible and short lengths of pipe connected with couplings will not be permitted.

H. The Fire Protection Contractor shall use every precaution in the installation of all piping to prevent dirt, chips, or other foreign materials entering the inside of piping. All pipes shall be clean and blown out to the satisfaction of the Architect before closing of any line. Keep the ends of piping capped or blind flanged during the construction of the system to keep out dirt or other foreign matter. The plugs and caps are to remain until permanent and final installation is made. The use of paper, waste, rags and so forth to close openings will not be permitted.

I. Unions or flanges shall be installed at all equipment valves and at such other places as may be necessary to disconnect piping or at each piece of equipment or accessory which may have to be disconnected to make repairs.

J. Bushing will not be inserted in fittings for reduction in size where fittings of required size are manufactured.

K. The Fire Protection Contractor shall also provide the necessary data and supervision for the provision of all holes in the structure, and also for the installation of equipment foundations, including bolt hole templates, weights and manufacturer's recommendations for proper emplacement design. This shall be furnished to the Construction Manager and other related subtrades.

L. Equipment and accessories shall be set level, plumb and in proper alignment with reference to adjacent walls. All surfaces coming in contact with walls, floors or other equipment shall have properly planed surfaces with suitable contact on wall and floors.

M. Clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible, before start of spray fire proofing work. Piping and equipment that interfere with proper application of fireproofing shall be installed after completion of spray fire proofing work. Patch and repair spray fireproofing cut or damaged during course of work specified under this Section. Trade responsible for damage shall bear cost of repair.

3.02 FIRE PUMP FLOW TEST

A. Notifications: Notify the authorities having jurisdiction at least three working days in advance of performing the flow test.

B. Perform fire pump flow test on existing fire pump in compliance with NFPA Standards 20 and 25.

C. Record measurements and submit fire pump test report indicating test results for review and approval before submitting hydraulic calculations and working plans.

D. Hydraulic graph shall indicate suction pressure, boost and discharge pressure.

3.03 HYDRAULICALLY CALCULATED SPRINKLER SYSTEM

A. The Contractor shall provide a hydraulically designed system in complete accordance with and as defined in applicable National Fire Protection Standards.

B. Verification of Hydraulic Information

1. The Contractor shall perform existing fire pump flow tests to establish water supply availability. Water supply information shall be provided on shop drawings as outlined in NFPA 13.
2. The Contractor shall confirm that hazard classifications/density requirements conform with the Owner's fire insurance underwriter's requirements and those of other authorities having jurisdiction.

C. Accompanying sprinkler shop drawings submitted to the Architect shall bear all sprinkler system requirements, water supply data, graph and work sheets all as defined by NFPA. The hydraulic graph shall include the following information:

1. Adjust flow test for friction and elevation.
2. System friction loss curve for sprinkler system with inside hose stream.
3. Available outside hose stream flow.
4. Fire pump discharge curve.

D. All calculations shall assume a 10 psi deterioration in static and residual pressures in the hydrant flow test results.

E. Velocity shall not exceed 20 FPS.

F. In addition to the above noted requirements, the hydraulic calculations shall include:

1. The hydraulically most remote area for each hazard classification/density requirements as noted on the contract documents.
2. If combination risers are shown interconnected with sprinkler piping, hydraulic calculations shall show the remote area being supplied solely from the hydraulically most remote combination riser.
3. Additional hydraulic calculations shall be submitted, when requested, which demonstrate that the Contractor's selected remote areas are indeed the hydraulically most demanding as well as remote.
4. If new work is to be connected to existing piping the Fire Protection Contractor shall verify that the existing piping can support demands generated by the hydraulic calculations.

3.04 INSTALLATION OF PIPING AND EQUIPMENT

A. Install the Work of this Section in compliance with the referenced NFPA Standards. Coordinate installation with work of other sections and install piping level or pitched back to main riser or low point drain. Provide drain valve on trapped piping. Install all sprinkler heads with return bend drops to ceilings.

B. Install sprinkler mains generally as shown on the Drawings. Run piping concealed above ceilings and within furred spaces. Obtain approval from the Architect for piping locations which require furrings not indicated on the Contract Drawings.

C. Install equipment and products provided under this Section in compliance with the product listing and the manufacturer's installation instructions.

D. Install chrome-plated escutcheons where piping passes through finished surfaces.

3.05 CONTINUITY OF SERVICES

A. Do not interrupt existing services without Owner's approval.

B. Schedule interruptions in advance, according to Owner's instructions. Submit, request for interruption with methods proposed to minimize length of interruption, in writing.

C. Interruptions shall be scheduled at such times of day and work to minimize impact on Owner's operations.

3.06 SHUTDOWNS

A. The Contractor shall work with the Owner in maintaining integrity of all fire protection systems in adjacent buildings as well as areas outside of this contract. Coordinate and minimize any and all shutdowns of the fire protection system as follows:

1. Give proper notice to Owner when making shutdowns and pay any fees required.
2. Perform any duties required by Owner when making a shut down.
3. Fill out a shutdown notice form answering all items request such as time and location of shutdown, systems affected, areas affected, etc. when requesting a shutdown.
4. Provide fire watch as required during a shutdown.
5. Duration of shutdowns shall be kept to a minimum.
6. In no case shall the fire protection system be shut down during off hours of work day without a fire watch.
7. System shall be returned to normal operating conditions at end of work day.

3.07 CONNECTIONS TO EXISTING SYSTEMS

A. Modify the system as required. Remove existing sprinkler mains and branches to accommodate new piping and offsets to piping and additional heads. The sprinkler system shall be fed from the existing riser or main as indicated on the plans.

B. This Contractor shall pay all costs associated with alarm shutdowns of existing systems necessary for new connections.

C. Refer to "Shutdowns" Section of this Specification.

D. Existing valves, flow switches and tamper switches shall remain, but shall be checked for proper operation and condition and shall be protected by the Contractor. Damage to these items occurring after checking for proper operation and condition shall be made good by the Contractor at his own expense with new identical materials. Provide temporary caps as required during system modification to maintain sprinkler protection.

3.08 TEMPORARY PROTECTION, IMPAIRMENTS AND SAFEGUARDING

A. The Contractor shall provide temporary protection during construction, alteration and demolition activities. Temporary protection shall be provided while portions of the existing fire protection sprinkler system or existing fire protective signaling systems are impaired or out of service.

B. Temporary protection shall be installed throughout the affected areas in accordance with local fire department requirements. Refer to Fire Alarm Specification, Division 28, for temporary fire detection equipment options.

C. Temporary fire protective devices shall be installed in accordance with the product's labeling, manufacturer's listing requirements and applicable codes.

D. Installation of temporary fire protective devices shall be coordinated with the construction alteration and demolition conditions and shall account for structural members, ductwork, piping and conduit racks as they occur or are encountered during construction.

E. Temporary fire protective devices shall be connected to the building's fire alarm system and shall function as permanent until replaced with final fire protection and fire protective systems. Refer to Fire Alarm Specification, Division 28, for additional information and requirements.

F. Temporary fire device layout shall be changed as necessary during construction in order to maintain proper coverage including spacing and location of devices as work progresses and building areas are impacted.

G. Temporary fire protective devices shall be added or relocated as directed by the local fire department.

H. Safeguarding of the building during demolition, alteration and construction shall be a joint cooperative effort involving the entire project team, and primarily the Fire Protection Contractor, the Fire Alarm Contractor, the General Contractor/Construction Manager, Owner and all Authorities Having Jurisdiction. The Fire Protection Contractor and Fire Alarm Contractor shall coordinate with any and all parties as appropriate in order to achieve proper safeguarding as described in the project documents.

I. The Contractors shall ensure proper building protection and safeguarding at all times during demolition, alteration, and construction in complete compliance with all applicable codes, regulations and standards, and in particular NFPA 241.

J. During times when the existing new building fire protection systems are impaired, the Contractors shall provide appropriate safeguarding of the renovation work area, and temporary heat detection or adequate alternate protection throughout the space, as coordinated with, and approved by, the tenant's and Owner's fire prevention program manager, building manager, Construction Manager, insurance underwriters, and all authorities having jurisdiction.

K. Safeguarding shall also apply to all related phasing, shut-downs, swing spaces, temporary services and facilities, relocations, etc. Alternative safeguarding such as, but not limited to, fire watch personnel, or temporary fire protection systems, may be considered if acceptable to the tenant/owner and authorities having jurisdiction. Refer to, and coordinate with, fire alarm systems documents, and safeguarding and impairments notes and specifications. Coordinate with fire alarm system Contractor and all other trades.

L. Provide (and include as shop drawings submittals) a complete demolition, alteration, construction, phasing and impairment plan to include the safeguarding information above, a schedule of project milestones and related work, and an anticipated schedule for installation, impairments, programming and all phases of final testing and completion of the work. This plan shall be coordinated with all authorities having jurisdiction, the tenant's/Owner's fire prevention program manager, construction manager, and shall include any and all information, drawings, and graphics to meet the approval of the authorities having jurisdiction.

The Contractors shall provide firewatch personnel or temporary protection as required by any authorities having jurisdiction, the tenant/owner, or the tenant's/Owner's insurance underwriters.

M. The above impairment plan shall be approved by all authorities, tenant/Owner fire prevention program manager, tenant/Owner insurance underwriters, etc., prior to any shutdowns or impairments.

N. All costs associated with the above safeguarding during demolition, alteration, construction, phasing, shutdowns, etc. with regard to fire protection systems shall be included in the Fire Protection Contractor's base bid.

3.09 FIRE PROTECTION DEMOLITION, RELOCATION AND ALTERATION

A. During the execution of the work, required relocation, renovation, or demolition of existing Fire Protection equipment and systems in the existing areas where new work and connections are scheduled to be made shall be performed by the Fire Protection Contractor as indicated on the drawings, as required by job conditions, and as determined and directed by the Construction Manager in close cooperation with the Architect and Owner's designated representative to facilitate the installation of the new systems and completion of this Contract. The Owner shall require the continuous operation of all existing systems while demolition and relocation work of new tie-ins are being performed. Outages required for construction purposes shall be scheduled for the shortest practical periods of time in coordination with the Owner's designated representative through the Construction Manager for specific, mutually agreeable periods of time after each of which the interruption shall cease and service shall be restored. This Contractor shall be responsible for any and all fire watch as required by the local fire department or Owner. This procedure shall be repeated to suit the Owner's working schedule as many times as required until all work is completed.

B. Prior to any deactivation and relocation, capping, valving, tie-in or demolition work, consult the drawings and arrange a conference with appropriate parties through the Construction Manager in the field to inspect each of the items to be deactivated, removed or relocated. Care shall be taken to protect all equipment designated to be relocated and reused. A minimum (5) working days advance notice shall be given to all parties.

C. All draining of existing systems, filling and venting required to remove and relocate existing piping systems shall be included and provided under this Contract as required to perform the various relocations or new tie-ins.

D. Except as otherwise noted, all deactivation, safe capping, valving, etc., of systems designated to be demolished by each Trade, as applicable, and all demolition, removal and disposal of demolished materials shall be performed as directed by the Construction Manager. All equipment scheduled to be removed shall be inspected by the Owner, and if he decides such equipment is to be salvaged, each Contractor shall deliver said equipment to an area within the site boundaries as determined by the Owner and the Architect.

E. The phasing of the work shall be performed in strict accordance with the Construction Manager's construction schedule. The new systems shall be installed and completely commissioned prior to occupancy. Coordinate requirements for temporary heat or rerouting of existing services as required to accomplish the construction schedule.

F. Fire Protection Contractor shall provide all temporary or permanent caps, valves, hangers, drains as required to perform the Fire Protection demolition, relocation and alteration.

3.10 SITE VISIT

A. Before commencing any work under this Section, verify all dimensions, elevations, pipe sizes and locations in the building and examine all adjoining work in which this work is in any way dependent. Visit and investigate all spaces and conditions to become familiar with installation and all requirements prior to bidding.

B. Each bidder shall visit the site and inspect all conditions affecting any aspect of the work. Failure to do so and misinterpretation of the plans and specifications resulting there from shall be entirely the responsibility of the bidder.

3.11 FIRE DEPARTMENT HOSE CONNECTION INSTALLATION

A. Install Fire Department valves between 3'-6" to 4'-6" above finish floor.

B. Install Fire Department valve Cabinets 4'-6" above finish floor to the top of the cabinet.

3.12 INSTALLATION AND SPACING OF SPRINKLER HEADS

A. Sprinkler Head Installation

1. Sprinkler spacing, densities and design shall comply with NFPA and the Owner's Insurance Underwriter.

B. Location of sprinkler heads in ceiling tiles:

1. Refer to Architectural reflected ceiling plans and room finish schedules for ceiling tile types. Mount sprinklers in center of tiles.
2. Align sprinkler heads with ceiling components such as lighting fixtures, HVAC diffusers and smoke detectors.

C. Provide additional heads as required by NFPA 13, including appendices to protect areas where ceiling head spray pattern is obstructed and below ducts and equipment 4 feet wide or wider. Mechanical room sprinkler layouts shall be based on approved ductwork submittals. Additional sprinkler heads required to provide complete sprinkler protection due to obstructions and/or coordination shall be provided at no additional cost to the Owner.

D. Provide sprinkler heads within privacy curtains or obtain written confirmation from the Owner that 18-inch curtain drop hangers will be used.

E. Provide upright heads within stair towers at the top and bottom of the stair tower.

F. Provide sprinkler head spray baffles to shield direct water spray from electrical equipment.

G. Provide sprinkler protection in electric rooms, elevator machine rooms and hoistways. Provide an indicating shut-off valve with tamper switch on the branch line located in an accessible area outside the protected space.

3.13 VALVE TAGS AND CHARTS

A. All valves on pipes of every description shall have neat circular brass valve tags of at least 1-1/2 inches in diameter, attached with brass hooks to each valve stem. Stamp on these valve tags in letters as large as practicable the number of the valve and the service and zone, such as "S.P.", "D", for standpipe, drain, respectively. The numbers of each service shall be consecutive.

B. These numbers shall correspond to numbers indicated for valves on the record drawings and on two printed detailed lists. These printed lists shall state the numbers and locations of each valve and the fixture or group of fixtures which it controls, and other necessary information, such as requiring the opening or closing of another valve or valves, when any one valve is to be opened or closed.

C. These printed lists shall be typed and shall be framed under glass, and mounted as directed by the Architect.

D. Copies of charts shall be included in O&M manuals.

3.14 IDENTIFICATION

A. All labeling of piping, materials and equipment, as outlined hereinafter for identification purposes, shall be performed by this Contractor.

B. Piping systems shall be identified with approved snap-on covers designating services and direction of flow. Location of identification covers shall be near access panels wherever possible on each riser and branch main, equipment, and on both sides of valves. The markers shall be as manufactured by WH Brady Co., Westline Products, Seton Name Plate Co., or approved equal.

C. Install markers on cleaned or painted piping only after piping is complete and has been accepted by the Architect.

D. Letters shall not be less than 1-1/2 inches in height. Arrows shall not be less than 9 inches long. Identification shall be installed on pipes above hung ceiling and furred spaces.

E. All systems shall be identified at intervals of approximately 20'', every change of direction and on both sides of wall where pipes pass through walls.

3.15 CORE DRILLING

A. This Contractor shall perform all core drilling required for the installation of the fire protection system. Locate all required openings and prior to coring coordinate the opening with the Construction Manager. Thoroughly investigate the existing conditions in the vicinity of the required opening prior to coring. Care must be taken so as not to disturb the existing building systems. Locate all other openings required for the Construction Manager. Patching of existing walls and openings shall be performed by the respective Trade responsible for the finish material in which the opening is made.

B. Before coring is performed, submit drawings showing location of cores to Structural Engineers for their review.

3.16 CLEANING OF SYSTEMS

A. Refer to Section 210500.

3.17 EQUIPMENT ACCESS REQUIREMENTS AND ACCESS PANELS

A. All work shall be installed so that all parts requiring inspection, operation, maintenance and repair are readily accessible as approved by the Owner. Minor deviations from the Drawing may be made to accomplish this, but changes of magnitude shall not be made prior to written approval from the Architect.

B. Furnish access panels if required in walls and ceilings as required to permit access for adjustment, removal and the replacement and servicing of all equipment, and all other items requiring maintenance and adjustments. Access panels shall be installed by the Trade determined by the Construction Manager.

C. Access panels shall be 12” X 12” minimum size and constructed of steel with primer coat of rust inhibitive paint and shall have continuous piano hinge, as manufactured by Inland Steel Products, Milcor, Walsh-Hannon or approved equal. Panel shall be key operated cylinders, keyed alike. Key lock system shall be coordinated with the Owner and shall be as approved by the Architect. Provide six (6) keys of type used for Owner's use.

3.18 SIGNS

A. Signs and nameplates in accordance with NFPA standards and/or this specification shall be provided at all drains, test and alarm valves and other areas as required by NFPA Standards.

3.19 MATERIALS AND EQUIPMENT HANDLING

A. Refer to Section 210500.

3.20 MAINTENANCE AND PROTECTION OF MATERIALS

A. Refer to Section 210500.

3.21 CLEANUP

A. Refer to Section 210500.

3.22 TESTING AND INSPECTION

A. This Contractor shall obtain and pay for all the inspection and tests required for this Section of the work. Defects discovered in work, materials and/or equipment shall be replaced at no cost to the Owner, and the inspection and test shall be repeated. When work is completed, this Contractor shall furnish a Certificate of Inspection and Approval to the Owner before final payment of the Contract will be allowed.

B. Test sprinkler piping and make watertight before painting and before concealment. Make partial tests as required, during the progress of the work. All tests shall be witnessed by the Owner's representative, Authorities Having Jurisdiction and a representative of the Engineer.

C. Test systems according to provisions of NFPA Standards and the additional requirements of the approving authority and this Section.

D. Modified sprinkler system shall be tested to a hydrostatic test of 200 psi or 50 psi higher than the normal working pressure of the system for (2) hours without loss as specified in NFPA 13.

E. This Contractor shall, with the parties noted herein, establish procedures to witness testing that are acceptable to the parties noted herein. All parties noted herein shall be notified in writing of the accepted testing procedure prior to any testing. This Contractor shall notify parties designated to witness testing at least 48 hours in advance of scheduled testing.

F. Conditions requiring testing in excess of the minimum requirements noted herein shall be performed in accordance with NFPA Standards and any requirements of Authorities Having Jurisdiction.

G. Should the Owner, Engineer or any Authority Having Jurisdiction require, this Contractor shall provide factory trained, manufactures authorized representatives to perform testing on any equipment and/or devices that may be an integral part of this Specification.

H. Dispose of test water and wastes after tests are complete, in a manner satisfactory to the Owner and Local Authorities.

I. Furnish to the Engineer completely executed test certificates with signatures of those required to witness testing. Test certificate forms shall follow NFPA formats as a minimum requirement.

J. Test and certify water flow, pressure and supervisory tamper switches.

K. Test fire department connection piping at 300 psi for one hour.

L. Test and certify water flow, pressure, and supervisory tamper switches.

M. Dry Systems: Perform both hydrostatic and pneumatic pressure tests and dry pipe valve operating work test.

1. Hydrostatic Test: Maintain at least 200 psi or 50 psi in excess of the maximum working pressure, for at least two hours.
2. Pneumatic Test: Maintain 40 psi air pressure for 24 hours. Correct all leaks which result in a pressure loss in excess of 1-1/2 psi.
3. Operating Working Test: Perform test and complete Contractor's material and test certificate.

N. Complete working tests of all systems in accordance with NFPA standards.

3.23 MANUFACTURER'S REPRESENTATIVE AND COMMISSIONING OF SYSTEMS

A. Refer to Section 210500.

3.24 INSPECTION SERVICE

A. After completion of the fire protection work and at start of the guarantee year, The Fire Protection Subcontractor shall execute the National Automatic Sprinkler and Fire Control Association, Inc. Standard Form of Inspection Agreement without charge to the Owner, calling for 4 inspections of the system during the guarantee year. During the year, inspections shall be made as per the Inspection Agreement plus the following maintenance shall be performed on the last inspection:

1. Operation of all control valves
2. Lubrication of stems of all control valves
3. Operation of all alarms
4. Cleaning of alarm valves and parts

B. The standard form, "Report of Inspection" shall be filled out in triplicate after each inspection and copies sent to the Owner and the Owner's insuring agency.

C. All inspections and maintenance shall be in accordance with applicable NFPA Standards, including NFPA #25, as a minimum. Requirements of Owner's Insurance and other Authorities Having Jurisdictions are also a part of this service.

END OF SECTION

DIVISION 22

PLUMBING TABLE OF CONTENTS

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SECTION 220500

BASIC PLUMBING MATERIALS AND METHODS

PART 1 GENERAL

1.01 PROVISIONS INCLUDED

A. Include General Conditions, Supplementary General Conditions Division 0 and applicable parts of Division 1 for conditions and Section 019100 Commissioning and requirements which may affect the work of this Section.

B. Examine all other Sections of the specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

C. Coordinate work with that of all other Trades affecting, or affected by work of this Section. Cooperate with such Trades to ensure the steady progress of all work under the Contract.

1.02 DEFINITIONS

A. Words in the singular shall also mean and include the plural, wherever the context so indicates and words in the plural shall mean the singular, wherever the context so indicates.

B. Wherever the terms "shown on drawings" are used in the specifications, they shall mean "noted", "indicated", "scheduled", "detailed", or any other diagrammatic or written reference made on the drawings.

C. Wherever the term "provide" is used in the specifications it will mean "furnish and install", "connect", "apply", "erect", "construct", or similar terms, unless otherwise indicated in the specifications.

D. Wherever the term "material" is used in the specifications it will mean any product", "equipment", "device", "assembly", or "item" required under the Contract, as indicated by trade or brand name, manufacturer's name, standard specification reference or other description.

E. The terms "approved", or "approval" shall mean the written approval of the Architect.

F. The term "specification" shall mean all information contained in the bound or unbound volume, including all "Contract Documents" defined therein, except for the drawings.

G. The terms "directed", "required", "permitted", "ordered", "designated", "prescribed" and similar words shall mean the direction, requirement, permission, order, designation or prescription of the Architect. The terms "approved", "acceptable", "satisfactory" and similar words shall mean approved by, acceptable or satisfactory to the Architect. The terms "necessary", "reasonable", "proper", "correct" and similar words shall mean necessary, reasonable, proper or correct in the judgment of the Architect.

H. "Piping" includes in addition to pipe or mains, all fittings, flanges, unions, valves, strainers, drains, hangers and other accessories relative to such piping.

I. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction or in crawl spaces.

J. "Exposed" means not installed underground or "concealed" as defined above.

K. "Invert Elevation" means the elevation of the inside bottom of the pipe.

L. "Plumbing Contractor" shall refer to the Contractor or his Subcontractors responsible for furnishing and installation of all work indicated on the Plumbing drawings and specifications, as applicable and or referenced to each Trade in the Architectural and/or Structural documents.

M. "Architect" shall refer to "Architectural Resources Cambridge (ARC)" and/or Engineer "Bard, Rao + Athanas Consulting Engineers, LLC".

N. "Owner" shall refer to the designated representatives of the Project Owner.

O. "Commissioning Agent (CA)" shall refer to the party employed by the Owner to witness the demonstration of all systems according to the commissioning plan. Refer to Section 019100.

P. "Construction Manager" shall refer to the Construction Manager (CM) "Fusco Corporation" for this project.

1.03 CODES, STANDARDS AND REFERENCES

A. All materials and workmanship shall comply with all applicable Codes, Specifications, Local and State Ordinances, Industry Standards and Utility Company Regulations, latest editions.

B. In case of difference between Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations and the Contract Documents, the Plumbing Contractor, as applicable, shall promptly notify the Architect in writing of any such difference.

C. In case of conflict between the Contract Documents and the requirements of any Code or Authorities Having Jurisdiction, the most stringent requirements of the aforementioned shall govern for budgetary purposes. However, no work will proceed until the Architect determines the correct method of installation.

D. Should any Contractor, as applicable, perform any work that does not comply with the requirements of the applicable Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations, he shall bear all costs arising in correcting the deficiencies, as approved by the Architect.

E. Applicable Codes and Standards shall include all State Laws, Local Ordinances, Utility Company Regulations and the applicable requirements of the following accepted Codes and Standards, without limiting the number, as follows:

1. State of Connecticut Plumbing Code – 2005 Edition, including all adopted supplements
2. State of Connecticut Building Code – 2005 Edition including all adopted Supplements
3. State of Connecticut -- Energy Code – Latest Edition
4. Environmental Protection Agency (EPA)
5. State of Connecticut Fire Prevention Regulations and Elevator Regulations
6. Local Ordinances, Regulations of the Local Building Department and Fire Department
7. National Electrical Code (NEC) – 2005 Amendments to NFPA 70
8. Recommendations of ASPE (American Society of Plumbing Engineers)
9. National Fire Protection Association (NFPA) Standards

a. NFPA 45 Standards on Fire Protection for Laboratories Using Chemicals

b. NFPA 30 Flammable and Combustible Liquids Code
c. NFPA 101 Life Safety
d. NFPA 99 Standards for Healthcare Facilities – 2002 Edition
e. NFPA 54 National Fuel Gas Code - 2012 edition

10. FGI Guidelines for Design and Construction of Health Care Facilities
11. Occupational Safety and Health Administration (OSHA)

F. In these specifications, references made to the following Industry Standards and Code Bodies are intended to indicate the accepted volume or publication of the Standard. All equipment, materials and details of installation shall comply with the requirements and latest revisions of the following Bodies, as applicable:

1. ANSI American National Standards Institute
2. ASME American Society of Mechanical Engineers
3. ASTM American Society of Testing Materials
4. CS Commercial Standards, U.S. Department of Commerce
5. FMG Factory Mutual Guidelines
6. FS Federal Specification, U.S. Government
7. MSS Manufacturers Standardization Society of the Valve and Fittings Industry
8. NEMA National Electrical Manufacturers Association
9. NFPA National Fire Protection Association
10. UL Underwriters' Laboratories, Inc.
11. AWS American Welding Society

G. The Plumbing Contractor for the work under his charge, shall give all necessary notices, obtain and pay for all permits, pay all governmental taxes, fees and other costs in connection with his work; file for necessary approvals with the jurisdiction under which the work is to be performed. The Plumbing Contractor shall obtain all required Certificates of Inspection for his work and deliver same to the Architect before request for acceptance of his portion of work and before final payment is made.

H. All equipment shall be installed per manufacturer's recommendations and requirements. The Contractor shall notify the Architect in writing when they intend to deviate from manufacturer's installation guidelines. The Architect shall advise if the installation is acceptable prior to installation.

1.04 REGULATORY REQUIREMENTS

A. Conform to maximum flame spread / smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255 and UL 723.

B. Adhesives and sealants shall conform to the requirements of the South Coast Air Quality Management District (SCAQMD) Rule 1168.

1.05 SUBMITTALS

A. Submit detailed shop drawings or brochures for approval of equipment and material proposed to be used on this project in accordance with Division One of the General Requirements.

B. The manufacturers listed within this specification have been pre-selected for use on this project. No submittal will be accepted from a manufacturer other than those specified. Should any Contractor wish to propose a substitution during the bid period, such request shall be made in writing to the Architect, at least 15 working days, prior to bid date.

If substitutions are deemed acceptable, such items shall be issued as an Addendum, prior to bid due date. The above requirement is mandatory.

C. Documents submitted shall show the following:

1. Principal dimensions, and details of construction.
2. Operating and maintenance clearances.
3. Weights of principal parts and total weights with information required for the design of supports and foundations.
4. Sizes and location of piping and connections.
5. Performance data, including pump curves.
6. Data on electric motors, including brake horsepower of driven equipment, nameplate ratings and classes, sound data, starting and running full load currents, required starter size and recommended overload heater ratings.
7. Approval stamp of Underwriters' Laboratory and other authorities having jurisdiction of Contract Drawings requiring such approval.
8. Certified performance guarantees.
9. Minimum scale for plumbing equipment/mechanical rooms shall be 1/4 inch equal 1 foot.

D. Submit brochures that contain only that information which is relative to the particular equipment or materials to be furnished. Do not submit catalogs that describe several different items other than those items to be used unless irrelevant information is marked out and relevant material is clearly marked.

E. Specifications Compliance Statement

1. The manufacturer shall submit a point by point statement of compliance with the specifications.
2. The statement of compliance shall consist of a list of all paragraphs (line by line).
3. Where the proposed system complies fully, such shall be indicated by placing the word "comply: opposite the paragraph number.
4. Where the proposed system does not comply, or accomplishes the stated function in a manner different from that described, a full description of the deviation shall be provided.
5. Where a full description of a deviation is not provided, it shall be assumed that the proposed system does not comply with the paragraph in question.
6. Submissions which do not include a point by point statement of compliance as specified shall be rejected.

1.06 GUARANTEE

A. Attention is directed to provisions of the General Requirements and Supplementary General Conditions regarding guarantees and warranties for work under this Contract.

B. Manufacturers shall provide their standard guarantees for work under this Contract, unless specified otherwise. However, such guarantees shall be in addition to and not in lieu of all other liabilities which the manufacturer and CM may have by Law or by other provisions of the Contract Documents. In any case, such guarantees and warranties shall commence when the

Owner accepts the various systems, as applicable and as determined by the Architect. The guarantees and warranties will remain in effect for a minimum period of (1) year thereafter except where longer periods are specifically stated and specified.

C. All materials, items of equipment and workmanship furnished by the Plumbing Contractor shall carry the warranty against all defects in material and workmanship. Any fault due to defective or improper material, equipment, workmanship or design which may develop shall be made good, forthwith, by and at the expense of the Plumbing Contractor responsible, including all other damage done to areas, materials and other systems resulting from this failure.

D. The Plumbing Contractor shall guarantee that all elements of the systems provided under his Contract, are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated on the drawings.

E. Upon receipt of notice from the Owner of failure of any part of the systems or equipment during the guarantee period, the affected part or parts shall be replaced by the Installing Contractor.

F. The Plumbing Contractor shall furnish, before the final payment is made, a written guarantee covering the above requirements.

1.07 COMMISSIONING

A. The Plumbing Contractor(s) must also include sufficient man-hours within their bids, for their participation with the Commissioning Team meetings and overall process and the rebalancing/readjusting/resetting all device setpoints, as described in Section 019100.

B. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Execution Requirements for substantial completion details. Refer to Section 019100, Commissioning, for detailed commissioning requirements.

1.08 THE CONTRACTOR

A. The Plumbing Contractor shall base his bid on site examinations performed by him. This requirement is mandatory. The Plumbing Contractor shall visit the proposed site where work is scheduled to be performed and ascertain for himself the amount of work required to fulfill the intent of his Contract and the complexity of the installation. The Plumbing Contractor shall not hold the Architect, his Consultants, agents or employees responsible for or bound by, any schedule, estimate or for any plan thereof. The Plumbing Contractor shall study all Contract Documents (HVAC, Fire Protection, Electrical, Architectural, Structural), etc., included under each Contract, to determine exactly the extent of work to be provided under each Section, and in installing new equipment and systems and coordinating the work with the other Trades and existing conditions.

B. The Plumbing Contractor shall faithfully execute his work according to the terms and conditions of the Contract and specifications and shall take all responsibility for and bear all losses resulting to him in the execution of his work.

C. The Plumbing Contractor shall be responsible for the location and performance of work provided under his Contract as indicated on the Contract Documents. All parties employed directly or indirectly by the Plumbing Contractor shall perform their work according to all the conditions as set forth in these specifications.

D. The Plumbing Contractor shall furnish all materials and perform all work in accordance with the project specifications and any supplementary documents provided by the Architect. The work shall include every item shown on the drawings and/or required by the specifications as interpreted by the Architect. All work and materials furnished and installed shall be new and of the best quality and workmanship. The Plumbing Contractor shall cooperate with the Architect so that no error or discrepancy in the Contract Documents shall cause defective materials to be used or poor workmanship to be performed.

1.09 COORDINATION OF WORK

A. The Plumbing Contractor shall compare his drawings and specifications with those of other Trades and report any discrepancies between them to the Architect and obtain from the Architect written instructions for changes necessary in the mechanical or electrical work, to ensure that all work is installed in coordination and cooperation with other Trades installing interrelated work. Before installation, the Plumbing Contractor shall make proper provisions to avoid interferences in a manner approved by the Architect. All changes required in the work of the Plumbing Contractor caused by his negligence, shall be corrected by him at his own expense, to the Architect's satisfaction.

B. Locations of piping and equipment shall be adjusted to accommodate the new work with interferences anticipated and encountered during installation. The Plumbing Contractor shall determine the exact routing and location of his systems prior to fabrication or installation of any system component. Accurate measurements and coordination drawings will have to be completed to verify dimensions and characteristics of the various systems' installations.

C. Lines which pitch shall have the right-of-way over those which do not pitch. For example, waste piping shall normally have the right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed.

D. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings. The Plumbing Contractor shall provide manual air vents and drains as required for his work to affect these offsets, transitions and changes in direction, as applicable.

E. All work shall be installed in a way to permit access (without damage to other parts) of valves, cleanouts, shock absorbers, traps and all other system components provided under this Contract requiring periodic replacement or maintenance. All piping shall be arranged in a manner to clear the openings of swinging overhead access doors, ceiling tiles and cleaning access doors in ductwork.

1. Access to any and all components requiring servicing, adjustment, calibration, maintenance or periodic replacement shall be provided so that the Owner's operations personnel can freely gain access without removal of any materials other than the access panel or ceiling tile. Access shall be understood to mean free, clear and unobstructed from the floor up to the device and/or component being serviced.
2. Fire-rated access doors with closers shall be provided for all rated assemblies.

F. The Contract Drawings are diagrammatic only intending to show general runs and locations of piping, valves, equipment and specialties and not necessarily showing all required offsets, details and accessories and equipment to be connected. All work shall be accurately laid out with other Trades to avoid conflicts and to obtain a neat and workmanlike installation which will afford maximum accessibility for operation, maintenance and headroom.

G. Where discrepancies in scope of work as to what Trade provides items, such as starters, disconnects, flow switches, electric control components, etc., exist, such conflicts shall be reported to the Architect prior to signing of the Contract. If such action is not taken, the Plumbing Contractor, as applicable, shall furnish such items as part of his work, for complete and operable systems and equipment, as determined by the Architect.

H. Where drawing details, plans and/or specification requirements are in conflict and where pipe is shown to be different between plans and/or between plans and sections or details, the most stringent requirement will be included in the Contract. Plumbing systems and equipment called for in the specification and/or shown on the drawings shall be provided under this Contract as if it were required by both the drawings and specifications. However, prior to ordering or installation of any portion of work which appears to be in conflict, such work shall be brought to Architect's attention for direction as to what is to be provided.

I. Final location of all outlets, sinks, faucets and trim shall be coordinated with the Architect’s elevation plans and/or other Architectural details, as applicable. Offsets of piping, added fittings, valves, elbows, flexible connections, etc., shall be provided as required to comply with the Architectural floor plans, elevation plans and/or installation details. Obtain approval of locations of all devices from Architect in the field, prior to installation.

J. Equipment and/or hoods, dishwashers, etc., or other type of equipment shown on the Plumbing or Architectural drawings to be provided with services, such as piping, traps, drains, valves, etc., shall be included under this Contract as applicable, including all piping connections to systems, to make equipment completely operable. Additional piping, valves, flexible fittings, etc., shall be provided to accomplish the above requirement, as required, all as part of this Contract, at no additional cost to the Owner.

1.10 COORDINATION DRAWINGS

A. Before materials are purchased, fabricated or work is begun, the Plumbing Contractor shall prepare coordination drawings in cooperation with all trades for all floors/areas, including buried systems/services (all-Trade-composite at 1/4" scale), showing the size and location of his equipment and lines, in the manner described herein under General Requirements. Any sections of difficult areas shown in the contract documents are for reference only and do not dictate how to layer or install the trades.

B. The HVAC Contractor shall take the lead in the coordination drawing process to produce the Architectural backgrounds. A detailed drawing schedule shall be produced to conform to the scale drawing requirements as herein listed and submitted for review. Coordination drawings are for the CM and Architects/Engineer use during construction and shall not be construed as shop drawings or as replacing any shop drawings. The coordination drawings, when corrected for actual "as-built" conditions, will be reviewed by the Architect, corrected and become the Record Drawings to be submitted to the Owner for his use.

C. The cost of producing and reproducing the drawings will be included under the Contract of each Trade, including the cost or preparation of the Architectural building outlines. This process may include multiple revisions to these drawings which will be included in the cost. The intent is to provide a fully coordinated set of documents between trades no matter how many times they may have to be redone. The HVAC Contractor shall take the lead to produce the Architectural backgrounds, show all ductwork, piping, etc., and circulate the drawings to any of his Subcontractors and the other Trades (Plumbing, Fire Protection, Electrical, etc.), so that they can indicate all their work as directed by the CM and Architect as required, to result in a fully coordinated installation.

D. In addition to the regular coordination drawing review, the plumbing work will also be reviewed by the Architect/Engineer to ensure that the system and equipment arrangements are suitable to provide maintenance access and service as follows:

1. Valves and instrumentation should be grouped where possible and positioned in accessible locations.
2. Valves on all insulated piping shall be furnished and installed with extended stem handles.

E. Prepare a complete set of computer-based drawings

1. Prepare a complete set of computer based drawings:
2. Format shall be:

a. REVIT (Latest Version)

3. Scale not less than 1/4" scale equals 1'-0", showing basic layout for the structure and other information as needed for preparation of Coordination Drawings.
4. The drawings shall indicate the layout of all specialty tradework as indicated herein and shall be designated as Coordination Drawings.
5. Any drawing requirement to assist the contractor will require:

a. A signed liability release form will be required from the Contractor prior to the release of the disk from the Engineer.

F. Highlight all fire rated partitions on the Coordination Drawings for appropriate coordination.

G. The main paths for the installation or removal of all MEP & FP equipment from mechanical and electrical rooms shall be clearly indicated on the Coordination Drawings.

H. Each of the specialty trades shall add its work to the base drawings with appropriate elevations and grid dimensions. Specialty trade information shall be required for mechanical rooms, crossovers and for spaces above ceilings where congestion of work may occur such as corridors and, where required, entire floors. Drawings shall indicate horizontal and vertical dimensions to avoid interference with structural framing, ceilings, partitions and other services. Indicate elevations relative to finish floor for bottom of piping. Sections shown in the contract drawings are diagrammatic only and all trades shall share and coordinate sectional views used.

1. Specialty Trade shall include:

a. Plumbing system
b. HVAC piping and associated control systems

c. Electrical
d. Sheet metal work
e. Fire protection system
f. Automatic temperature control
g. Fire alarm
h. Security
i. Telecommunications
j. Pneumatic tube
k. Commissioning Review and Comments

I. Upon completing their portion of the Coordination Drawings, each specialty trade shall sign, date and submit the Coordination Drawings to the CM, Architect/Engineer for review.

J. Where conflicts occur with placement of materials of various trades, the CM shall be responsible to coordinate the available space to accommodate all trades. Any resulting adjustments shall be initialed and dated by the affected specialty trade Contractor. The CM shall then final date and sign each drawing.

K. Fabrication of materials shall not start until Coordination Drawings have been signed, reviewed, and distributed to all parties as indicated herein.

L. Distribution of Coordination Drawings: (Modified for clarification)

1. The CM shall provide one print of each Coordination Drawing to:

a. Each specialty trade Subcontractor.
b. Owner.
c. General Contractor.
d. Architect (for record purposes).
e. Engineer.

M. After Distribution

1. Resolve all interferences not previously identified.

N. Coordination Drawings shall include but are not necessarily limited to:

1. Structure. (Beams, cross bracing, columns, gusset plates, etc.).
2. Partition/room layout, including indication of smoke and fire resistance rated partitions.
3. Ceiling layout and heights.
4. Light fixtures.
5. Access panels.
6. Sheet metal, heating coils, heat pumps, grilles, diffusers, duct flanges, and pipe hanger/supports and pipe support steel, guides, expansion compensators, kitchen exhaust access doors, and take-offs from the duct risers, etc.
7. All heating piping and valves.
8. Smoke and fire dampers including access doors.
9. Soil, waste and vent piping.
10. Primary water and gas pipes.
11. Major electrical, fire alarm, and security conduit runs (All sizes) panelboards, feeder conduit and racks of branch conduit (All). Motor control centers, starters and disconnects including shaft coordination for larger conduit riser junction boxes to ensure access for JBs and JBs sized to access all cables, and access to splice cables.

12. Sprinkler piping and heads.
13. All equipment, including items in the Contract as well as Owner Furnished / Contractor Installed (O.F.C.I.) and Owner Furnished / Owner Installed (O.F.O.I.) items.
14. Equipment located above finished ceiling requiring access for maintenance and service. In locations where acoustical lay-in ceilings occur indicate areas in which the required access area may be greater than the suspended grid systems.
15. Rainwater piping
16. Existing conditions, including but not limited to, Mechanical, Plumbing, Fire Protection and Electrical items.
17. ATC panels
18. Cable tray
19. Beam Penetrations

O. All shaft coordination drawings shall be detailed with the appropriate sizes for all ducts, HVAC pipe, conduits, fire protection piping & Plumbing waste, vent, water, gases etc. Hanger support types, miscellaneous support steel shall be detailed to allow for proper clearances and appropriate insulation thickness. Shaft coordination drawings shall be submitted for review in plan and elevation views.

P. The Architect's response to all requests for information (RFI's) generated by the trade contractors shall be distributed to all other affected trades as if this information was contained in the original contract documents. In other words, the party that issues an RFI is responsible for distributing the information to all affected parties.

Q. The Plumbing Contractor must include in his bid sufficient dollar amounts to coordinate the work of this Contract. This project is complex and will require additional time to coordinate all Trades and allow implementation of the Owners Standards and maintenance serviceability requirements. This requirement shall include, but not be limited to, producing the coordination drawings, as many times and as many drawings as required, to ensure serviceability of equipment, as approved by the Architect.

1.11 RECORD DRAWINGS

A. The Plumbing Contractor shall maintain, current at the site, a set of Contract Drawings for his portion of the work on which he shall accurately show the actual installation of all work provided under his Contract indicating any variation from the Contract Drawings, in accordance with the General Conditions and Supplementary General Conditions. Changes whether resulting from formal change orders, requests for information, or other instructions issued by the Architect shall be recorded. Include changes in sizes, location and dimensions of piping, equipment, etc.

B. The Plumbing Contractor shall indicate progress by coloring-in various pipes and associated appurtenances exactly as they are installed. This process shall incorporate both the changes noted above and all other deviations from the original drawings whether resulting from job conditions encountered or from any other causes.

C. The marked-up and colored-up prints will be used as a guide for determining the progress of the work installed. They shall be reviewed periodically by the Architect and Owner's representatives and they shall be corrected if found either inaccurate or incomplete. This procedure is mandatory. Marked up drawings shall include all flow diagrams, schedules, details and control diagrams.

D. The Plumbing Contractor shall meet at a minimum on a monthly basis, with the Owner's representative to transfer the information from his Plumbing marked-up and colored-up prints to a set which will become the basis for preparation of as-built drawings.

E. Upon completion of the project, each Contractor shall submit his marked-up drawings to the Architect for review and comment. After the Architect reviews and comments on this set of documents, each Contractor shall prepare as-built drawings on CAD using AutoCad (Latest Version). When the work is completed, each Contractor shall provide 2 hard copies to the Architect for submittal to the Owner and disks with all documentation and a set of reproducible drawing plots marked "As-Built" drawings. The Contractor shall bear all costs of producing the CAD "As-Built" drawings, providing all necessary drawing changes and printing the reproducible drawings for the work under his charge.

1.12 GIVING INFORMATION

A. The Plumbing Contractor shall keep himself fully informed as to the shape, size and position of all openings required for his apparatus and shall give information to the Architect and other Contractors [or Subcontractors] sufficiently in advance of the work so that all openings may be built in advance.

1.13 EQUIPMENT AND MATERIALS

A. Equipment and materials shall be delivered to the site and stored in original sealed containers, suitably sheltered from the elements, but readily accessible for inspection by the Architect until installed. All items subject to moisture damage such as controls, motors, etc., shall be stored in dry, heated spaces.

B. The Plumbing Contractor shall have his equipment tightly covered and protected against dirt, water and chemical or mechanical injury and theft. At the completion of the work, equipment and materials shall be cleaned, polished thoroughly and turned over to the Owner in a condition satisfactory to the Architect. Damage or defects developing before acceptance of the work shall be made good at the Plumbing Contractor's or his Subcontractor’s expense as applicable.

C. The Plumbing Contractor shall make necessary field measurements to ascertain space requirements, for equipment and connections to be provided under his Trade and shall furnish and install such sizes and shapes of equipment to allow for the final installation to conform to the drawings and specifications.

D. Manufacturers' directions shall be followed completely in the delivery, storage, protection and installation of any equipment. Promptly notify the Architect in writing of any conflict between any requirements of the Contract Documents and the manufacturer's directions and obtain the Architect's written instructions before proceeding with the work. Should any Contractor perform any work that does not comply with the manufacturer's directions or written instructions from the Architect, he shall bear all costs to correct any deficiencies that should arise.

E. The Plumbing Contractor shall furnish and install all equipment, accessories, connections and incidental items necessary to fully complete the work under his Contract for use, occupancy and operation by the Owner.

F. Where equipment of the acceptable manufacturers requires different arrangement or connections from those shown, it shall be the responsibility of the Plumbing Contractor to install the equipment to operate properly and in harmony with the original intent of the drawings and specifications.

When directed by the Architect, the Plumbing Contractor shall submit drawings showing the proposed installation. If the proposed installation is approved, the Plumbing Contractor shall make all necessary changes in all effected related work provided under other Sections including location of roughing-in connections by other Trades, electrical requirements, piping, supports, insulation, etc. All changes shall be made at no increase in the Contract amount or additional cost to the other Trades and/or Owner.

G. Testing Agency Labeling Requirements

1. All equipment and materials required for installation under these specifications shall be new and without blemish or defect.
2. Equipment and materials shall be products which will meet with the acceptance of the Authorities Having Jurisdiction over the work and as specified hereinbefore.
3. Where such acceptance is contingent upon having FM Global approval, it shall be provided with FM Global label. Factory manufactured and assembled packaged equipment, such as the examples of equipment listed below, shall have the entire assembled package inspected and labeled by Factory Mutual.
4. All equipment shall meet OSHA standards.
5. All products shall be listed and labeled by UL or other national testing laboratories such as ETL and the products shall be so labeled.

    a. Label of Underwriter's Laboratories, ETL or other nationally recognized testing agency acceptable to the Authorities Having Jurisdiction.
    b. This Labeling shall include not just the control panel and/or motor but all wiring and devices included in the package as a complete package. Note: Providing a series of individually labeled electrical devices that are then assembled into a package does not meet this requirement, the whole assembly must be labeled as an assembly. The manufacturers have the option of having the equipment inspected and labeled at the factory or at the site after installation. This requirement shall supersede any other specification language hereinbefore or hereinafter that requires only portions of the equipment to be labeled.
    c. Some examples of packaged equipment requiring Labeling:

        1) Dental Vacuum Pump System
        2) Amalgam Separator System
        3) Dental Air Compressor System
        4) Medical Air System
        5) Medical Vacuum System
        6) Water Heaters

H. All equipment of one type (such as valves, pumps, plumbing fixtures, etc.), shall be the product of one manufacturer.

I. Equipment prepurchased on behalf of the Owner or by the Owner himself, if assigned to any of the Contractors, shall be received, inspected, installed, etc., as if it was purchased by the Contractors as applicable. All guarantees, service contracts, etc., shall be the same as for all other equipment provided under this Contract.

1.14 CUTTING AND PATCHING

A. The Plumbing Contractor shall be responsible for all core drilling, as required for work under his Contract, but in no case shall he cut into any structural elements without the written approval of the Architect.

B. All cutting, rough patching and finish patching, shall be coordinated and provided under this Contract.

C. All concrete and masonry equipment bases and pads shall be coordinated and provided under this Contract.

1.15 USE OF PREMISES

A. The Plumbing Contractor shall confine all of his apparatus, storage of materials and construction to the limits indicated on the drawings and directed by the Architect and he shall not encumber the premises with his materials.

B. In storing materials within areas (structure or ground), or when used as a shop, the Plumbing Contractor shall consult with the CM and shall restrict his storage to space designated for such purposes. The Plumbing Contractor will be held responsible for repairs, patching or cleaning arising from any unauthorized use of premises.

C. Notwithstanding any approvals or instructions which must be obtained by the Plumbing Contractor from the Architect in connection with use of premises, the responsibility for the safe working conditions at the site shall remain the Plumbing Contractor's. The Architect or Owner shall not be deemed to have any responsibility or liability in connection therewith.

1.16 PROTECTION

A. All materials such as valves, fittings, piping, equipment, etc., shall be properly protected and all piping openings shall be temporarily closed by the Plumbing Contractor or his Subcontractor’s installing same, so to prevent obstruction and damage. The Plumbing Contractor shall take precautions to protect his materials from damage and theft.

B. The Plumbing Contractor shall furnish, place and maintain proper safety guards for the prevention of accidents that might be caused by the workmanship, materials, equipment or electrical systems provided under his Contract.

1.17 DAMAGE CORRECTION AND EXTRA WORK

A. The Plumbing Contractor shall be held responsible and shall pay for all damages caused by his work to the new and existing building structures and new and existing equipment, piping, duct systems, etc., and all work and finishes installed under this Contract in the new or in existing building. Repair of such damage shall be done as herein before specified, at the expense of the Plumbing Contractor and to the Architect's satisfaction.

B. The Plumbing Contractor shall promptly correct all work provided under his Contract and rejected by the Architect as defective or as failing to conform to the Contract Documents whether observed before or after completion of work and whether or not fabricated, installed or completed. The Plumbing Contractor shall bear all costs of correcting such rejected work.

C. No claim for extra work will be allowed unless it is authorized by the Architect in writing before commencement of the extra said work.

1.18 TOUCH-UP PAINTING

A. The Plumbing Contractor shall thoroughly clean all equipment and systems provided under this Contract from rust, splatters and other foreign matter or discoloration, leaving every part of each system in an acceptable prime condition. The Plumbing Contractor, for the work under his Contract, shall refinish and restore to the original condition all equipment and piping which has sustained damage to the manufacturer's prime and finish coats of paint and/or enamel.

1.19 HOUSEKEEPING PADS

A. The Plumbing Contractor shall coordinate housekeeping pads for:

1. All equipment indoors or outdoors
2. All floor supports or braces

B. Pads shall be 4" high above the finished floor. Pads for steam water heaters shall be a minimum of 18” above finish floor. Contractor shall be responsible for coordinating the required height to allow steam condensate to connect to mechanical equipment by gravity.

C. Each pad shall be a minimum of 6" larger then the equipment, support or isolation base in all directions and shall not obstruct floor drains.

D. Pads shall be formed, poured with concrete, and tooled by the CM.

E. Pads shall not be poured until after the M.E.P. coordination drawings are completed and the equipment shop drawings have been submitted and reviewed.

1.20 PIPE SLEEVES, PLATES AND ESCUTCHEONS

A. Where piping pass through masonry or concrete walls or floors (even if openings are cored), the Plumbing Contractor shall provide and set individual sleeves for each pipe and all other work under his charge, as necessary for passage of all pipes. Sleeves shall be of sufficient size to provide 1/2" air space around the pipe passing through (including insulation where pipes are externally insulated). All openings shall be sealed, smokeproofed and made tight. The Plumbing Contractor shall be responsible for the exact location of sleeves provided under his Contract and shall coordinate all requirements for piping sleeves. In the event that failure to do so requires cutting and patching, it shall be done at this Contractor’s expense.

B. The Plumbing Contractor, for work under his charge, shall determine the required inside diameter of each individual wall opening or sleeve before ordering, fabrication or installation.

C. Sleeves passing through lightproof or soundproof walls and floors and through firewalls shall be sealed and made tight using only approved materials and methods.

D. All wall openings or pipe penetrations shall utilize fire stop materials and assemblies bearing a UL Listed rating. Fire stop, UL Listed details for all applicable pipe material penetrations shall be submitted for review prior to fabrication or installation of any materials.

E. Sleeves and inserts shall not be used in any portions of the building, where their use would impair the strength or construction features of the building. Elimination of sleeves must be approved by the Architect.

F. Provide chrome plated brass escutcheons with set screw for exposed piping, in all areas except in mechanical rooms. In this area use plain brass or cast iron escutcheons suitable for painting. All escutcheons shall be sized to fit the bare pipe or insulation in a snug and neat manner. They shall be of sufficient size to cover sleeved openings for the pipes and of sufficient depth to cover sleeves projecting above floors. Escutcheons shall be as manufactured by Beaton & Caldwell, Dearborn Brass, or Grinnell. All escutcheons shall be of one piece construction.

G. Pipe or duct sleeves shall be made of Schedule 40 pipe, 20 gauge galvanized steel or 16 gauge steel as follows:

1. Sleeves on pipes passing through masonry or concrete construction shall be Schedule 40 pipe.
2. Sleeves on pipes passing through drywall construction shall be 20 gauge galvanized steel.
3. Sleeves on pipes passing through fire rated partitions shall be 16 gauge steel.
4. Sleeves on piping passing through non-rated drywall construction shall be 20 gauge galvanized steel.

H. Pipe sleeves shall be set as follows:

1. Set sleeves 1" above finish floor, (except set sleeves, 6" above finish floor at penthouses or mechanical rooms and 6” above finished roof) and flush on each side of walls. Coordinate roof penetrations with roofing Contractor.
2. Sleeves shall be set securely in place before concrete is poured when placed in concrete construction.

I. Except as otherwise specified, underground piping passing through exterior walls or foundation slabs on grade, shall have penetration closures of the modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Links shall be loosely assembled with bolts to form a continuous belt around the pipe and with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely watertight seal between the pipe and wall, reducing chances of cathodic reaction between these members. The Plumbing Contractor for work under his charge shall determine the required inside diameter of each individual wall opening or sleeve before ordering, fabrication or installation. The inside diameter of the wall opening shall be sized to fit the pipe and ensure a watertight joint. Where applicable, when installing seals, take into account the pipe O.D. if non-standard due to coating or jacketing.

1.21 THROUGH PENETRATION FIRE STOP SYSTEMS

A. See Section 220584.

1.22 MISCELLANEOUS IRON AND STEEL

A. Each trade shall provide all primary and secondary steel supports and hangers as shown on the drawings and/or as required to support equipment, piping or any other materials provided under the work of this Section.

B. The work of this Section of designing, furnishing and installing all miscellaneous metal work associated with the system, and related items as indicated on the drawings and/or as specified herein, and includes, but is not limited to the items listed herein below.

C. The scope of work shall include:

1. Intermediate beams to hang piping from the roof. All piping must be hung from beam or supported from the floor. Provide supplemental steel for support of equipment.
2. Support of piping in shafts in addition to support provided by structure.
3. Piping support in underground concrete trench. (Provide galvanized supports/materials)
4. Pipe anchors in the building.
5. Hangers, brackets, angel irons or rods required for the support and protection of Plumbing equipment.
6. Field prime painting of galvanized steel and field finish painting.
7. All supports exposed to the outdoors shall be galvanized supports/materials.

D. Shop Drawings for General Miscellaneous Items

1. Submit Shop Drawings of all miscellaneous metal items to Architect for approval, showing sizes and thickness of all members, types of materials, methods of connection and assembly, complete dimensions, clearances, anchorage, relationship to surrounding work by other Trades, shop paint, and other pertinent details of fabrication and installation.

E. Samples

1. Submit duplicate samples of all materials to be furnished under this Section if, and in size and form, requested by Architect.

F. Do not order materials or begin fabrication until Architect's approval of submittals has been obtained.

G. In addition to the governing laws and codes, the following Specifications and Codes form a part of this Specification:

1. American Iron and Steel Institute applicable standards.
2. American Institute of Steel Construction "Code of Standard Practice for Steel Buildings and Bridges" and "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings".
3. American Welding Society Code: Standard Code for Arc and Gas Welding in Building Construction.

H. All materials shall be new stock, free from defects impairing strength, durability or appearance and of best commercial quality for each intended purpose.

1. Unless otherwise specifically called for, work of this Section shall be fabricated of structural steel conforming to ASTM Specification A36.
2. Steel pipe shall be seamless steel pipe conforming to ASTM Specification A53, Schedule 40.
3. Steel tubing shall be seamless steel tubing conforming to ASTM Specifications A500 to A501.
4. Construction specialties such as slotted inserts, wedge inserts, etc., shall be as manufactured by Hohmann and Barnard, Gateway Erectors, Inc. or Richmond Screw Anchor Co.
5. Non-ferrous metals shall be as specified under descriptions of specific items, herein below.

I. Provide all anchors, bolts, sockets, sleeves, and other parts required for securing each item of work of this Section to the construction, including furnishing to concrete workers all required insets and sleeves for use at concrete.

1. All exposed fastenings shall be of the same material and finish as the metal to which applied, unless otherwise noted.
2. Welding rods shall conform to AWS Standards and the recommendation of the welding rod manufacturer.
3. Shop primer for other ferrous surfaces shall be a high-quality, lead-free, rust-inhibitive primer, Tnemec No. 10-99 Metal Primer or equivalent by Devoe and Raynolds Co.or Carboline.

J. Metal surfaces shall be clean and free from mill scale, flake, rust and rust pitting. Metal work shall be well formed and finished to required shape and size, true to details, with straight, sharp lines and angles and smooth surfaces. Curved work shall be true radii. Exposed sheared edges shall be eased.

K. Weld all permanent connections. Welds shall be continuous on all exposed surfaces and where required for strength on concealed surfaces. Exposed welds shall be ground flush and smooth, with voids filled with metallic filling compound (metallic filling compound not permitted on surfaces to receive hot-dip galvanizing). Tack-welding will not be permitted unless specifically called for. Do not use screws or bolts where they can be avoided. Where used, heads shall be countersunk, screwed up tight, and threads nicked to prevent loosening.

L. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall give ample strength and stiffness. Joints exposed to weather shall be formed to exclude water.

M. Do all cutting, punching, drilling and tapping required for attachment of anchor bolts and other hardware and for attachment of work by other Trades. All such cutting, punching, drilling, etc., shall be done prior to hot-dip galvanizing of the various components.

N. Live loads shall be not less than the minimum required by law. Where specific live load are not set forth in the laws and codes applicable to this work, and are not given on the Drawings or in this Specification, designs shall be such as to support the live loads which may normally be imposed without failure, without deflection of more than 1/360 of length of any member, and without permanent deformation, all with a factor of safety of not less than 2 1/2 to 1.

O. Shop Painting

1. All ungalvanized ferrous metals under this Section shall be given a shop coat of rust inhibitive primer of type specified above.

a. Immediately before shop painting, remove all rust, loose mill scale, dirt, weld flux, weld spatter, and other foreign material with wire brushes and/or steel scrapers. Power tool clean in accordance with SSPC SP-3 (Power Tool Cleaning). Remove all grease with oil by use of solvent recommended by paint manufacturer. Sandpaper exposed surfaces as required to produce smooth, even finishes.
b. Apply paint by spray process in strict accordance with manufacturer's printed instructions to uniform thickness(es) recommended by manufacturer. Apply thoroughly and evenly and work well into corners and joints taking care to avoid sags and runs.

c. Do not paint surfaces to be embedded in concrete, or to be welded in the field. After field welds are complete, grind smooth and flush, thoroughly clean and then apply specified primer over all unprimed in the field by brush roller.

d. After erection, sand smooth and retouch all portions of the shop coats chipped or damaged during erection, and coat all field welds and connections with primer equivalent to that used for the shop coat.

P. Installation

1. All materials shall be carefully handled and stored under cover in manner to prevent deformation and damage to the materials and to shop finishes, and to prevent rusting and the accumulation of foreign matter on the metal work. All such work shall be repaired and cleaned prior to erection.
2. Work shall be erected square, plumb and true, accurately fitted, and with the tight joints and intersections. All anchors, inserts and other members to be set in concrete or masonry shall be furnished loose by this Trade to be built-into concrete and masonry and by those Trades as the work progresses. Later cutting or drilling shall be avoided wherever possible.
3. Where members, other than expansion bolts or inserts, are fastened into concrete, set such members in holes formed as specified below, and secure permanently in place by installation of proprietary-type expanding grout manufactured specifically for such purpose, used strictly in accordance with manufacturer's directions. Holes to receive members shall be formed with galvanized sheet metal sleeves, expanded polystyrene foam, or other approved method to provide at least 1/2 inch clearance around entire perimeter. At exposed applications, hold expanding grout back 1/2 inch from finish surface and fill voids with Portland cement grout to match color and texture of surrounding concrete surface.
4. Electrolytic Isolation

   a. Where dissimilar metals are to come into contact with one another, isolate by application of a heavy coating of bituminous paint on contact surfaces in addition to shop coat specified above. Do not permit the bituminous paint in any way to remain on surfaces to be exposed or to receive sealant.

Q. Piping supports shall be coordinated with the building structure and shall span between roof beams as required.

1.23 WATERPROOFING, FLASHING AND COUNTERFLASHING

A. Unless specifically indicated otherwise on the drawings, the Plumbing Contractor shall provide all counterflashing and waterproofing of all piping, drains and equipment provided by him, which pierce roofs, walls and other weatherbarrier surfaces. All work under this paragraph shall be coordinated with the CM.

B. All work shall be performed in a workmanlike manner to ensure weatherproof installation. Any leaks developed due to the Plumbing Contractor's work shall be repaired at his expense, to the Architect's satisfaction.

C. Pipes passing through slabs shall have the sleeve extended above floors as hereinbefore specified to retain any water and the space between the pipe and sleeve caulked waterproof fire stopping. The top and the bottom shall be sealed with monolastic caulking compound.

D. All flashing required for piping penetrations shall be provided by the CM.

1.24 PLUMBING IDENTIFICATION

A. See Section 220553.

1.25 VALVE TAGS, NAMEPLATES AND CHARTS

A. See Section 220553.

1.26 ELECTRICAL WORK, MOTORS AND CONTROLLERS

A. See Division 26.

1.27 PARTS LIST AND INSTRUCTIONS FOR OPERATION AND MAINTENANCE

A. The Plumbing Contractor shall thoroughly instruct the representative(s) of the Owner, to the complete satisfaction of the Architect, in the proper operation of all systems and equipment provided by him. The Plumbing Contractor shall make arrangements, via the CM as to whom the instructions are to be given in the operation of the basic and auxiliary systems and the periods of time in which they are to be given. The Architect shall be completely satisfied that the representative of the Owner has been thoroughly and completely instructed in the proper operation of all systems and equipment before final payment is made. If the Architect determines that complete and thorough instructions have not been given by the Plumbing Contractor to the Owner's representative, then the Plumbing Contractor shall be directed by the Architect to provide whatever instructions are necessary until the intent of this paragraph of the specification has been complied with. All time required for Owner's instruction to satisfy the above requirements shall be included in this Contract. No extra compensation for such instructions will be allowed.

B. The Plumbing Contract shall submit to the Architect for approval a total of six (6) typed sets, bound neatly in loose-leaf binders, of all maintenance and operating instructions for the installation, operation, care and maintenance of all equipment and systems. All data and literature furnished shall be specific for the make and model of the equipment furnished. General non-specific catalog data will not be acceptable. Information shall indicate possible problems with equipment and suggested corrective action. The manuals shall be indexed for each type of equipment. Each section such as valves, plumbing fixtures, water heaters, etc., shall be clearly divided from the other sections. A sub-index for each section shall also be provided. The methodology of setting-up the manuals shall be submitted to the Architect and Owner through the CM for approval prior to final submission of manuals.

C. The instructions shall contain information deemed necessary by the Architect and shall include, but not be limited to, the following:

1. Instructional classes on equipment and systems operation for Owner's representative and maintenance personnel, by engineering staff of each Contractor. Minimum of 48 hours of instruction for minimum of (6) people. Instruction shall include:

   a. Explanation of manual and its use.
   b. Summary description of the Plumbing systems.
   c. Purpose of systems.

2. System

   a. Detailed description of all systems.

b. Illustrations, schematics, block diagrams, catalog cuts and other exhibits.

3. Operations

a. Complete detailed, step-by-step, sequential description of all phases of operation for all portions of the systems, including start-up, shutdown, adjusting and balancing. Include all posted instruction charts.

4. Maintenance

a. Parts list and part numbers.
b. Maintenance, lubrication and replacement charts and manufacturer's recommendations for preventive maintenance, as applicable to his work.
c. Troubleshooting charts for systems and components.
d. Instructions for testing each type of part.
e. Recommended list of on-hand spare parts.
f. Complete calibration instructions for all parts and entire systems.
g. Instruction for charging, filling, draining and purging, as applicable.
h. General or miscellaneous maintenance notes.
i. Initial Equipment Start-up reports and run time logs.

5. Manufacturer's Literature

a. Furnish complete listing for all parts required for models actually furnished.
b. Names, addresses and telephone numbers of manufacturers and suppliers.
c. Describe and operation of all models actually furnished.
d. Furnish all and only pertinent brochures, illustrations, drawings, cuts, bulletins, technical data, certified performance charts and other literature with the model actually furnished to be clearly and conspicuously identified.
e. Internal wiring diagrams and engineering data sheets for all items and/or equipment furnished under each Contract.
f. Guarantee and warranty data.

6. Each Contractor shall furnish instructions for lubricating each piece of equipment installed by him. Instructions shall state type of lubricant, where and how frequently lubrication is required. Frame instructions under plexiglass and hang in a location as directed by Architect.

1.28 MANUFACTURER'S REPRESENTATIVE AND START-UP OF SYSTEMS

A. The Plumbing Contractor shall provide, at appropriate time or as directed by the Architect, the on-site services of a competent factory trained Engineer or authorized representative of particular manufacturer of equipment provided under his Contract, such as for the pumps, water heaters, etc. provided under this Contract, to instruct the Owner, inspect, adjust and place in proper operating condition any item provided by him, as applicable.

B. The Plumbing Contractor, as applicable, shall start up and set in operating condition all major equipment and systems, such as the hot water system, etc., in the presence of the applicable equipment manufacturer's representatives, and the Owner and Architect's representatives. In no case will major systems and equipment be commissioned by any of the Contractor's forces alone, without the assistance or presence of the equipment manufacturers.

C. A written report shall be issued by the particular equipment manufacturer and the Plumbing Contractor summarizing the results of the start up and performance of each system for the Architect's record. No additional compensation will be allowed for any Contractor for such services.

D. The Plumbing Contractor shall prepare and submit to the Architect for acceptance, a schedule of anticipated system commissioning. No system shall be commissioned without prior acceptance of the schedule by the Architect and Owner. No system shall be commissioned prior to submittal and acceptance of the operations and maintenance manuals.

1.29 ELECTRICAL ROOM REQUIREMENTS

A. The Plumbing Contractors shall not install any piping or equipment in or through electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms, unless piping or equipment is intended to serve these rooms. If any Contractor violates this requirement, he shall remove and/or relocate all items as required at his expense and to the satisfaction of the Architect.

1.30 HOISTING EQUIPMENT AND MACHINERY

A. All hoisting equipment and machinery required for the proper and expeditious prosecution and progress of the work under this Contract shall be furnished, installed, operated and maintained in safe condition by the Plumbing Contractor for his material and/or equipment delivered to the designated hoisting area. All costs for hoisting operating services shall be borne by the Plumbing Contractor for all equipment and work under his charge.

1.31 STAGING

A. All staging, exterior and interior, required to be over 8'-0" in height shall be furnished and erected by the Plumbing Contractor for work under his charge and maintained in safe condition by him for proper execution of his work.

1.32 PHASING, DEMOLITION AND MAINTAINING EXISTING SERVICES

A. During the execution of the work, required relocation of existing equipment and systems in the existing areas where new work and connections are scheduled to be made shall be performed by the Plumbing Contractor as indicated on the drawings, as required by the job conditions and as determined by the CM in close cooperation with the Architect and Owner's designated representative to facilitate the installation of the new systems and completion of this Contract. The Owner will require the continuous operation of all existing systems while demolition relocation work of new tie-ins is being performed. Outages required for construction purposes shall be scheduled for the shortest practical periods of time, in coordination with the Owner's designated representative for specific, mutually agreeable periods of time after each of which the interruption shall cease and service shall be restored. This procedure shall be repeated to suit the Owner's working schedule as many times as required until all work is completed.

B. Prior to any deactivation and relocation, capping, valving, tie-in or demolition work, consult the drawings and arrange a conference with the Architect and the Owner's representative in the field to inspect each of the items to be deactivated, removed or relocated. Care shall be taken to protect all equipment designated to be relocated and reused. Give notice to all parties, with a minimum of (10) working days in advance.

C. All draining of existing systems, filling and venting required to remove and relocate existing piping systems shall be included and provided under this Contract as required to perform the various equipment or piping relocations or new tie-ins.

D. Except as otherwise noted, all deactivation, safe capping, valving, etc., of systems designated to be demolished shall be provided by the Plumbing Contractor, as applicable, and all demolition, removal and disposal of demolished materials shall be performed by the CM. All equipment scheduled to be removed shall be inspected by the Owner, and, if he decides that such equipment is to be salvaged, the Plumbing Contractor shall deliver said equipment to an area within the site boundaries as determined by the Owner and Architect.

E. The phasing of the work shall be performed in strict accordance with the CM construction schedule. The new systems will be installed and completely commissioned prior to occupancy. Coordinate requirements for temporary heat or rerouting of existing services as required to accomplish the construction schedule.

F. The Plumbing Contractor shall follow and comply with the Owner's Shut-down Notification Procedures.

G. Plumbing Contractor shall provide all temporary or permanent caps, valves, hangers, drains, vents as required to perform the Plumbing demolition, relocation and alteration.

1.33 CROSS AND INTERCONNECTIONS

A. No plumbing fixtures, equipment, device or piping shall be installed which will provide a cross or interconnection between a distributing supply or a drainage system, waste or soil pipe which will permit or make possible the backflow of sewage, polluted water or waste into the domestic water supply system.

1.34 CONNECTIONS TO EQUIPMENT

A. Furnish and install waste and vents, traps, cold water, hot water, non-domestic cold and hot water, medical/laboratory gases, dental air, dental vacuum, piping, shutoffs, backflow preventers, pressure reducing valves, vacuum breakers, shock absorbers, regulators and flexible tubing for all final connections to kitchen, medical and laboratory equipment, headwalls, casework and sinks provided under other Sections. Roughing for this equipment shall be as indicated on the drawings.

B. The Plumbing Contractor shall provide all pipe connections, drains, overflows, shock absorbers**,** relief valves and vents, power connections, etc., to make equipment operable, as provided under other Sections of the specifications, as shown on the Architectural and/or each Trade's drawings and herein specified, including final connections to equipment to result in a complete system, fully operational. Coordinate location of all equipment with Architect. Obtain installation diagrams and methods of installation of all equipment from manufacturers. Follow instructions strictly. If additional information is required, obtain same from Architect. If equipment is indicated on the Architectural drawings, it shall also be construed and understood by the Plumbing Contractor to be constructed as shown on the Plumbing drawings and shall be fully serviced and connected at no extra cost to the Owner.

C. Obtain exact roughing in dimensions from manufacturers of all service locations before connecting to or roughing for equipment. Provide shutoff valves at each piece of equipment.

D. Owner provided equipment shall be furnished and set under other Sections. Roughing for and final connections to including piping shall be provided by this Contractor. Equipment included shall be (but not limited to):

1. Dental equipment
2. Prefabricated medical gas headwalls
3. Preformed sink tops
4. Scrub stations
5. Laboratory casework and trim

1.35 SUSTAINABLE DESIGN INITIATIVES

A. The project has been registered under the USGBC LEED – NC Version 2.2 Green Building Rating System. Contractor responsibilities relative to the LEED Certification process in general and credit documentation in particular are defined in Division 1.

B. Plumbing systems and equipment with particular emphasis on sustainable design and integral to LEED Certification include, but are not limited to, the following:

1. Premium Efficient Motors
2. Low Flow Plumbing Fixtures
3. Low VOC Sealants and Adhesives
4. Construction IAQ Management Plan

PART 2 PRODUCTS

2.01 NOT USED

PART 3 EXECUTION

3.01 NOT USED

END OF SECTION

SECTION 220510

3D BUILDING INFORMATION MODELING

1.01 OVERVIEW

A. Building Information Modeling (BIM) is the development and use of a 3-dimensional computer model to represent a virtual model of the facility and the process for constructing the facility. Once the model is developed, it can be used to simulate the construction process and to manage the operations of the facility. The Building Information Model can be created by combining many different 3D models from the designers and contractors into a composite model. From this composite model, views and data appropriate to various users' needs can be extracted and analyzed to generate information, to make decisions and to improve the process of delivering the building.

1.02 OUTCOME

A. The purpose of BIM is to create a model that may be used for coordination of all trades throughout the construction process, with the final product being an as-built model of the Project which contains all of the major elements of construction that could be used by the Owner for future operation and maintenance of the building.

1.03 REQUIRED DISCLAIMER

A. All users shall be required to sign a disclaimer as follows:

TERMS OF USE OF 3D COMPUTER MODEL FOR THE UCONN PROJECT ("Project")

This 3D Computer Model for the Project is provided by Architectural Resources Cambridge (ARC) (Architect) to user (individually, a "User", or collectively, "Users") at the User's request subject to the terms and conditions stated below (the "Terms of Use"):

The 3D Model is made available to User solely for his convenience and for informational purposes only. The User is not to rely upon the 3D Computer Model and the data and/or information contained therein in preparing any of the coordination documents for the Project. The User acknowledges that the 3D Computer Model is not a part of the Construction or Contract Documents for the Project and that the Architect makes no representations or warranties, express or implied, regarding the 3D Computer Model's, accuracy or completeness or the data and/or information contained therein.

By opening the files provided, the User agrees that these terms apply to the 3D Model in its entirety, together with all of its component parts and data The User acknowledges that the requirements of these Terms of Use apply to all of User's principals, employees and agents.

The User agrees that the use of the 3D Computer Model is solely at the User's risk and that the User assumes full responsibility and liability in connection with the User's use of the 3D Computer Model and the information and/or data contained therein. The User agrees that the Architect has no responsibility for any deficiencies, inaccuracies, errors and/or omissions contained in the 3D Computer Model or the data and/or information contained therein. The Architect has no responsibility for any deficiencies or defects in the User's documents, work and/or services resulting from the User's use of the 3D Computer Model in lieu of the Construction and/or Contract Documents for the Project.

The User acknowledges and agrees a) that the use of the 3D Computer Model is not a substitute for professional judgment; b) that the use of the 3D Computer Model does not relieve the User from applying the appropriate standard of care and skill relevant to the use of the 3D Computer Model and its contents; c) that the 3D Computer Model is only to be used as a tool to assist the User in connection with the Project; d) that the User is solely responsible for verifying the accuracy of all results created with the use of the 3D Computer Model; and (e) the Architect is not responsible or liable for the means and methods of construction and the User's use of the 3D Computer Model shall in no way give rise to such responsible or liable by the Architect or its consultants.

THE ARCHITECT AND ITS CONSULTANTS SPECIFICALLY DISCLAIM ALL WARRANTIES WHETHER EXPRESSED, IMPLIED OR STATUTORY, INCLUDING, WITHOUT LIMITATION, ALL WARRANTIES OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE, CONSTRUCTABILITY, NON-INFRINGEMENT, COMPATIBILITY, SECURITY OR ACCURACY AND USERS' USE OF THE 3D COMPUTER MODEL IS AT ITS OWN RISK. USER ASSUMES FULL RESPONSIBILITY AND RISK OF LOSS RESULTING FROM USE OR INABILITY TO USE THE 3D COMPUTER MODEL OR ITS CONTENT.

The User further agrees that the 3D Computer Model contains information that is confidential and proprietary to the Architect, and that the Architect retains the copyright and all other reserved rights in the work product reflected in the 3D Computer Model that was prepared by the Architect or its consultants for the Project. The Architect grants the User a non-exclusive, non-transferable royalty-free license to use the 3D Computer Model for informational purposes only in connection with the Project in strict accordance with these Terms of Use. The User agrees that the 3D Computer Model will be used solely and exclusively for the Project and that it will not use the 3D Computer Model and the data and/or information contained therein, in whole or in part, for any purpose or project other than the Project. The User further agrees that the 3D Computer Model will continue to be kept confidential by the User, and that it shall not be disclosed in any manner, transferred or exchanged to any third parties by the User without the express written consent of the Architect.

Upon completion of the User's involvement with the Project or at any time upon written request of the Architect, the User shall promptly deliver to the Architect the 3D Computer Model and any other material containing or reflecting any information or data in the 3D Computer Model (whether prepared by the Architect, the User or otherwise) and will not retain copies, extracts or other reproductions, tangible or intangible, in whole or in part of the 3D Computer Model. The User's non-disclosure and non-use obligations set forth herein shall survive the return, destruction or deletion of the 3D Computer Model. If the User becomes legally compelled, by subpoena or court order, to disclose the 3D Model, or any information contained therein, the User shall provide the Architect with prompt notice so that a protective order or other appropriate remedy may be sought by and at the expense of the Architect and/or compliance with the provisions of this Terms of Use may be waived.

User hereby agrees that the Architect shall be entitled to equitable relief, including injunction, in the event of any breach of the Terms of Use, including without limitation its obligations to maintain the confidentiality of the 3D Model, that the granting of such relief will not be opposed and that such relief shall not be the exclusive remedy for such breach. The Architect's failure to insist upon strict adherence to any term of these Terms of Use shall not be considered a waiver thereof or deprive the Architect of the right subsequently to insist upon strict adherence to that term or any other term of this Terms of Use.

The User hereby agrees, to the fullest extent permitted by law, that in no event shall the Architect be liable to User for any damages or losses of any kind including, but not limited to, damages for death or bodily injury to persons, injury to property, and direct, indirect, consequential, special, or incidental damages, resulting from any error, omission, inaccuracy, deficiency or defect in or problem with, the 3D Computer Model or the data and/or information contained therein. Without limiting the foregoing, the User acknowledges that the 3D Computer Model and the data and/or information contained therein may be inaccurate and/or incomplete and that the Architect will have no obligation to update or modify the 3D Computer Model or any of the data and/or information contained in it because the 3D Computer Model was prepared solely for informational purposes and is not part of the Construction or Contract Documents for the Project.

The User agrees that in the event the User, its officers, directors, shareholders, partners, agents, employees, consultants or independent contractors use the 3D Computer Model or the information and/or data contained therein, it shall, to the fullest extent permitted by law, defend, indemnify and hold the Architect and its officers, directors, shareholders, partners, principals, consultants, agents and employees harmless from and against any and all actions, damages, demands, claims, suits, losses, liability, judgments, recoveries, costs and expenses, including, but not limited to, reasonable attorney's fees which any of them may incur in connection with, arising from, resulting from or related to any use of the 3D Computer Model or the data and/or the information contained therein by the User or any third party who receives the 3D Computer Model from the User. Such claims include, without limitation, any claim which may arise due to deletions, omissions or variations of data due to mechanical or technical failure in connection with the transmission of the 3D Computer Model.

The User acknowledges and agrees that it is not in privity of contract with the Architect as of result of these Terms of Use with respect to any claims or causes of action related to or arising out of the Project. The User further agrees to obligate any contractor, consultant or other party who uses the 3D Computer Model to be bound by the terms and conditions contained herein. Any User's use of the 3D Computer Model and the information and/or data contained therein constitutes such User's acceptance of all the terms here specified.

ACCEPTED & AGREED:

Name: _____

Title: _____

Date: _____

1.04 SCOPE OF WORK

A. General Scope Requirements

1. In general, the BIM scope of work for the Project is to create a technically accurate and detailed 3D computer model of the architectural, structural, mechanical, plumbing and electrical systems.
2. The computer model (in plan view) shall extend to five feet beyond the exterior walls of the building. Vertically, the model shall extend from the lowest extent of the foundations up through and including the roof of the top-most floor. To the extent that the scope includes building systems, those systems will be included to the full horizontal and vertical extents of the model including underground utilities and roof mounted items.

3. The level of detail defined in the Specific Scope Requirements is the minimum level of detail required in the model. Greater detail than the minimum should be incorporated into the model where important details are necessary for communicating information about a system.
4. Each Trade Contractor shall provide shop drawings in both 2D and 3D model format.
5. The 3D model shall be located and oriented to the pre-determined world coordinates for the project to allow easy integration into the BIM for the project.
6. The 3D model shall include the project control grid. This grid should be visible when viewing the model in a true view along the X, Y or Z axis.
7. The 3D model shall be layered and constructed in a manner such that all elements of the model can be converted into a 2D dimensioned drawing for use in the field.
8. The 2d shop drawing scale should be 1'-0" = 3/8" unless specified otherwise or as required for full comprehensible and reviewable details.
9. Each drawing should include a key map referencing the location in the building.
10. In addition to the native file format, the Trade Contractor shall provide translation of the 3D model into a .DWG, CIS/2 or other agreed upon file format that can be viewed using NavisWorks Manager.
11. The following changes shall be promptly incorporated into the drawings and model, on a regular basis:

    a. RFIs, Bulletins and Owner changes
    b. Changes in the sequence of work
    c. Field modifications
    d. Shop drawing review comments
    e. Changes requested by the Design Build Contractor

12. All revised 3d model or 2D drawing submittals shall have a written narrative to define changes from previous submittals. Typical drafting techniques such as 'clouds' or 'bubbles' are acceptable means of tracking changes on the 2D drawings. [Layer control shall be used to define changes in the 3D model. All revisions shall be shown in both 2D and 3D formats].
13. The working 3D model will be shared with the Trade Contractors and design team at least once every two weeks. This will be performed by posting the model to the project FTP site or PrologWeb. The Trade Contractor will post the native file format and an agreed upon file format as defined in Item J above.
14. Pre-detailing meeting:

    a. Shall determine the lead trade.
    b. The order that coordination work will be added to the model.

15. The 3D modeling and layering conventions will be established at a pre-detailing meeting to be attended by:

    a. Concrete Contractor and detailer
    b. Steel Fabricator and detailer
    c. Mechanical Contractors and detailers
    d. Electrical Contractors and detailers
    e. Plumbing Contractors and detailers
    f. Fire protection Contractors and detailers
    g. Other trades.

16. Each Trade Contractor will submit its 3D modeling software and proposed file format(s) for approval prior to proceeding with detailing. The Trade Contractor will also provide a 3D mock-up of a specific portion of the project, to be agreed upon at a future time, in full detail in order to verify the compatibility of the file formats.
17. Each Trade Contractor shall provide viewer licenses only for its specific 3D software to the following:

    a. Owner
    b. Design Build Contractor
    c. Architect
    d. Engineer of Record

18. Each Trade Contractor and detailers shall have the capability to host and attend web meeting using Microsoft Live Meeting software.
19. Each Trade Contractor shall complete the drawings and model in a time frame capable of meeting the Project Schedule.
20. Each Trade Contractors are advised that the model shall be shared among all trades and shall be the basis of coordination and fabrication. Costs incurred for post-coordination changes caused by unauthorized deviations from the model shall be borne by the Trade Contractor that initially deviated from the model. This determination is at the sole discretion of the Design Build Contractor.
21. The base architectural BIM will be created using AutoDesk's Revit Building.
22. The 3D modeling effort is intended to augment and assist in the MEP coordination process. Before first submission shop drawings, the elements shall be first pass coordinated in the 3D model. The model is intended to find conflicts before shop drawings are reviewed and approved.
23. In addition to the requirements set forth in the contract documents, final models shall be submitted reflecting true "as-built" conditions.

B. Plumbing Technical Scope Requirements

1. All plumbing piping will be modeled. All plumbing equipment will be modeled to its overall height, width and depth. Pipes will be modeled to the outside diameter of the pipe or the pipe insulation, whichever is greater. Pipe slope will be incorporated in the model.
2. Pipe fittings and connections will not be modeled. All valves, clean outs and accessories will be modeled.
3. Each Trade Contractor to provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
4. Each Trade Contractor shall be prepared to attend weekly coordination meetings to resolve conflicts within the model.
5. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
6. The 3D model is to include access areas for equipment – included as a modeled element such that clash detection and coordination can be accommodated relating to access.
7. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
8. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
9. All items modeled shall have a level of intelligence associated with them, including, at a minimum, material type, size, insulation, etc.

10. All items located within mechanical rooms shall have a level of intelligence associated with them that includes, at a minimum, material type, size, insulation, manufacturer, product numbers, serial numbers, maintenance schedules, operation and maintenance data, etc.
11. All conduits shall be modeled.

C. Electrical Technical Scope Requirements

1. All electrical equipment including switchgear, transformers and panelboards will be modeled to its overall size. All necessary clearances for electrical equipment will be modeled as a separate volume. All conduits shall be modeled.
2. All light fixtures will be modeled as an overall volume require for that fixture.
3. Each Trade Contractor shall provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
4. Each Trade Contractor shall be prepared to attend weekly coordination meetings to resolve conflicts within the model.
5. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
6. The 3D model is to include access areas for equipment – included as a modeled element such that clash detection and coordination can be accommodated relating to access.
7. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
8. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
9. All panelboards modeled shall have a level of intelligence associated with them that accurately identifies at a minimum the panel schedule.
10. All items located within electrical rooms and closets shall have a level of intelligence associated with them that includes, at a minimum, material type, size, manufacturer, product numbers, serial numbers, maintenance schedules, operation and maintenance data, etc.

D. Fire Protection Technical Scope Requirements

1. All fire protection equipment including pipe, valves, heads, risers and drains will be modeled.
2. All light fixtures will be modeled as an overall volume require for that fixture.
3. Each Trade Contractor to provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
4. This Trade Contractor shall be prepared to attend weekly coordination meetings to resolve conflicts within the model.
5. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
6. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
7. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
8. All items modeled shall have a level of intelligence associated with them that accurately identifies at a minimum the material type, rating, model number, etc.

9. All conduits shall be modeled

E. Mechanical / Sheetmetal Technical Scope Requirements

1. All ducts and air handling equipment will be modeled. Ducts will be modeled to the outside face dimension. Equipment will be modeled to its overall height, width and depth. All piping associated with the mechanical system will be modeled. Pipes will be modeled to the outside diameter of the pipe or pipe insulation (whichever is greater).
2. Pipe hangers and hanger assemblies and dunnage will be modeled for clash detection and coordination. Fittings and connections will not be modeled. The intent of this model is to show the ductwork and piping, etc. in a true representation of the actual condition at construction completion.
3. Pipe fittings and connections will not be modeled. All valves, clean outs and accessories will be modeled.
4. Each Trade Contractor to provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
5. Each Trade Contractor shall be prepared to attend weekly coordination meetings to resolve conflicts within the model.
6. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
7. The 3D model is to include access areas for equipment – included as a modeled element such that clash detection and coordination can be accommodated relating to access.
8. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
9. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
10. All items modeled shall have a level of intelligence associated with them including, at a minimum, the material type, size, insulation, etc.
11. The Basement Level and Penthouse Mechanical Rooms shall have a level of intelligence associated with them that includes at a minimum material type, size, insulation, manufacturer, product numbers, serial numbers, maintenance schedules, operation and maintenance data, etc.
12. Each Trade Contractor shall include in their base bid BIM/Coordination facilities on site. The Design Build Contractor shall provide a Coordination Trailer for the Construction Team's use throughout the duration of the project. The HVAC Trade Contractor must provide a CAD workstation capable of running the Trade Contractor's CAD software as well as the following BIM software:

    a. NavisWorks Manager (current version)
    b. AutoCAD REVIT Architecture Suite (current version)
    c. AutoCAD REVIT MEP Suite (current version)

13. Each Trade Contractor shall turn over the above software complete with Licenses at Final Completion for the Owner's use.
14. All conduits shall be modeled.

F. Fire Alarm Technical Scope Requirements

1. All fire Alarm equipment including Fire Alarm conduit sizes/routing and Fire Alarm Panels and associated panels will be modeled.

2. Each Trade Contractor to provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
3. This Trade Contractor shall be prepared to attend weekly coordination meeting to resolve conflicts within the model.
4. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
5. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
6. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
7. All items modeled shall have a level of intelligence associated with them that accurately identifies at a minimum the material type, rating, model number, etc.
8. All conduits shall be modeled.

G. ATC Technical Scope Requirements

1. The ATC equipment including conduit and panels will be modeled.
2. Each Trade Contractor to provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
3. This Trade Contractor shall be prepared to attend weekly coordination meeting to resolve conflicts within the model.
4. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
5. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
6. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
7. All items modeled shall have a level of intelligence associated with them that accurately identifies at a minimum the material type, rating, model number, etc.
8. All conduits shall be modeled.

END OF SECTION

SECTION 220529

HANGERS AND SUPPORTS

PART 1 GENERAL

1.00 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 220500 and other Division 1 Specification Sections, apply to this Section.

1.01 WORK INCLUDED

A. Furnish and install all hangers, supports and assemblies for all parts of the Plumbing systems. This shall include all piping and equipment specified in this Division and as shown on the drawings

B. All materials shall be new and manufactured for the specific purpose of supporting systems, equipment, pipes and accessories.

C. All system components shall be installed in accordance with local codes including seismic isolation as required and specified under Section 220548.

D. Secure all permits and local/state approval for the components as specified and included under this Section.

1.02 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1. Section 220500 – Basic Plumbing Materials and Methods
2. Section 220510 – 3D Building Information Modeling
3. Section 220548 – Plumbing Vibration Control and Seismic Restraints
4. Section 220553 – Plumbing Identification
5. Section 220584 – Through Penetration Firestop Systems
6. Section 221120 – Plumbing Distribution Piping
7. Section 221130 – Drainage and Vent Piping
8. Section 221140 – Plumbing Specialties
9. Section 223000 – Plumbing Equipment
10. Section 224000 – Plumbing Fixtures
11. Section 226000 – Laboratory Plumbing Systems
12. Section 227000 – Medical Plumbing Systems

1.03 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

1. Material standards shall be as specified or detailed hereinafter and as following:

a. ASME B31.9 – Building Services Piping, The American Society of Mechanical Engineers.
b. ASME B31.1 – power piping.
c. ASTM F 708 – Standard Practice for Design and Installation of Rigid Pipe Hangers.
d. MSS SP-58 – Pipe Hangers and Supports – Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry.
e. MSS SP-69 – Pipe Hangers and Supports – Selection and Application; Manufacturers Standardization Society of the Valve Fittings Industry.
f. MSS SP-89 – Pipe Hangers and Supports – Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry.
g. MSS-SP-127-2001 – Bracing for Piping Systems.

1.04 SYSTEM DESCRIPTION

A. In addition to special hangers and supports specified elsewhere in this Section and shown on the drawings for piping and equipment, furnish and install safe and substantial means of support for all parts of the Plumbing systems. Shop drawings shall be submitted for review and approval for all supports. All piping and supports in all mechanical rooms and penthouses shall be installed with vibration isolators and Seismic restraints. This requirement is mandatory and shall be strictly enforced.

B. All piping shall be hung to true alignment, using appropriate and substantial hanger arrangements. Wire and strap hangers will not be permitted. Hangers shall be located so that piping and hangers will be clear of other piping, hangers, conduits, lighting and other obstructions.

C. The hanging and supporting of piping and equipment shall conform to recommendations of the manufacturers of same and American National Standard, ANSI/MSS SP-58 and SP-69 latest edition, except where requirements of this specification exceed the above referenced Standards.

1.05 SUBMITTALS

A. See Section 220500 and General Conditions for additional requirements.

B. All brackets and hangers shall be submitted for review. Include the method of hanging and supporting all piping and equipment.

C. The Architect is to be notified when the first bracket is assembled so that the installation can be reviewed in the field.

D. Provide location of all inserts to be used for hanging piping and equipment and the weight of all components (including water weight).

1.06 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products of the type specified in Part 2 – Products.

B. Installer: Company specializing in performing work of the type specified in this section, with documented experience.

C. Welders: Certify in accordance with ASME.

1.07 REGULATORY REQUIREMENTS

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

B. Conform to ASME B31.1 code for power piping.

C. All applicable seismic codes.

D. ASTM F708 for design and installation of pipe hangers.

E. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations

1. Provide certificate of compliance from Authority Having Jurisdiction, indicating approval of welders.

1.08 DELIVERY, STORAGE AND HANDLING

A. All hangers and supports shall be delivered in containers and shall be kept in a dry and protected area.

B. All exposed hangers, supports, etc. shall be given 2 coats of rust resistant paint of a color selected by the Architect prior to installation.

1.09 ENVIRONMENTAL

A. Do not paint or install inserts, hangers and/or supports when environmental conditions are outside the specific limitations of the referenced codes and manufacturer's recommendations.

PART 2 PRODUCTS

2.01 GENERAL

A. Pipe supports shall be of type and figure number as specified.

B. Acceptable manufacturers subject to compliance with the specifications shall be as follows:

1. Pipe Hangers

a. Carpenter & Patterson
b. B-Line
c. Grinnell
d. National Pipe Hanger Corp.

e. Piping Technology & Products Inc.
f. PHD Manufacturing, Inc.

2. Constant Force Hangers.

a. Anvill International, Inc.
b. Piping Technology & Products Inc.
c. Piping Accessories, Inc.
d. Rilco Manufacturing Co.
e. PHD Manufacturing, Inc.

3. Channel Support Systems

a. B-Line Systems, Inc.
b. Grinnell Corp. Power-Strut Unit
c. GS Metals Corp.
d. Michigan Hanger Co., Inc. O-Strut Div.
e. National Pipe Hanger Corp.
f. Thomas & Betts Corp.
g. Unistrut Corp.
h. Wesanco, Inc.

4. Thermal-Hanger Shield Inserts

a. Carpenter & Patterson, Inc.
b. Michigan Hanger Co., Inc.
c. PHS Industries, Inc.
d. Pipe Shields, Inc.
e. Rilco Manufacturing Co., Inc.
f. Value Engineered Products, Inc.

2.02 PIPE HANGERS

A. Bracket assemblies for supporting piping are to be fabricated by welding and all irregular surfaces are to be smoothed up by grinding. Shop drawings shall be submitted for review for each type bracket. The Architect is to be notified when the first bracket is assembled so that installation can be reviewed in the field. Exposed hangers, supports and brackets are to be given (2) coats of rust resistant paint of the color as selected by the Architect. Additionally, provide for Architect's review, the following:

1. Location of all inserts to be used for hanging piping where applicable and the weight of such pipe or equipment to be hung, including the weight of water, valves and insulation.
2. Method of hanging and support of all piping and other equipment.

B. All pipe supports shall be of type and arrangement as hereinafter specified. They shall be so arranged as to prevent excessive bending stresses between supports.

C. All bracket clamp and rod sizes indicated in this specification are minimum sizes only. This Section shall be responsible for structural integrity of all supports. All structural hanging materials shall have a safety factor of (5) built in. Beam clamps shall be 2-sided steel clamps designed to firmly attach to the flange of the beam with the load directed downward on the centerline of the beam web. Beam clamps shall be similar to B-Line #B3055 or approved equal.

D. Other forms of hangers and supports shall be used to accommodate special or unusual job conditions or conditions not covered herein, subject to the approval of the Architect. When special conditions require the use of concrete inserts which are not "built in", such inserts may be used in locations approved by the Architect and shall be similar to Phillips "Red Head" or approved equal. Explosive powder studs or detonator assisted studs or anchors will not be permitted.

E. All pipes shall be hung free of dependence on pipe sleeves for support.

F. All auxiliary steel required for pipe and equipment supports shall be furnished and installed by the Plumbing Contractor.

G. Threaded pipe, chains, wire and perforated straps will not be accepted. No piping shall be supported from ductwork, conduit or other piping. All system components and equipment shall be independently supported. Distribute hangers on parallel piping to avoid overloading of structure.

H. Hangers and supports used for systems exposed to weather shall be hot dipped galvanized in accordance with ASTM A153-73 or A123. Rods and nuts shall be electro-galvanized.

I. All horizontal water, drain, waste, vent and rainwater piping shall be hung with clevis steel hangers similar to B-Line #B3100. Groups of pipes in the same horizontal plane and with the same pitch may be supported on B-Line #3160 gang hangers. Wall brackets shall be similar to B-Line #B3066 and #B3077.

J. Unless otherwise noted, maximum pipe hanger spacing shall not exceed the recommendations of the pipe manufacturer and the following:

Horizontal

1.	Copper Tubing up to 1-1/4":	6'-0" o.c.
2.	Copper Tubing 1-1/2" and larger:	10'-0" o.c.
3.	Cast Iron Pipe:	5'-0" o.c.
4.	Steel Pipe:	12'-0" o.c.
5.	Stainless Steel up to 1-1/4":	6’-0" o.c.
6.	Stainless Steel 1-1/2" and larger:	10’-0" o.c.
7.	Polypropylene (Lab waste) 1-1/2" and smaller:	4’-0" o.c.
8.	Polypropylene (Lab waste) 2" and larger:	8"-0" o.c.
9.	Polypropylene/PVDF (pure water):	5"-0" o.c.

10. In addition, hangers shall be installed within 2'-0" of each change in direction and on each side of valves 3" in size and up.
11. All piping shall be supported vertically at each floor and at the base of all risers.

Vertical

Cast Iron:	at base and every story height
Steel:	every other story height
Copper:	each story height but not more than 10 ft. intervals
Polypropylene/PVDF	

K. Hanger rods shall be of steel and not less in diameter than:

1.	For pipe 2" and under:	3/8"
2.	For pipe 2 1/2" and 3":	1/2"
3.	For pipe 4" and 5":	5/8"
4.	For pipe 6":	3/4"
5.	For pipe 8", 10" and 12":	7/8"
6.	For pipe 14" and 16":	1"
7.	For pipe 18" and up:	1 1/4"

L. Hangers for polypropylene and PVDF pure water piping shall be a trough V-bottom clevis hanger with continuous angle 18 gauge galvanized steel support similar to B-Line #B3106V.

M. Insulated piping shall be fitted with 16 gauge steel covering protectors at each hanger location similar to B-Line #B3151.

N. Hangers for uncovered (uninsulated) copper or brass piping, including medical gases, shall be factory-applied plastic-coated steel band or copper plated.

O. All vertical piping shall be supported with steel riser clamps similar to B-Line #B3773. Such clamps on copper tubing shall be applied over couplings only.

P. Drop rods for hangers may be used wherever possible and shall be installed prior to slabs being poured. Drop rod details shall be submitted to the Architect and Engineer for review.

2.03 MISCELLANEOUS MATERIALS

A. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

B. Structural Steel: ASTM A 36M, steel plates, shapes, and bars, black and galvanized.

C. Grout: ASTM C 1107, Grade B, factory-mixed and packaged, non-shrink and non-metallic, dry, hydraulic-cement grout.

1. Characteristics: Post hardening and volume adjusting recommended for both interior and exterior applications.
2. Properties: Non-staining, non-corrosive and non-gaseous
3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.01 PREPARATION

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.02 INSTALLATION

A. Pipe Hangers and Supports.

1. Install in accordance with ASME B31.9, ASTM F 708, or MSS SP-89 or NFPA-13.
2. Support piping and equipment as specified under Part 2.
3. Install hangers to provide minimum ½ inch space between finished covering and adjacent work.
4. Place hangers with 24 inches of each horizontal elbow and on each side of valves 3” in size and up.
5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
6. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
8. Provide copper plated hangers and supports for copper piping or between hanger support and piping.
9. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

B. Where pipe support members are welded to structural building framing, scrape, brush clean and apply two coats of zinc rich primer to welds.

3.03 INSERTS

A. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

B. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 4 inch.

C. Finish inserts, flush with slab surface.

D. Inserts: Steel, slotted type, factory-painted.

1. Single rod: Similar to Grinnell Figure 281.
2. Multi-rod: Similar to Carpenter and Paterson 1480 Type 1.
3. Clip form nails flush with inserts.
4. Maximum load 75 percent of rating.

3.04 SUPPORTS FROM BUILDING CONSTRUCTION

A. Inserts, Beam Clamps, Steel Fishplates (in concrete fill only), Cantilever Brackets or Other Means.

B. Submit for Review.

C. Grouped Lines and Services

1. Trapeze Hangers fabricated of Bolted Angles or Channels.

D. Where Building Construction is Inadequate

1. Provide Additional Framing.
2. Submit for Review.

3.05 EXPANSION DEVICES

A. Expansion anchors: Similar to Hilti "Drop-In Anchor HDI" flush type.

B. Drill concrete to receive required expansion cases on concrete fasteners.

C. Install in shear only, not in tension.

3.06 EQUIPMENT BASES AND SUPPORTS

A. Provide rigid anchors for pipes immediately after vibration connections to equipment.

B. Refer to Specification Section 220500 for additional information.

C. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.

D. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.07 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.

B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base-metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.08 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.09 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 220548

PLUMBING VIBRATION CONTROLS AND SEISMIC RESTRAINTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 220500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all necessary vibration isolation materials to eliminate excessive noise and vibration from all building mechanical systems.

B. Seismic restraints for all systems shall be installed in accordance with:

1.	Code	State of Connecticut Building Code – 2005 Edition including all adopted supplements
2.	Use group	III
3.	Seismic design category	C
4.	Site classification	D
5.	Building I_p (Importance Factor)	1.5
6.	All Life safety systems	Importance Factor = 1.5
7.	Emergency electrical	Importance Factor = 1.5
8.	Hazardous systems	Importance Factor = 1.5
	a. Natural Gas piping	Importance Factor = 1.5
	b. Natural Gas Vents	Importance Factor = 1.5
9.	Plumbing systems	
	a. Medical gas	Importance Factor = 1.5
	b. Laboratory gases	Importance Factor = 1.5
	c. Nitrogen piping system	Importance Factor = 1.5
	d. Compressed air system	Importance Factor = 1.5
	e. High Purity water system	Importance Factor = 1.5
	f. Pneumatic gases	Importance Factor = 1.5
	g. Domestic water system	Importance Factor = 1.5
	h. Non Potable water system	Importance Factor = 1.0
	i. Dental Vacuum System	Importance Factor = 1.0
	j. Dental Air System	Importance Factor = 1.0
	k. Waste and vent system	Importance Factor = 1.0
	l. Laboratory waste and vent	Importance Factor = 1.5
	m. Storm Drain system	Importance Factor = 1.0
10.	Other systems	
	a. All other electrical systems	Importance Factor = 1.5
	b. All other plumbing systems	Importance Factor = 1.5
	c. Control conduits	Importance Factor = 1.5

C. Piping types

1. High deformability piping:

a. Welded steel
b. Welded stainless steel
c. Socket welded steel
d. Grooved steel that is ASME B31.1
e. Brazed copper
f. Grooved copper

2. Limited-deformability

a. Threaded Steel
b. Grooved steel that is not ASME B31.1
c. Soldered copper

3. Low-deformability

a. PVC
b. Cast iron
c. Glass
d. Non-ductile plastic

D. All trapeze supported Items weighing 10 Lbs per foot or greater shall be braced. This weight shall include all pipes and conduits filled with water.

E. Secure all permits and local/state approval for the installation of all components included under this Section.

F. The work in this Section shall include the following:

1. Vibration isolation elements for equipment.
2. Equipment isolation bases.
3. Piping flexible connectors.
4. Seismic restraints for isolated equipment.
5. Seismic restraints for non-isolated equipment.
6. Seismic restraints for piping
7. Certification of seismic restraint designs and installation supervision.
8. Certification of seismic attachment of housekeeping pads.

G. Coordinate closely with Hangers and Supports, Pipe Expansion and Structural documents.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1. Section 220500 – Basic Plumbing Materials and Methods
2. Section 220529 – Hangers and Supports
3. Section 221120 – Plumbing Distribution.

4. Section 221140 – Plumbing Specialties.
5. Section 223000 – Plumbing Equipment.
6. Section 226000 – Laboratory Plumbing Systems.
7. Section 226700 – Process Water Systems.
8. Section 227000 – Medical Plumbing Systems.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. NEBB– Procedural Standards for Measuring Sound and Vibration; National Environmental Balancing Bureau.
2. NEBB– Sound and Vibration in Environmental Systems; National Environmental Balancing Bureau.
3. SMACNA – Guidelines for Seismic Restraint of Mechanical Systems.
4. ASHRAE Guidelines – HVAC Applications; Chapter– Sound and Vibration Control, Chapter – Seismic Restraint Design, Latest Edition.
5. ASCE Standard 7 Minimum Design Loads for Buildings and Other Structures

1.05 SUBMITTALS

A. See Section 220500 and General Conditions for additional requirements.

B. The Vibration Isolation Submittal shall include descriptive data for all products and materials including the following:

1. Product Descriptions

a. A complete description of products to be supplied, including product data, dimensions, specifications and installation instructions.
b. An itemized list of isolated and non-isolated equipment. Detailed schedule and selection data for each vibration isolator and seismic restraint supporting equipment, including:

1) Equipment identification mark
2) Isolator type
3) Actual load
4) Static deflection expected under actual load
5) Specified minimum static deflection
6) Additional deflection-to-solid under load
7) Ratio of spring height under load to spring diameter
8) Base type
9) Seismic restraint type

c. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.

2. Show equipment base construction for all equipment, including dimensions, structural member sizes and support point locations.
3. Indicate isolation devices selected with complete dimensional and deflection data.
4. Show all methods of suspension and support for ceiling hung equipment.
5. Detail methods of isolation for pipes piercing walls and slabs.
6. Provide specific details of seismic restraints and anchors, including number, size and locations for each piece of equipment.
7. Provide special details necessary to convey complete understanding of the work to be performed.

C. Seismic Analysis and Certification submittals shall include the following:

1. Seismic restraint calculations must be provided for all connections of equipment to the structure.
2. Calculations to support seismic restraint designs shall be stamped by a registered Professional Engineer.
3. Analysis must indicate calculated dead loads, derived loads, and materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and weld length.
4. A seismic design liability insurance certificate must accompany all submittals.
5. Coordinate all hangers and supports.
6. Provide Approved Agencies Certificate of Compliance meeting Seismic Category D for all components. Tests shall include anchorage, structural and on line capability from analytical or shaker test method.

    a. Where the requirements of this specification cannot be met by any vendor, the contractor will submit a written summary indicating the lack of resources.

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

E. Provide seismic certifications for all equipment including, but not limited to:

1. Medical air compressors
2. Medical vacuum pumps
3. Water heaters
4. Medical gas equipment
5. VFDs
6. Motor control centers
7. Pumps
8. Seismic joints

1.06 QUALITY ASSURANCE

A. All vibration isolators shall have calibration markings or some method to determine the actual deflection under the imposed load after installation and adjustment.

B. All isolators shall operate within the linear portion of their load versus deflection curves. Load versus deflection curves shall be furnished by the manufacturer and must be linear over a deflection range of at least 50% above the design deflection.

C. The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than ±10%, and shall be non-resonant with equipment forcing frequencies or support structure natural frequencies.

D. All neoprene components shall have a shore hardness of 30 to 50 ±5%, after minimum aging of (20) days or equal oven aging.

E. Substitution of internally isolated and restrained equipment in lieu of the isolation and restraints specified in this Section is acceptable provided all conditions of this Section are met. The equipment manufacturer shall provide a letter of guarantee stating that the specified noise and vibration levels will be obtained and that the seismic restraints shall be in compliance with these specifications. All costs for converting to the specified external vibration isolation and/or restraints shall be borne by the equipment manufacturer/installing contractor should submissions or installations be found to be unacceptable pursuant to the intent of this specifications.

F. Should any rotating equipment cause excessive noise or vibration, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

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

H. Manufacturer Responsibility

1. Manufacturer of vibration and seismic control equipment shall have the following responsibilities:

   a. Determine vibration isolation and seismic restraint sizes and locations.
   b. Provide equipment vibration isolation and seismic restraints as scheduled or specified.
   c. Guarantee specified isolation system deflections.
   d. Provide installation instructions, drawings and field supervision to ensure proper installation and performance of systems.
   e. Provide certification by a licensed engineer that all mounts and restraints meet the project requirements for seismic loading.

2. Substitution of internally isolated mechanical equipment in lieu of the specified isolation of this Section must be approved for individual equipment units and is acceptable only if above acceleration loads are certified in writing by the equipment manufacturer and stamped and sealed by a licensed Civil or Structural Engineer.
3. Licensed Engineers shall be licensed in the project state.

I. Contractor Responsibilities

1. The Contractor performing the work on equipment in the section shall have the following responsibilities.

   a. Identify the components that are part of the Quality Assurance Plan.

      1) All flammable, combustible and highly toxic piping and their associated mechanical systems.
      2) All equipment using combustible or toxic energy sources.

   b. Identify all Special inspection and Testing.
   c. List control procedures within the contractor's organization including methods and frequency of reporting and their distribution.
   d. List personnel and their qualifications exercising control over the seismic aspects of the project.

2. Purchased and/or fabricated equipment must be designed to safely accept external forces of 1.8 g load in any direction for all rigidly supported equipment, piping without failure and permanent displacement of the equipment. Resiliently supported equipment, piping and Life safety equipment such as fire pumps, smoke exhaust fans, emergency generators and other life safety designated equipment must be capable of accepting external forces of up to 3.6 g in any direction without permanent displacement or failure of the equipment.

1.07 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 code for installation of piping system and ASTM F708 for design and installation of pipe hangers.

B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

C. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.08 DELIVERY, STORAGE AND HANDLING

A. All vibration control and seismic restraint equipment shall be delivered in containers and shall be kept in a dry and protected area.

B. All exposed hangers, supports, etc. shall be given 2 coats of rust resistant paint of a color selected by the Architect prior to installation.

PART 2 PRODUCTS

2.01 ISOLATORS AND RESTRAINTS – GENERAL

A. Acceptable Manufacturers subject to compliance to specifications.

   1. Mason Industries (MI)
   2. Amber/Booth (AB)

3. Kinetics Noise Control (KNC)
4. Vibration Eliminator Co. (VEC)
5. Vibration Mountings & Controls (VMC)

B. The Mechanical Contractor shall provide necessary vibration isolation materials to eliminate excessive noise and vibration from being transmitted from Plumbing equipment to the occupied areas of the structure, and to serve as the basis for seismic restraint design for the entire Plumbing system within the building. This includes all non-structural components such as, but not limited to, pumps, tanks, piping, etc. (hereinafter called equipment).

C. Seismic restraints and vibration isolation types shall be capable of accepting, without failure, seismic forces determined in accordance with:

1. International Building Code
2. State/Country Codes
3. Local codes enforced at the specified project location.

D. Isolators and supports shall maintain the equipment in a captive position and not short circuit isolation during normal operating conditions. Isolators shall have provisions for bolting and/or welding to the structure.

E. All metal parts of vibration isolation units installed out-of-doors shall be cold dip galvanized, cadmium plated, or neoprene or PVC coated after fabrication. Galvanizing shall meet ASTM Salt Spray Test Standards and Federal Test Standard #14.

F. All base supported isolators shall have base plates with bolt holes for fastening the isolators to the support members.

G. Isolator types are scheduled to establish minimum standards. At the Contractor's option, laborsaving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories must not degrade the vibration isolation system.

H. Static deflection of isolators shall be as scheduled in this Section and as shown on the drawings. All static deflections stated are the minimum acceptable deflection under actual load. Isolators shall be selected for no less than 50% reserve deflection beyond actual operating conditions.

I. Attachment plates to be cast into housekeeping pads, concrete inserts, beam clamps, etc. that may be required for seismic compliance shall be provided by this Section.

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

2.02 SEISMIC RESTRAINT TYPES

A. Type I

1. Type I shall comply with general characteristics of spring isolator Type A with snubbing restraint in all directions capable of supporting equipment at fixed elevations during installation. Cast or aluminum housings, except ductile iron are not acceptable.
2. Type I seismic restraint shall be similar to Mason Industries Type SLRS.

B. Type II

1. Each corner or side of equipment base shall incorporate a seismic restraint snubber having a minimum of 5/8" thick resilient pad limit stop. Seismic snubbers shall be in accordance with manufacturer's recommendations.
2. Type II seismic restraints shall be similar to Mason Industries Type Z-1011 or Z-1225.

C. Type III

1. Type III shall be multiple metal cable or strut type with approved fastening devices to equipment and structure. System to be field bolted to deck or to overhead structural members using 2-sided beam clamps or appropriately designed inserts for concrete. All parts of the system including cables, excluding fasteners, are to be of a single supplier to ensure seismic compliance.

D. Type IV

1. Type IV shall have double deflection neoprene isolator (minimum 0.3") encased in ductile iron or steel casing.
2. Type IV seismic restraints shall be similar to Mason Industries Type BR, RBA or RCA.

E. Type V

1. Non-isolated equipment shall be field bolted or welded (powder shots not acceptable) to the structure as required to meet seismic forces. Bolt diameter, imbedment data and/or weld length must be shown in certified calculations.

2.03 VIBRATION ISOLATOR TYPES

A. Type A (Floor Spring and Neoprene)

1. The Type A spring isolator shall:

a. Have a minimum outside diameter to overall height of 0.8:1.
b. Have corrosion resistance where exposed to corrosive environment with:

1) Springs cadmium plated or electro-galvanized.
2) Hardware cadmium plated.
3) All other metal parts hot dip galvanized.

c. Have reserve deflection (from loaded to solid height) of 50% of rated deflection.
d. Have minimum 1/4" thick neoprene acoustical base pad on underside, unless designed otherwise.
e. Be designed and installed so that ends of springs remain parallel.

2. Type A isolator shall be similar to Mason Industries Type SLF.

Note: Must be used with Seismic Restraint II.

B. Type B (Floor Spring and Neoprene Travel Limited)

1. The Type B spring isolator shall be the same as Type A with the following additional features.

   a. Built-in vertical limit stops with minimum 1/4" clearance under normal operation.
   b. Tapped holes in top plate for bolting to equipment.
   c. Capable of supporting equipment at fixed elevation during equipment installation. Installed and operating heights shall be identical.
   d. Adjustable and removable spring pack with separate neoprene isolation pad.

2. Type B isolator shall be similar to Mason Industries Type SLR.

   Note: This isolator must be bolted or welded to the structure.

C. Type C (Spring Hanger Rod Isolator)

1. Spring isolator (Type A) seated on a steel washer within a neoprene cup incorporating a rod isolation bushing.
2. Spring diameters and hanger box shall allow 30° of hanger rod movement.
3. Type C isolator shall be similar to Mason Industries Type 30 or W30.

   Note: Must be used with Seismic Restraint III.

D. Type D

1. Same as Seismic Restraint Type IV.

E. Type E (Elastomer Hanger Rod Isolator)

1. Molded (minimum 1 3/4" thick) neoprene element with projecting bushing lining the rod clearance hole. Static deflection at rated load shall be minimum 0.035".
2. Steel retainer box encasing neoprene mounting capable of supporting equipment up to (4) times the rated capacity of the element.
3. Type E isolator shall be similar to Mason Industries Type HD.

   Note: Must be used with Seismic Restraint III.

F. Type F (Combination Spring/Elastomer Hanger Rod Isolator)

1. Spring and neoprene elements in a steel retainer box with the features as described for Type C and Type E isolators.
2. Type F isolator shall be similar to Mason Industries Type 30N.

   Note: Must be used with Seismic Restraint III.

G. Type G (Pad Type Elastomer Isolator)

1. 0.75" minimum thickness, 50 psi maximum loading, ribbed or waffled design.
2. Minimum 0.1" deflection.
3. 1/16" galvanized steel plate between multiple pad layers.

4. Provide load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.
5. Type G isolators shall be similar to Mason Industries Type Super W.

Note: Bolting required for seismic compliance. Neoprene and duck washers and bushings shall be provided to prevent short circuiting.

H. Type H (Pad Type Elastomer Isolator)

1. Laminated cotton duck and neoprene, maximum loading 1000 psi, minimum 1/2" thick.
2. Provide load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.
3. Type H isolator shall be similar to Mason Industries Type HL.

Note: Bolting required for seismic compliance. Neoprene and duck washers and bushings shall be provided to prevent short circuiting.

I. Type I (Thrust Restraints)

1. A spring element similar to Type A isolator shall be combined with steel angles, back-up plates, threaded rod, washers and nuts to produce a pair of devices capable of limiting movement of air handling equipment to 1/4".
2. Restraint shall be easily converted in the field from a compression type to tension type.
3. Unit shall be factory pre-compressed.
4. Thrust restraints shall be installed on all cabinet fan heads, axial or centrifugal fans and other equipment as scheduled.
5. Type I restraint shall be similar to Mason Industries Type WB.

J. Type J (Steel Rails)

1. Steel members of sufficient strength to prevent equipment flexure during operation.
2. Height saving brackets as required to reduce operating height.
3. Type J isolator shall be similar to Mason Industries Type ICS.

K. Type K (Pipe Anchors and Guides)

1. Acoustical pipe anchor or guide, consisting of a telescopic arrangement of (2) sizes of steel tubing separated by a minimum 1/2" thickness of Type H pad.
2. Vertical restraints shall be provided by a similar material arranged to prevent vertical travel in either direction (anchors only).
3. Allowable loads on isolation materials shall not exceed 500 psi, and the design shall be balanced for equal resistance in any direction.
4. Anchors and guides must be bolted or welded to meet seismic criteria.
5. Type K anchor shall be similar to Mason Industries Type ADA.

L. Type L (Isolated Clevis Hanger)

1. Combination clevis or rod roller hanger and a Type C, E, or F, isolation hanger.
2. System shall be pre-compressed to allow for rod insertion and standard leveling.
3. Type L hanger shall include Mason Industries Type CCB clevis brace.

2.04 EQUIPMENT BASES

A. All curbs and roof rails are to be bolted or welded to the building steel or concrete deck to attain acceleration criteria and shall be wind restrained for 110 mph wind loads.

B. Type B-1 (Integral Structural Steel Base)

1. The integral structural steel base shall be reinforced as required to prevent base flexure at equipment start-up and misalignment of driver and driven units.
2. Height saving brackets shall be provided, as required, to reduce operating height and maintain 1" operating clearance under base.
3. Member depth shall be a minimum of 1/10 of the longest unsupported span.
4. Type B-1 equipment base shall be similar to Mason Industries Type M or WF.

Note: Must be used with Restraint I, II or IV.

C. Type B-2 (Concrete Inertia Base)

1. Concrete inertia base shall have rectangular structural concrete forms for floating foundations. The base depth shall be a minimum of 1/12 the longest span, but not less than 6" or greater than 14". Forms shall include concrete reinforcement consisting of 1/2" bars or angles welded in place on 6" centers both ways in a layer 1 1/2" above the bottom. Provide an additional top layer of reinforcing for all bases exceeding 10'-0" in one direction.
2. Isolators shall be set into pocket housings which are an integral part of the base construction and set at the proper height to maintain 1" clearance below the base. Base shall be furnished with templates for equipment attachment and anchor bolt sleeves.
3. Type B-2 equipment base shall be similar to Mason Industries Type K or KIPWF.

Note: Must be used with Restraint I, II or IV.

2.05 FLEXIBLE PIPE CONNECTOR

A. All flexible connectors shall be:

1. Installed on the equipment side of the shutoff valves, horizontal and parallel to equipment shafts whenever possible. All piping between the flexible connector and the equipment shall be independently supported off the equipment base.
2. Provided wherever rigidity supported piping is connected to equipment.

B. Type FC-1 (Elastomer Connector)

1. Manufactured of nylon tire cord and EPDM, both molded and cured in hydraulic presses. Neoprene used in lieu of EPDM is not acceptable.
2. Straight connectors to have (2) spheres reinforced with a molded in external ductile iron ring between the spheres.
3. Rated at 250 psig/170°F, dropping in a straight line to 170 psig/250°F for sizes 1 1/2" to 12".
4. All sizes shall employ control cables with neoprene end fittings isolated from anchor plates by means of 1/2" bridge bearing neoprene bushings.
5. Connectors shall be installed pre-extended per manufacturer's recommendations to prevent elongation under pressure.

6. Minimum safety factory of 3.6:1 at maximum pressure ratings shall be certified by test reports. Submittals shall also include (2) test reports by independent consultants showing minimum reduction of 20 dB in vibration accelerations and 10 dB in sound pressure levels at typical blade passage frequencies.
7. Connectors bolted to Victaulic type coupling or gage, butterfly or check valves to have a minimum 5/8" flange spacer installed between the connector and the coupling flange.
8. Connectors for pipe size 2" and smaller shall have threaded female union couplings on each end. Larger pipe sizes shall be fitted with flange couplings.
9. Type FC-1 flexible connector shall be similar to Mason Industries Super-Flex Type MFTNC or MFTFU.

C. Type FC-2 (Flexible Stainless Steel Hose)

1. Stainless steel hose and braid rated with 3:1 safety factor.
2. 2" and smaller with male nipples, 2 1/2" and larger with fixed steel flanges.
3. Lengths as follows:

Size		Length	Size		Length	Size		Length
1/2	x	9	2	x	14	8	x	22
3/4	x	10	2 1/2	x	13	10	x	26
1	x	11	3	x	14	12	x	28
1 1/4	x	12	4	x	15	14	x	30
1 1/2	x	13	5	x	19	16	x	32
			6	x	20			

4. Type FC-2 flexible connector shall be similar to Mason Industries Type BSS.
5. 250 PSIG working pressure.

D. Type FC-3 (Unbraided Exhaust Hose)

1. Low pressure stainless steel annularly corrugated with flanged ends.
2. Maximum temperature of 1500°F.
3. Lengths (in inches) as follows:

Size		Length	Size		Length
2 1/2	x	15	8	x	22
3	x	16	10	x	26
4	x	17	12	x	28
5	x	18	14	x	30
6	x	19	16	x	32

4. Type FC-3 flexible connector shall be Mason Industries Type SDL-RF or equal by approved manufacturer.

E. Type FC-4 (Bronze Braided Flexible Hose)

1. Bronze hose and braid rated with a minimum 3:1 safety factor (minimum 150 psi).
2. Copper tube ends.
3. Minimum lengths (in inches) as follows:

Size		Length	Size		Length	Size		Length
1/8	x	7 1/2	3/4	x	11 1/2	3	x	27
1/4	x	8 1/4	1	x	13	3 1/2	x	32
3/8	x	9	1 1/4	x	14 3/4	4	x	33
1/2	x	9 3/4	1 1/2	x	17	5	x	41

Size		Length	Size		Length	Size		Length
5/8	x	10	2	x	20	6	x	48
			2 1/2	x	24			

4. Type FC-4 flexible connector shall be similar to Mason Industries Type BFF.
5. 250 PSIG working pressure.

F. Seismic Expansion Joints

1. Provide seismic expansion joints on all piping, conduits or other systems crossing building expansion seismic joints. Provide these joints to allow for the movement in the XY&Z direction as indicated on the structural documents.
2. Pressure rated for 250 PSIG at maximum service temperature.

2.06 VIBRATION ISOLATION SCHEDULE

Equipment	HP	Mtng	On Grade ****				Above Grade			
			Isol	Defl	Base	Restr	Isol	Defl	Base	Restr
Base Mounted Pumps	to 15	Flr	A	1.0	B-2	II	A	1.5	B-2	I,II
	>15	Flr	A	1.5	B-2	II	A	2.0	B-2	I,II
In Line Pump		Clg	---	---	---	---	F	.30	---	III
Air Compressors		Flr	A	1.0	B-2	II	A **	See	B-2	I,II
Vacuum Pumps							F	Guide	---	III

* Used on vertically arranged units. Rails shall be 1.5 times the unit height.
** Substitute Type B isolator for Outdoor installations.
*** Substitute Type B-2 base for floor mounted Class 2 and 3 fans.
**** "On Grade" shall mean slab on grade only.
***** Fans in all units shall be isolated in accordance with chart.

Notes:

1. "Isol", "Base" and "Restr" columns indicate letter type as appears in the specs.
2. "Mtng" refers to method of support of equipment from the structure.
3. "See Guide" indicates isolator deflection selection to be taken from Deflection Guide below.

Deflection Guide	
RPM	MW Deflection
<400	3.5"
<600	2.5"
>600	1.5"

PART 3 EXECUTION

3.01 GENERAL

A. Isolation and seismic restraint systems must be installed in strict accordance with the manufacturer's written instructions and submittal data. Vibration isolators shall not cause any change of position of equipment resulting in stress on equipment connections.

B. Design Criteria

1. All mechanical equipment such as pumps, compressors, heaters, etc. shall be isolated from the building structure by means of noise and vibration isolators.
2. All piping in mechanical equipment rooms and penthouses shall be isolated from the building structure by means of noise and vibration isolation hangers and provided with seismic restraints.
3. Piping penetrations through floors and walls shall not be rigidly connected to the building structure. Provide sleeves with clearances around the outside, as recommended by the vibration materials manufacturer. All such penetrations shall be smokeproofed and firestopped in an approved manner as hereinbefore specified.
4. Generally, isolation facilities shall be designed to limit equipment room floor or roof loading to a maximum of 50 lbs./sq.ft. and vibration isolators shall be carefully and specifically selected for each piece of equipment.
5. Piping found to have water hammer or other objectionable vibration or noise which cannot be eliminated by proper grading or other natural means shall be braced, trapped, hung with vibration isolation hangers, equipped with air chambers or mechanical shock absorbers, flexible pipe connectors, or otherwise silenced using means as approved by the Architect.
6. Motor driven equipment which is to be isolated shall have motor mounted on the isolated equipment or shall have motor, equipment and drive mounted on a common base.
7. The Contractor shall not install any equipment, piping or conduit which makes rigid contact with the "building" unless permitted in this Specification. Building includes, but is not limited to, slabs, beams, columns, studs and walls.
8. Isolation mounting deflection shall be (minimum) as specified or scheduled on drawings.
9. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering or electrical, to avoid any contact which would reduce the vibration isolation.
10. Bring to the Architect's attention, prior to installation, any conflicts with other trades that will result in unavoidable rigid contact with equipment or piping as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
11. Bring to the Architect's attention any discrepancies between the specifications and field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the contractor's expense.
12. Obtain inspection and approval of any installation to be covered or enclosed, prior to such closure.
13. Correct, at no additional cost, all installations which are deemed defective in workmanship or materials.

3.02 SPRING RISER SUPPORT SYSTEM

A. All vertical riser subjected to thermal expansion and/or construction as noted herein or on the documents, shall be supported by spring isolators and central anchors designed to insure loading within design limits at structural support points. The riser design must include the initial load, initial deflection, change in deflection, final load and change in load at all spring support locations. In order to minimize load changes, the initial spring deflection must be at least 4 times the thermal movement. The submittal must also include anchor loads when installed, cold filled, and at operating temperature. Include calculated pipe stress at end conditions and branch off locations as well as installation instruction. The submittals must be stamped and signed by a licensed Professional Engineer in the employ of the vibration vendor for at least five years.

B. Neutral resilient anchors close to the center of the run shall direct movement up and down. The anchors shall be capable of holding an upward force equal to the water weight when the system is drained. If one level cannot accommodate this force, anchors can be located on 2 or 3 adjacent floors. Resilient guides shall be spaced and sized properly depending on the pipe diameter.

C. Proper provision shall be made for seismic protection in seismic zones, as required.

D. The support spring mounts shall be specification Type A, anchors Type ADA, telescoping guides Type VSG, all similar to as manufactured by Mason Industries, Inc.

E. The isolation vendor shall provide and design all brackets at riser spring and anchor locations where standard clamps lack capacity or do not fit. The contractor must install and adjust all isolators under the supervision of the designing isolation vendor or his representative.

3.03 EQUIPMENT ISOLATION INSTALLATION

A. Equipment shall be isolated and restrained as per the vibration isolation schedule at the end of this Section.

B. Place floor mounted equipment on 4" high concrete housekeeping pads (unless detailed otherwise) properly doweled or expansion shielded to the deck to meet acceleration criteria. Anchor isolators and/or bases to housekeeping pads. Housekeeping pad concrete work shall be by Division 3. Housekeeping pads shall be sized to have a minimum of 6” of clearance all around the equipment or 12 bolt diameters, whichever is greater.

C. Additional Requirements

1. The minimum operating clearance under inertia bases shall be 2".
2. The minimum operating clearance under other bases shall be 1".
3. All bases shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the equipment, isolators and restraints.
4. The isolators shall be installed without raising the equipment.
5. After the entire installation is complete, and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. The blocks shall be barely free and shall be removed. Remove all debris from beneath the equipment and verify that there are not short circuits of the isolation. The equipment shall be free in all directions.
6. Install equipment with flexibility in wiring.

3.04 PIPING ISOLATION INSTALLATION

A. Isolate piping outside shafts connected to rotating or reciprocating equipment and pressure reducing stations as follows:

1. All water piping in mechanical rooms.
2. Piping within 50'-0" or 100 pipe diameters (whichever is greater) from connected isolated equipment.

B. The isolators shall be installed with the hanger box hung as closely as possible (without direct contact) to the structure.

C. The isolators shall be suspended from substantial structural members sized for a maximum deflection of L/360 at mid span, not from slab diaphragm, unless specifically permitted by the structural engineer.

D. Hanger rods shall not short circuit the hanger box.

E. Horizontal suspended water piping 1 1/4" to 2" shall be suspended by Type E isolators with a minimum 3/8" deflection. Water pipe larger than 2" shall be supported by Type F isolators with a minimum 0.75" deflection or same deflection as equipment for the first (3) locations nearest equipment, whichever is greater.

1. Type L isolators may be substituted for the above.
2. Horizontal floor and roof supported pipe shall be the same as above except use isolators Type D and Type A, respectively.

F. Vertical riser pipe supports, where required, under 2" diameter shall utilize Type H isolation.

G. Vertical riser guides, where required, shall avoid direct contact of piping with the building.

H. Pipe anchors or guides, where required, shall utilize Type K isolators.

I. Riser sway supports, where required, shall utilize (2) neoprene elements (Type G or H) to accommodate tension and compression forces.

J. Install Type FC-1 (FC-4 for refrigerant piping) flexible connectors at all connections of pipe to isolated equipment such as pumps, as shown on the drawings.

K. Install FC-2, FC-3 or FC-4 type connectors only at locations which exceed temperature or service (such as gas, fuel oil, or refrigerant) limitations of FC-1.

3.05 SEISMIC RESTRAINTS INSTALLATION

A. All floor mounted equipment, whether isolated or not, shall be bolted or welded to the structure to allow for required acceleration. Bolt points, diameter of inserts, imbedment depth and weld length as shown on approved submittal drawings shall be followed in all respects.

B. All suspended equipment shall be 2-point or 4-point independently braced with Type III restraints, installed taut for non-isolated equipment, such as piping and slack with 1/2" cable deflection for isolated equipment. Note: Stiffeners for support rods may be required, certifications shall clearly delineate when such stiffening is required or not.

1. Piping Bracing: Schedule 10 thru 40 welded, screwed, flanged or grooved; 40'-0" maximum transversely, 80'-0" maximum longitudinally, and within 4'-0" each change of direction. No- hub piping shall be at 10’-0” intervals or 40’-0” if 1.0 g couplings are used.

C. Seismic restraints are not required:

1. Only when explicitly permitted by the code. These permitted exceptions shall be detailed clearly on the first page of the seismic submittal.

D. Seismic restraints are not required on the following (there are no exceptions for piping containing flammable or hazardous material or connected to life/safety equipment):

1. Piping in mechanical equipment rooms less than 1 1/4".
2. Other piping less than 2 1/2".
3. All pipe suspended by individual hangers 12" in length or less from the top of the pipe support to the bottom of the support for the hanger.

E. Where base anchoring of equipment is insufficient to resist seismic forces, restraints such as Type III shall be located above the unit's center of gravity to resist "G" forces.

Note: Vertically mounted tanks and upblast tubular centrifugal fans may require this additional restraint.

F. For overhead supported equipment, overstress of the building structure must not occur. Bracing may occur from:

1. Upper flanges of structural beams.
2. Upper truss chords in bar joists.
3. Cast-in-place inserts or drilled and shielded inserts in concrete structures.

G. Inspection

1. On completion of installation of all vibration isolation and seismic restraint devices herein specified, the local representative of the isolation materials manufacturer shall inspect the completed system and report in writing any installation errors, improperly selected isolation or restraint devices, or other faults that could affect the performance of the system. Contractor shall submit a report to the Architect, including the manufacturer's representative's final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.
2. Provide all special inspections in accordance with IBC and as specified herein.

   a. Continuous inspection: The full-time observation of work by an approved special inspector pursuant to IBC. The following pieces of equipment require these inspections:

      1) All equipment using combustible or toxic energy sources.
      2) All electric motors and motor control centers.
      3) Reciprocating and rotating type machinery.
      4) Pipe.
      5) Tanks, heat exchangers & pressure vessels.

   b. Periodic inspection: Provide intermittent observation of work by an approved special inspector of the following pieces of equipment in compliance with IBC.

      1) All smoke control systems during construction & prior to concealment for leakage testing.
      2) Isolator units for seismic isolation system.
      3) All flammable, combustible and highly toxic piping and their associated mechanical systems.

c. After all inspections a written report shall be provided.

3.06 INSTALLATION INSTRUCTIONS

A. Adjust all base and piping isolators as required to prevent stress transfer to equipment.

B. Set steel bases for 1" clearance between housekeeping pad and base. Set concrete inertia bases for 2" clearance. Adjust equipment level.

C. Position equipment, structural base and concrete base on blocks or wedges at proper operating height.

D. Provide all equipment and provide operating load conditions before transferring base isolation loads to springs and removing wedges.

E. Install inertia bases of type and thickness, with isolators of type and static deflection indicated.

F. Provide isolators as specified and install in accordance with the manufacturers recommendations. Seismic restraints shall not be installed until isolators are adjusted and equipment height is finalized.

G. Provide forms for 4" high housekeeping pads under all floor mounted equipment, including those with inertia blocks. Provide necessary reinforcing.

H. Install equipment with flexibility in wiring connection.

I. Verify all installed isolators and mounting system permit equipment motion in all directions.

J. Adjust or provide additional resilient restraints to flexibly limit lateral motion to 1/4" during start-up of equipment.

K. Before start-up, clean out all foreign matter between bases and equipment to prevent short circuit.

L. Install flexible pipe connectors on pipe connected to equipment supported by vibration isolation. Hook up piping to equipment and mains with spool pieces. After completion of pressure testing but prior to start-up, remove spool pieces and install flexible pipe connectors. Identify spool pieces as to equipment served and either entering or leaving.

M. Provide seismic displacement joints for all piping and conduits crossing building expansion joints or building seismic joints.

3.07 CERTIFICATION

A. Upon completion of installation of all vibration isolation devices and seismic restraints, the Mechanical Contractor shall hire an independent Seismic Professional Engineer to visit the site, inspect the completed project and certify in writing to the Architect that all systems are installed properly, or require correction.

END OF SECTION

SECTION 220553

PLUMBING IDENTIFICATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 220500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install nameplates, valve tags, valve charts, stencils and pipe markers on all Plumbing equipment and piping.

B. Provide nameplates with the unit number and service designation on all Plumbing equipment.

C. Indicate all valve tag numbers on Record Drawings and submit framed under glass valve tag charts including valve service and location.

D. Install color coded ceiling tacks in acoustical tile ceilings or color coded tape on ceiling grid to identify location of equipment and valves that require regular maintenance.

E. Provide underground plastic pipe markers 6 to 8 inches below finish grade, directly above buried pipes.

F. Provide manufactured pipe identification stencils with flow arrows and service indicated. All backgrounds of the stencils shall be color coded with specific service designation

G. Prepare valve charts and frame under plexiglass. All valves and the tag numbers shall be shown on the Record As-Built Drawings.

H. Provide valve computer data base to match chart.

I. Provide at each emergency station and non-potable water fixture code required signage.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1. Section 220500 – Basic Plumbing Materials and Methods
2. Section 220529 – Hangers and Supports
3. Section 220548 – Plumbing vibration Controls & Seismic Restraints
4. Section 220584 – Through Penetration Firestop Systems
5. Section 221110 – Plumbing Valves
6. Section 221120 – Plumbing Distribution
7. Section 221130 – Drainage and Vent Piping
8. Section 221140 – Plumbing Specialties
9. Section 223000 – Plumbing Equipment
10. Section 224000 – Plumbing Fixtures
11. Section 226000 – Laboratory Plumbing Systems

12. Section 227000 – Medical Plumbing Systems

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ASME A 13.1 – Scheme for Identification of Piping Systems; The American Society of Mechanical Engineers.

1.05 SUBMITTALS

A. See Section 220500 and General Conditions for additional requirements.

B. Product Data: Submit product description including materials, attachment methods, color coding and lettering sizes.

1.06 QUALITY ASSURANCE

A. All materials, lettering and individual system color coding schemes shall be uniform and of one single manufacturer.

B. No identification shall be installed until all systems are complete and insulated.

C. All surfaces shall be cleaned.

D. No nametag or identification shall break or penetrate a surface used as a vapor barrier.

1.07 REGULATORY REQUIREMENTS

A. Conform to all local/state and NFPA requirements for color-coding or painting of systems, piping or equipment related to Life Safety or Fire Protection.

1.08 DELIVERY, STORAGE AND HANDLING

A. All identification systems shall be stored in sealed containers in suitable locations to keep the containers and contents dry and clean.

1.09 ENVIRONMENTAL REQUIREMENTS

A. All surfaces shall be cleaned and dry before applying any form of identification or tagging.

B. Consult with the manufacturer prior to installation for the proper tagging and identification procedure and materials to be used on exterior outdoor equipment.

1.10 EQUIPMENT LABELING

A. Testing Agency Labeling Requirement

1. All equipment and materials required for installation under these specifications shall be new and without blemish or defect.
2. Equipment and materials shall be products which will meet with the acceptance of the Authorities having Jurisdiction over the work and as specified hereinbefore.
3. Where such acceptance is contingent upon having the FM Global label. Factory manufactured and assembled packaged equipment, such as the examples of equipment listed below, shall have the entire assembled package inspected and labeled by Factory Mutual.
4. All equipment shall meet OSHA standards.
5. All products shall be listed and labeled by UL or other national testing laboratories such as ETL and the products shall be so labeled.

    a. Label of Underwriter's Laboratories, ETL or other Nationally-recognized testing. Provide organization.
    b. This labeling shall include not just the control panel and/or motor, but all wiring and devices included in the package as a complete package. Note: providing a series of individually labeled electrical devices that are then assembled into a package does not meet this requirement, the whole assembly must be labeled as an assembly. The manufacturers have the option of having the equipment inspected and labeled at the factory or at the site after installation.

6. Labeled Equipment

    a. Some examples of packaged equipment requiring labeling are as follows:

        1) Dental Air Compressor System
        2) Dental Vacuum System
        3) Amalgam Separator System
        4) Medical Air Compressor System
        5) Water Heaters
        6) Laboratory and/or medical air compressor
        7) Medical Vacuum Pump sets

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable manufactures contingent on compliance with the specification.

1. Seton
2. W. H. Brady Company
3. Marning Services Incorporated

2.02 PIPE IDENTIFICATION AND VALVE TAGS

A. All piping, except that piping which is within inaccessible chases, shall be identified with semi-rigid plastic identification markers equal to Seton Setmark pipe markers.

1. Direction of flow arrows is to be included on each marker.
2. Each marker background shall be appropriately color coded with a clearly printed legend to identify the contents of the pipe in conformance with the “Scheme for the Identification of Piping Systems” (ASME A13.1-1981).
3. Setmark snap-around markers shall be used for overall diameters up to 6” and strap-around markers shall be used above 6” overall diameters.
4. Markers shall be located:

   a. Adjacent to each valve
   b. At each branch
   c. At each cap for future
   d. At each riser takeoff,
   e. At each pipe passage through wall (each side)
   f. At each pipe passage at 20’ – 0” intervals maximum.

5. Underground pipe markers:

   a. Provide detectable tape on all underground piping:
   b. Labels shall be color coded and labeled the same as indoors.

B. Valve tags

1. All valves shall be designated by distinguishing numbers and letters carefully coordinated with a valve chart.
2. Valve tags shall be color coded 0.032” anodized aluminum tags, with engraved letters similar to Seton S Type 250-BL or approved equal.

   a. Plumbing tags shall be square 2” x 2” similar to Seton 42769.
   b. Lettering shall be ¼” high for type service and ½” for valve number. Tag shall indicate service and valve number.
   c. Each service shall be a different color.

3. Tag shall be attached to valves with chain similar to Seton No 16 stainless steel jack chain.
4. Whenever a valve is above a hung ceiling, the valve tag shall be located immediately above the hung ceiling.

C. Furnish a minimum of two (2) typed valve lists

1. Each framed under glass or Plexiglas. Each chart shall be enclosed in an approved 0.015” thick plastic closure for permanent protection.
2. Valve numbers shall correspond to those indicated on the Record Drawings and on the printed valve lists.
3. The printed list shall include the valve number, location and purpose of each valve.
4. It shall state other necessary information such as the required opening or closing of another valve when one valve is to be opened or closed.
5. Printed framed valve lists shall be displayed in each Mechanical Room or in a location designated by the Owner.

D. Valve data base.

1. Provide a valve data base for all valves to operate on the building computer.
2. Every valve shall include:

a. Tag Number
b. Service (cold water, etc.)
c. Size
d. Operation
e. Location
f. Manufacture
g. Model number
h. Submittal reference

2.03 EQUIPMENT NAMEPLATES

A. Equipment nameplates shall be 3” x 6” long, 0.02” aluminum with a black enamel background with engraved natural aluminum letters similar to Seton Style 2065-20. Nameplate shall have pressure sensitive taped backing.

B. The nameplate shall contain the unit or equipment designation (“AHU” for air handling unit, “HP” for heat pump, “P” for circulating pump, etc.), unit number and area or system served.

C. Nameplates for exterior equipment shall be applied with waterproof adhesive.

2.04 CEILING TACKS OR TAPE

A. Provide steel color coded ¾ inch diameter ceiling tacks in acoustical tile ceilings or color coded tape applied to ceiling grid to locate equipment, valves or dampers that require regular maintenance or are part of a Life Safety System.

B. The tacks or tapes shall be color codes as follows (coordinate with Owner):

1. Yellow – HVAC
2. Red – Life Safety (fire dampers, sprinkler valves, etc.)
3. Green - Plumbing Valves.
4. Blue – Heating/Cooling Valves

2.05 EMERGENCY STATION AND NON-POTABLE WATER SIGNAGE

A. Provide in accordance with code, signage of contrasting color (either red and white or green and white) stating “Safety Shower” or “Emergency Eye Wash Station” or “Non-Potable Water – DO NOT DRINK” for the respective fixtures. Mount signage as directed by the Architect.

PART 3 EXECUTION

3.01 PREPARATION

A. All surfaces shall be cleaned and insulated (if applicable) prior to installing any identification.

B. Exterior surfaces of outdoor equipment shall be dry and prepared to accept the specified identification.

3.02 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion. Seal with clear lacquer.

B. Install valve tags with chain.

C. Install plastic pipe markers in accordance with manufacturer's Instructions.

D. Install plastic tape markers complete around pipe in accordance with manufacturer's instructions.

E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

F. Identify pumps, domestic hot water heaters, water treatment devices, etc. with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

G. Identify control panels and major control components outside panels with plastic nameplates.

H. Install detector tape on all underground services in accordance with the manufactures recommendations.

I. Identify valves in main and branch piping with valve tags.

J. Identify piping, concealed or exposed, with pipe markers or where buried using plastic tape pipe markers. Use tags on piping ¾ inch diameter and smaller. Identify service, flow direction and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION

SECTION 220584

THROUGH-PENETRATION FIRESTOP SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 220500 and Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Through-penetration firestop systems for penetrations through the following fire-resistance-rated assemblies, including both empty openings and openings containing penetrating items:

1. Floors
2. Roofs
3. Walls and partitions
4. Smoke barriers
5. Construction enclosing compartmentalized areas.
6. Other rated assemblies.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1. Section 220500 – Basic Plumbing Materials and Methods
2. Section 220529 – Hangers and Supports
3. Section 220548 – Plumbing vibration Controls & Seismic Restraints
4. Section 220553 – Plumbing Identification
5. Section 221110 – Plumbing Valves
6. Section 221120 – Plumbing Distribution
7. Section 221130 – Drainage and Vent Piping
8. Section 221140 – Plumbing Specialties
9. Section 223000 – Plumbing Equipment
10. Section 224000 – Plumbing Fixtures
11. Section 226000 – Laboratory Plumbing Systems
12. Section 227000 – Medical Plumbing Systems

1.04 REFERENCES

A. American Society for Testing and Materials Standards (ASTM):

1. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials
2. ASTM E814: Standard Test Methods for Fire Tests of Through-Penetration Firestops
3. ASTM E119: Standard Test Methods for Fire Tests of Building Construction Materials
4. ASTM E1399: Standard Test Methods for Cyclic Movement and Measuring of Joint Systems

5. ASTM E1725: Standard Test Methods for Fire Tests of Fire-Resistive Barrier Systems of Electrical Systems Components
6. ASTM E1966: Standard Test Methods for Fire Tests of Joints

B. Underwriters Laboratories, Inc. (UL):

1. UL 723 Surface Burning Characteristics of Building Materials
2. UL 1479 Fire Tests of Through-Penetration Firestops, including optional air leak test
3. UL 2079 Fire Test of Building Joint Firestop systems
4. UL Fire Resistance Directory (Component Listing Test Criterion)

C. National Fire Protection Agency (NFPA)

1. NFPA 80 Standard Fire Door and Window Assembly Tolerances
2. NFPA 252 Standard Fire Test for Fire Rated Doors (not specified for positive or negative furnace test pressure)
3. NFPA 257 Standard Fire Test for Fire Rated Windows (not specified for positive or negative furnace test pressure)
4. NFPA 101 Life Safety Code
5. NEC 70 National Electrical Code

1.05 PERFORMANCE REQUIREMENTS

A. General: For the following constructions, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly penetrated.

1. Fire-resistance-rated load-bearing walls, including partitions, with fire-protection-rated openings.
2. Fire-resistance-rated non-load-bearing walls, including partitions, with fire-protection-rated openings.
3. Fire-resistance-rated floor assemblies.
4. Fire-resistance-rated roof assemblies.

B. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.

C. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, as determined per ASTM E 814, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas.

1. Penetrations located outside wall cavities.
2. Penetrations located outside fire-resistive shaft enclosures.
3. Penetrations located in construction containing fire-protection rated openings.
4. Penetrating items larger than 4-inch diameter normal pipe or 16 sq. in. in overall cross-sectional area.

D. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide product that after curing do not deteriorate when exposed to these conditions both during and after construction.

1. For piping penetrations for plumbing and wet pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
2. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved either by installing floor plates or by other means.
3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

E. For through-penetration firestop systems exposed to view, provide products with flame-spread ratings of less than 25 and smoke-development ratings of less than 450, as determined per ASTM E 84.

1.06 SUBMITTALS

A. See Section 220500 and General Conditions for additional requirements.

B. Product Data: For each type through-penetration firestop system product indicated.

C. Shop Drawings: For each through-penetration firestop system show each kind of construction condition penetrated, relationships to adjoining construction, and kind of penetrating items. Include firestop design designation of testing and inspecting agency acceptable to authorities having, jurisdiction that evidences compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
2. Where Project conditions require modification of qualified testing and inspecting agency's illustration to suit a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer.

D. Submit complete plans indicating clearly where all seals are located and the type of seal to be used at that location

E. Qualification Data: For firms and persons specified to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

F. Product Certificates: Signed by manufacturers of through-penetration firestop system products certifying that products furnished comply with requirements.

G. Product Test Reports: From a qualified testing agency indicating through-penetration firestop system complies with requirements, based on comprehensive testing of current products.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed through-penetration firestop systems similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.

C. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in “Performance Requirements” Article:

1. Through-Penetration Firestop Systems tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, ITS, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
2. Through-penetration firestop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements:

a. Through-penetration firestop system products hear classification marking of qualified testing and inspecting agency.
b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:

1) UL in “Fire Resistance Directory.”
2) ITS in “Directory of Listed Products.”

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers’ labels identifying product and manufacturer, date of manufacture; lot number; shelf life, if applicable, qualified testing and inspecting agency’s classification marking applicable to Project; curing time; and mixing instructions for multicomponent materials.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.09 PROJECT CONDITIONS

A. Environmental Limitations: Do not install through-penetration fires top systems when ambient or substrate temperatures are outside limits permitted by through penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturer’s written instructions by natural means or, where this is inadequate, forced-air circulation.

1.10 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

C. Notify Owner's inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.

D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until Owner's inspecting agency and building inspector, if required by authorities having jurisdiction, have examined each installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable manufacturers subject to compliance with the specifications shall be one of following:

1. A/D Fire Protection Systems, Inc.
2. Hilti Construction Chemicals, Inc.
3. Nelson Firestop Products
4. RectorSeal Corporation (The)
5. Specified Technologies Inc.
6. 3M Fire Protection Products
7. Tremco
8. United Stated Gypsum Company

2.02 FIRESTOPPING GENERAL

A. Compatibility: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and fired experience.

B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:

1. Permanent forming/damming/backing materials, including the following:

   a. Slag-/rock-wool-fire insulation.
   b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
   c. Fire-rated form board

2. Temporary forming materials
3. Substrate primers
4. Collars
5. Steel sleeves

2.03 MIXING

A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.

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

3.02 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop systems manufacturer and the following requirements:

1. Remove from surfaces of openings substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contactor by cleaning methods used to remove smears from firestop systems materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.03 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Install fill materials for firestop systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 FIELD-QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified independent inspecting agency to inspect through-penetration firestop systems and to prepare test reports.

1. Inspecting agency will state in each report whether inspected through-penetration firestop systems comply with or deviate from requirements.

B. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued.

C. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

3.05 IDENTIFICATION

A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels.

1. The words: “Warning-Through-Penetration Firestop System-Do Not Disturb. Notify Building Management of Any Damage.”
2. Contractor’s name, address, and phone number.
3. Through-penetration firestop systems designation of applicable testing and inspecting agency.
4. Date of installation.
5. Through-penetration firestop systems manufacturer’s name.
6. Installer’s name.

3.06 CLEANING AND PROTECTION

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

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

END OF SECTION

SECTION 221110

PLUMBING VALVES

PART 1 GENERAL

1.01 WORK INCLUDED

A. The work shall include labor, materials, tools, equipment, transportation, insurance, temporary protection, supervision and incidental items essential for proper installation and operation, even though not specifically mentioned or indicated on the drawings but which are usually provided or are essential for proper installation of systems related to this Section, as indicated on the drawings and specified herein.

B. The specification and drawings described the minimum requirements that must be met for the installation of work as shown on the drawings and as specified hereinunder.

C. Shop Drawings

1.02 RELATED SECTIONS

A. Examine drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1. Section 220500 – Basic Plumbing Materials and Methods
2. Section 220529 – Hangers and Supports
3. Section 220548 – Plumbing Vibration Controls and Seismic Restraints
4. Section 220553 – Plumbing Identification
5. Section 220584 – Through-Penetration Firestop Systems
6. Section 221120 – Plumbing Distribution Piping
7. Section 221130 – Drainage and Vent Piping
8. Section 221140 – Plumbing Specialties
9. Section 223000 – Plumbing Equipment
10. Section 224000 – Plumbing Fixtures
11. Section 226000 – Laboratory Plumbing Systems
12. Section 227000 – Medical Plumbing Systems

1.03 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ANSI American National Standards Institute
2. ASME American Society of Mechanical Engineers
3. ASTM American Society of Testing Materials
4. AWS American Welding Society
5. CS Commercial Standards, U.S. Dept. of Commerce
6. FM Factory Mutual
7. FS Federal Specification, U.S. Government

8. MSS Manufacturers Standardization Society of the Valve and Fittings Industry
9. UL Underwriters Laboratories, Inc.
10. OSHA Occupational Safety and Health Act
11. NFPA National Fire Protection Assn.

1.04 ALTERNATES

A. Refer to Section 01230 - ALTERNATES.

1.05 SYSTEM DESCRIPTION

A. Provide shut-off, gate, ball, butterfly, check, strainers, balancing and other types of valves as shown on the drawings and required for proper maintenance, isolation and safety of piping systems.

B. Provide isolation valves at system drains and piping mains and branches for fixtures and piping systems, etc., at all fixtures and equipment and before and after backflow preventers, meters, pumps, and pressure reducing valves.

1.06 SUBMITTALS

A. Refer to Section 220500.

B. Valves and strainers of the same type shall be of the same manufacturer. Before purchasing any valve, the Contractor shall submit for approval the name of the manufacturer, the figure number which he proposes to furnish, and engineering data on each figure number. For manufacturers, see schedules herein.

1.07 QUALITY ASSURANCE

A. Refer to Section 014000 – QUALITY REQUIREMENTS

B. Qualifications

1. Manufacturer: Company specializing in manufacturing valve and strainer products specified in this section, with documented 10 years' experience. All valves shall be of United States manufacture.

C. Quality Standards

1. Valves and strainers shall be marked at the factory and shall contain manufacturer name, catalog or figure number, size and pressure class marked on the valve body, arrows to indicate direction of flow on check, globe and angle valves and UL label.

1.08 REGULATORY REQUIREMENTS

A. Refer to Section 220500.

B. Conform to State and Local Plumbing Code for installation of water heater safety valves and backflow prevention devices.

C. Provide certificate of compliance from the authorized representative indicating approval of installation of water heaters, piping, vents and backflow prevention devices.

PART 2 PRODUCTS

2.01 VALVES, FLANGES AND UNIONS

A. General

1. All systems under this Section shall be provided with valves to permit complete and/or sectional control of the system. They shall be located to permit easy operation, replacement and repair. They shall be installed where shown on the drawings, or as herein specified. They shall be the product of the specified manufacturer. All valves on the domestic water system shall be lead-free and meet NSF/ANSI 61.
2. All equipment shall be installed with isolation valves for service shut off. Equipment shut off valves shall be screwed ends or flanged. If screwed ends are provided, a union between equipment and valve shall be provided.

B. Water Valves

1. Isolation/shut-off valves 3" and smaller shall be all bronze ball valves Watts Series LFB-6081, Apollo 77CLF-200, Nibco S-585-66-LF, Hammond UP8311A or Milwaukee UBA450, full port Teflon seated ball and 2-piece valve body designed for 600 psi water.
2. Isolation/shut-off valves 4" and larger shall be Nibco F-619-RW bronze fitted gate valves, flanged ends, iron body, 200 psi WOG, OS&Y valves or butterfly type, flanged ends, iron body, aluminum bronze discs, stainless steel stems and replaceable EPDM seats, 200 psi WOG, Nibco LD 2000 or Hammond 6211.
3. Drain valves shall consist of hose end drain or ball valve with cap and chain. Provide at all low points in water piping system and at the base of all risers so that entire system may be drained, Apollo 70LF-200-HC, Nibco 585-70-HC-LF or Hammond 8501.
4. Check valves 2” and smaller shall be Nibco S-413-Y-LF, solder end, bronze body swing check, bronze disk, 200 psi WOG.
5. Check valves 2-1/2” and larger shall be Watts Series 411, Nibco F-918B or Hammond IR1124, flanged end, iron body with epoxy coated trim, swing check, 200 psi WOG.
6. Balancing valves for hot water circulation shall be Circuit Setter type, Armstrong, B&G, Nibco or approved equal with memory stop and calibrated nameplate.

C. Emergency Showers/Eyewash Stations

1. Valves 3” and smaller shall be all bronze ball valves Watts Series LFB-6081, Apollo 77CLF-200, Nibco S-585-66-LF, Hammond UP8311A or Milwaukee UPBA 450, full port teflon seated ball and 2-piece valve body designed for 600 psi WOG.
2. All isolation/shut-off valves on supplies to emergency stations (deluge showers, eye/face washers and drench hoses) shall be either locked open or have the handles removed and be labeled as “Emergency Shower Valve”.
3. Provide six (6) master keys for valves locked open.
4. Each valve shall be labeled “For Emergency Shower Valve”.

D. Natural Gas Valves

1. Valves 3” and smaller shall be Apollo Series 70-100-07, Nibco F.P. 600 or Hammond 8501-03, threaded bronze ball valve, 600 psi WOG.
2. Valves 4” and larger shall be Rockwell Figure 143, semi-steel, lubricated plug valve, flanged ends, wrench operated, 200 psi WOG.
3. All natural gas valves shall be approved by the state and local codes.

E. Dental Vacuum Valves

1. PVC Body, double-seal ball valve with replaceable neoprene or TFE seat seals. Provide valves suitable for at least 100 PSIG, cold water, non-shock working pressure. Operating parts of the valve shall be removable without removing from line.

F. Mixing Valves

1. Provide at the Building C Domestic Hot Water System a master thermostatic mixing valve. The units shall be thermostatic controllers with check stops, strainers, outlet thermometer, volume control and chrome finish as detailed on the drawings. Powers high/low mixing valve, (for flow rates of 40 GPM at 10 PSID). Leonard or Lawler approved equals.
2. Emergency station (shower and eye/facewash) mixing valve shall be Powers or approved equal. The valve shall be capable of high and low flows, positive hot water shut-off, integral cold water by-pass, integral check stops, strainer, volume control, thermometer and control mechanism to fail open to full capacity flow of cold water in the event of either the hot water supply is shut down or thermostatic control failure.
3. Lavatories shall be provided with point of use mixing valves, Powers #480 or approved equal where required by code. Device shall comply with ASSE 1070 and shall have lock feature.

G. Temperature and Pressure Relief Valves

1. Units in compliance with ANSI Z21.22, requirements and AGA certified, ASME rated, automatic reseating to suit installation, 150 psi pressure setting, 210°F setting.

H. Vacuum Relief Valve

1. Units in compliance with ANSI Z21.22, requirements, automatic cold water closed system, vent sized in accordance with 1/2 cross-sectional area of inlet piping to tank, Conbraco #37-201-01 1/2” NPT, Watts #36 or approved equal.

I. Thermal Check Valve

1. Refer to "Check Valves" herein. Provide a 1/8" diameter hole drilled in the clapper on cold water inlet piping to tank.

J. Flanges

1. Flanges shall be companion type, faced and drilled for not less than 125# steam working pressure complete with necessary adapter, and shall be of size and material of adjacent piping.

K. Unions

1. Provide union connections to fixtures and equipment. Union connections include compression fittings, grooved couplings, and flared fittings.

    a. Unions on copper piping shall be bronze minimum working pressure of 200 psi.
    b. Unions on steel and iron shall be ferrous ground joint brass to iron, rated for the working pressure of the system.

L. Dielectric Fittings

1. Provide separation between copper and ferrous piping systems such as nipples, unions or flanges. Components shall be equal to Watts or Clearflow.

M. Solder

1. Domestic water, waste and vent: 95-5 lead free, ASTM B32.

PART 3 EXECUTION

3.00 CONNECTIONS TO EQUIPMENT

A. Refer to Section 220500 – Basic Plumbing Materials and Methods.

3.01 IDENTIFICATION OF SYSTEMS

A. Refer to Section 220503 – Plumbing Identification.

3.02 VALVE TAGS, NAMEPLATES AND CHARTS

A. Refer to Section 220500 – Basic Plumbing Materials and Methods.

3.03 FINAL ADJUSTMENTS AND BALANCING

A. Upon completion of installation and equipment start-up, adjust systems to within operation parameters, temperatures, pressures and flows. Include adjustments to pressure relief valves, pressure regulating valves, temperature control valves for water systems, and verify normally closed/open valve positions.

B. Balance water systems over a period of several days to ensure proper pressure, flows and circulating. Adjust temperature limit stops on shower valves to a maximum of 112°F. Verify proper settings for hot water circulation loops and aquastat controls. Master mixing valves shall be set at 120°F according to their specific usage.

C. Adjust all metering and infrared control faucets for Public Lavatories to operate for a minimum of 10 seconds at a flow rate of 0.5 GPM.

END OF SECTION

SECTION 221120

PLUMBING DISTRIBUTION PIPING

PART 1 GENERAL

1.01 WORK INCLUDED

A. The work shall include labor, materials, tools, equipment, transportation, insurance, temporary protection, supervision and incidental items essential for proper installation and operation, even though not specifically mentioned or indicated on the drawings but which are usually provided or are essential for proper installation of systems related to this Section, as indicated on the drawings and specified herein.

B. The specifications and drawings describe the minimum requirements that must be met for the installation of work as shown on the drawings and as specified hereinunder.

C. Shop drawings.

D. Field acceptance testing.

E. Specific work:

1. Provide potable and industrial (non-potable) water piping, etc., as shown on the drawings and as specified, complete.
2. Provide new connections to existing systems.
3. Relocate existing risers.
4. Removal of existing systems.

1.02 RELATED SECTIONS

A. Examine drawings and criteria sheets and other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1. Section 220500 – Basic Plumbing Materials and Methods
2. Section 220529 – Hangers and Supports
3. Section 220548 – Plumbing Vibration Controls and Seismic Restraints
4. Section 220553 – Plumbing Identification
5. Section 220584 – Through Penetration Firestop Systems
6. Section 221110 – Plumbing Valves
7. Section 221130 – Drainage and Vent Piping
8. Section 221140 – Plumbing Specialties
9. Section 223000 – Plumbing Equipment
10. Section 224000 – Plumbing Fixtures
11. Section 226000 – Laboratory Plumbing Systems
12. Section 227000 – Medical Plumbing Systems

1.03 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

1. Material standards shall be as specified or detailed hereinafter and as follows:

a.	ANSI	American National Standards Institute
b.	ASME	American Society of Mechanical Engineers
c.	ASTM	American Society of Testing Materials ASTM B88-78: Wrought Copper Fittings
d.	AWS	American Welding Society
e.	CS	Commercial Standards, U.S. Dept. of Commerce
f.	FM	Factory Mutual
g.	FS	Federal Specification, U.S. Government
h.	MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
i.	UL	Underwriters Laboratories, Inc.
j.	OSHA	Occupational Safety and Health Act
k.	ASPE	American Society of Plumbing Engineers

1.04 SUBMITTALS

A. Refer to Section 220500 and General Conditions for additional requirements.

B. Submittals – The following documents shall be provided:

1. Pipe and fittings for each system.

1.05 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing pipe and fitting products specified in this section, with document experience.

B. Installer: Company specializing in performing work of the type specified in this section, with document experience.

C. All grooved joint pipe couplings, fittings and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

1.06 PLUMBING, DEMOLITION, RELOCATION AND ALTERATION

A. Refer to Section 220500.

1.07 CROSS AND INTER-CONNECTIONS

A. Refer to Section 220500.

1.08 DELIVERY, STORAGE AND HANDLING

A. Accept pipe and fittings on site in shipping containers with labeling in place. Inspect for damage.

PART 2 PRODUCTS

2.01 PIPING, FITTINGS AND JOINTS

A. Copper Tubing and Fittings

1. All Aboveground Potable Water, Tempered Water and Non-Potable Water Systems

a. Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead free solder.

2. Type K Below Ground Water Systems (3" and Smaller)

a. Tubing to be Type K, soft temper brazed joints with bituminous coating. Conforming to ASTM B88 and fittings conforming to ASME B16.22.

B. Schedule 40 Black Steel Pipe and Fittings

1. Above Ground Natural Gas

a. Black steel pipe Schedule 40 and conforming to ASTM A120-74 (seamless type). Fittings shall be black malleable screwed type conforming to ANSI B16.3-71 for pipe 2 1/2" and smaller.
b. Pipe 3" and larger and for systems where pressure exceeds 14 w.c. shall be welded.
c. Gas piping dropping inside concrete block partitions shall be factory wrapped for corrosion protection.

C. Dental Vacuum Piping and Fitting

1. Polyvinyl Chloride (PVC)

a. Shall be ASTM D1785, Type 1 (normal impact), Grade 1 (chemical resistance), and Schedule 40 pipe. Provide socket ASTM D2566 fittings and ASTM D2564 IPS WELD-ON 724 Heavy Bodied Solvent Cement for chemical use with IPS WELD-ON® P-70 primer. Provide DWV (drain-waste-vent). Use long radius fittings for turns and wye fittings for branching, as defined in Section 22 1130, DRAINAGE AND VENT PIPING.

2. Cleanouts

a. Same size and material as pipe. Provide accessible and easily removable cleanouts. As defined in Section 22 1130, DRAINAGE AND VENT PIPING.

3. Apply piping identification ANSI A13.1.

4. Piping shall be pitched, 1/4” per 10’-0”, back to main dental vacuum riser and wet separator tank. All branch tank offs shall be from the top of the pipe. Trapped or sagging sections shall not be allowed.

2.02 SLEEVES AND PLATES, ESCUTCHEONS, FIRESTOPPING AND SMOKESTOPPING

A. Refer to Section 220500.

2.03 ANCHORS, EXPANSION JOINTS AND OFFSETS

A. Make proper provisions for expansion and contraction in all parts of the hot water and hot water recirculation piping systems wherever possible by means of pipe bends, pipe offsets, swing connections or changes in direction of piping. Where piping deflection cannot be employed to absorb expansion and contraction, furnish expansion joints. Expansion joints in copper piping shall be two-ply stainless steel bellows protected from torsion and misalignment by an outer steel or brass casing. Stroke shall provide for a minimum total expansion of 1 3/4 inch per hundred feet in copper piping between anchors. Ratings shall be 150 psig w.p. and 300°F temperature, designed for use with copper pipe. Expansion joints shall be as manufactured by U.S. Flexible Metallic Tubing Company, Robertshaw-Fulton or approved equal.

B. Provide pipe guides where necessary or required to confine lateral movement and on each side of expansion loops or expansion joints. Guides for piping 2 inches and under shall be Teflon lined copper, as manufactured by Keflex-Mave Type "BC" or approved equal. Guides for piping 2 1/2 inch and up shall be fabricated steel, covered inside and outside with protective coating, top half removable.

C. All mains and risers having expansion offsets or joints shall be securely anchored to the building construction in such a manner as to throw all expansion towards the offsets of joints. All anchors shall be constructed from heavy galvanized iron, secured to the pipe and securely fastened to the construction. Anchors shall be furnished with turnbuckles or other suitable means for adjustment. The Plumbing Contractor shall be responsible for any additional structural items that may be required for proper installation of hangers. Anchors, guides and supports shall be approved by the Architect.

D. Expansion and contraction of grooved copper tubing systems shall be provided with loops or bends installed in accordance with manufacturer’s recommendations.

2.04 AIR VENTING AND DRAINAGE

A. Grade all piping, except waste piping, for drainage through equipment or through accessible hose bibb drain valves in low points so that systems can be completely free of water by gravity flow.

B. All high points in closed water piping systems shall be relieved of air through equipment vents or through accessible manual vents on the high points of the pipe lines. Vent valves on large piping and equipment shall be 1/2 inch gate valves with discharge pipes to convenient points for catching discharge; if impractical, provide caps and chains. Plumbing Subcontractor shall submit plans indicating vents at all high points in system for review.

C. Vent valves on small piping and equipment shall be 1/4 inch gate valves with discharge pipe to convenient points for catching discharge; if impractical, provide caps and chains.

D. All draining, venting and filling of existing systems where new connections will be made under this Contract, as required, shall be provided under this Contract.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Inspect site conditions in areas where piping and equipment will be installed and verify the impact of the installation before fabricating systems to be installed.

B. Notify the Architect immediately regarding any substantially different conditions than those shown in the Contract Documents.

3.02 INTERIOR COPPER WATER PIPING INSTALLATION

A. Test all water piping in accordance with this Specification.

B. Pipe used in piping assembly must be clean of dirt and obstructions and shall have ends square and reamed before butting into the fittings.

C. Cut the tube to the required length with tube cutter designed for copper work.

D. Remove burrs from the inside and outside of the cut edge and clean the end of the tube with steel wool or sand cloth until all discoloration is removed and metal is smooth and bright.

E. Oxides will be removed by sand cloth, brush, etc.

F. Removal of oxides or discoloration of pipe and fittings by acids or self-cleaning flux is forbidden.

G. Apply a thin, uniform and complete coating of reliable brand of soldering flux meeting the ASME AWS/A5.8, lead free to the cleaned surfaces of the tube and fittings.

H. When joints are soldered, remove excess solder with a cloth or brush leaving a fillet of solder in the chamber at the end of the fitting.

I. All piping must be true and plumb and with proper pitch for draining after soldering.

J. All lines of water piping shall be protected from water hammer by shock absorbers. Where shock absorbers are used, they shall be as manufactured by Josam Mfg. Co., JR Smith, or Zurn Mfg. Co., shall conform to the Plumbing and Drainage Institute published requirements and shall be made accessible through access panels.

K. Furnish and install all valves required to isolate sections of the piping system extending into areas scheduled for construction at a later date. Provide any and all draw-off valves which may be required to properly chlorinate the system in sections as required by the phasing of the Building. Identify isolation and phasing valves as such with valve tags and include same on charts and as-built drawings.

L. All connections to tanks and equipment shall be made with unions.

M. Grooved joint piping systems shall be installed in accordance with the manufacturer’s guidelines and recommendations. All grooved couplings, fittings and specialties shall be supplied by same manufacturer.

3.03 DISINFECTION OF DOMESTIC WATER SYSTEMS

A. General

1. All water piping systems shall be thoroughly disinfected with a solution containing not less than 50 ppm of available chlorine by this Plumbing Contractor. The chlorinating material shall be either liquid chlorine or sodium hypochlorite solution.
2. This work is to be supervised by the Owner's representative and performed by an Owner approved chemical testing laboratory and results sent to the Architect/Engineer or his representative for verification. All costs shall be borne by this Plumbing Contractor. Results of test shall also be forwarded to OSBI for compliance review.
3. The testing laboratory shall submit a summary of the test procedure to the Owner for approval prior to any work being performed. All work to be in accordance with the Owner's requirements. This Plumbing Contractor shall provide any and all valves, pipe and connections required to disinfect the water supply system totally or in part as required. Provide isolating valves and draw-off valves for proper containment, phasing and flushing.

B. Procedure

1. The water systems shall be tested and thoroughly flushed prior to chlorination.
2. The chlorine shall be introduced at a point of the system so as not to create a hazard to the existing systems. The disinfection solution shall be allowed to remain in the system for a period of 24 hours, during which period all valves and faucets shall be opened and closed several times with the chlorine drawn to all points in the system. After disinfection, the solution shall be flushed from the system with potable water until the residual chlorine content is not greater than 0.2 ppm for the domestic potable system. Prior to any further testing procedures, the Engineer and the Owner shall review all draw-off valve locations and chlorine introduction locations.
3. The Contractor is to allow ample time for the chlorination of the water systems and is to plan the chlorination just prior to occupancy if possible. If the system is to sit dormant for any extended period of time prior to occupancy, the Contractor is to flow water to all points in the building to completely flush the systems prior to occupancy. A full (3) days' notice will be given the Owner and Engineer prior to the start of disinfection.

C. Tests

1. The Owner's representative shall select a location on the floor for a chlorine concentration test and a chlorine residual, a coliform bacteria and total plate count bacteria tests. The laboratory report shall include sample locations, chlorine concentration, chlorine residual, coliform bacteria count and, after flushing, total plate count bacteria tests.
2. Acceptable limits for total plate count shall be 300 per 100 ml sample. Acceptable levels of chlorine residual shall be 0.2 ppm, for the domestic potable water system.
3. If these parameters are not met, continued flushing of the water systems shall be required until they are met.
4. Full Owner acceptance of the water systems shall not be given until these parameters are met, documented and submitted by the Testing Laboratory selected.
5. Incoming exterior water mains shall be disinfected similarly except chlorine introduction shall be from the point of new water service connection to the existing main. System shall be disinfected when water pressure testing is completed and accepted.

3.04 CONNECTIONS TO EXISTING SYSTEMS

A. Water Systems

1. All piping systems to be connected to the existing systems shall only be connected once the new piping is installed, tested and chlorinated. The connection to the existing piping system shall be made in cooperation with the Owner.

3.05 CONNECTIONS TO EQUIPMENT

A. Refer to Section 220500.

3.06 TESTING OF PIPING SYSTEMS

A. General

1. All piping systems shall be subjected to testing with water, gas or air as noted and shall hold tight at the pressure head stated for the time interval required without adding air or water. While any system is being tested, required head or pressure shall be maintained until all joints are inspected. All systems tested in the existing building shall be tested with air before water.
2. All tests shall be witnessed by the inspector having jurisdiction and the Architect/Engineer, with 48 hour notice given these authorities.
3. All equipment, material and labor required for testing any of the various systems or any part thereof shall be furnished by this Contractor.

B. Water Piping Systems: Upon completion of all water supply systems or a section of them as required, they shall be tested and proved tight under a water pressure of 150 psi. Gauge should be located on the lowest point of the new system and pressure shall hold for a period of (1) hour without introducing additional water. The water used for testing shall be from a domestic water source of supply.

C. Defective Work: If inspection or tests show defects, such defective work or material shall be replaced and inspection and tests shall be repeated. All repairs to piping shall be made with new materials. No caulking of screwed joints or holes will be acceptable.

3.07 NATURAL GAS PIPING INSTALLATION

A. Gas meter(s), service piping to meter(s), and regulators will be provided by the local gas company. Gas piping provided under this Contract shall begin on the building side of the meter and extend to gas fired equipment.

1. All piping shall pitch to drains at drip legs at least 6" long. Branch connections shall be taken off the top or side of the piping main.
2. At each equipment connection, on the downstream side of any required equipment regulators, provide shutoff valve and union with drip leg.
3. At gas booster pressure reducing valve and all other vented gas regulators, provide individual vent piping to the exterior, with turned down elbow and stainless steel insect screen.
4. All gas valves shall be installed in accessible locations. Valves shall be provided at each branch runout from the supply main.
5. This Contractor shall install all gas valves supplied by equipment suppliers.

6. Piping shall be securely fastened, separately hung and shall not be strapped or supporting other systems. Piping drops in concrete block walls or buried shall be factory wrapped for protection from corrosion.
7. All gas piping to laboratories shall first be connected to a master gas shut-off valve located in a cabinet immediately inside the lab.
8. Furnish and install aluminum check valves in all gas piping that enters rooms where compressed air is installed or when both compressed air and gas piping connect to the same piece of equipment.

3.08 NATURAL GAS TESTING

A. All gas piping shall be tested in accordance with NFPA-54 2012 edition.

B. Prior to acceptance and initial operation, all piping installations shall be inspected and pressure tested to determine that the materials, design, fabrication, and installation practices comply with the requirements of this code.

C. Where repairs or additions are made following the pressure test, the affected piping shall be tested. Minor repairs and additions are not required to be pressure tested provided that the work is inspected and connections are tested with a noncorrosive leak-detecting fluid or other leak-detecting methods approved by the authority having jurisdiction.

D. The test medium shall be air, nitrogen, carbon dioxide, or an inert gas.

E. Pipe joints, including welds, shall be left exposed for examination during the test. Appliances and equipment that are not to be included in the test shall be either disconnected from the piping or isolated by blanks, blind flanges, or caps. Flanged joints at which blinds are inserted to blank off other equipment during the test shall not be required to be tested.

F. Where the piping system is connected to appliances, equipment, or equipment components designed for operating pressures of less than the test pressure, such appliances, equipment, or equipment components shall be isolated from the piping system by disconnecting them and capping the outlet(s).

G. Test pressure shall be measured with a manometer or with a pressure measuring device designed and calibrated to read, record, or indicate a pressure loss due to leakage during the pressure test period. The source of pressure shall be isolated before the pressure tests are made. Mechanical gauges used to measure test pressures shall have a range such that the highest end of the scale is not greater than 5 times the test pressure. The test pressure to be used shall be no less than 1½ times the proposed maximum working pressure, but not less than 3 psi (20 kPa), irrespective of design pressure. Test duration shall be not less than ½ hour for each 500 ft3 (14 m3) of pipe volume or fraction thereof. The duration of the test shall not be required to exceed 24 hours. The piping system shall withstand the test pressure specified without showing any evidence of leakage or other defects. Any reduction of test pressures as indicated by pressure gauges shall be deemed to indicate the presence of a leak unless such reduction can be readily attributed to some other cause.

H. The leakage shall be located by means of an approved gas detector, a noncorrosive leak detection fluid, or other approved leak detection methods. Matches, candles, open flames, or other methods that provide a source of ignition shall not be used

I. Where leakage or other defects are located, the affected portion of the piping system shall be repaired or replaced and retested.

J. Gas utilization equipment shall not be placed in operation until after the piping system has been tested and purged.

K. When piping is placed in operation, the air or inert gas in the piping shall be displaced with fuel gas. The air can be safely displaced with fuel gas provided that a moderately rapid and continuous flow of fuel gas is introduced at one end of the line and air is vented out at the other end. The fuel gas flow shall be continued without interruption until the vented gas is free of air. The point of discharge shall not be left unattended during purging. After purging, the vent shall then be closed.

L. The open end of piping systems being purged shall not discharge into confined spaces or areas where there are sources of ignition unless precautions are taken to perform this operation in a safe manner by ventilation of the space, control of purging rate, and elimination of all hazardous conditions.

3.09 IDENTIFICATION OF SYSTEMS

A. Refer to Section 220553.

END OF SECTION

SECTION 221130

DRAINAGE AND VENT PIPING

PART 1 GENERAL

1.01 WORK INCLUDED

A. The work shall include labor, materials, tools, equipment, transportation, insurance, temporary protection, supervision and incidental items essential for proper installation and operation, even though not specifically mentioned or indicated on the drawings but which are usually provided or are essential for proper installation of systems related to this Section, as indicated on the drawings and specified herein.

B. The specifications and drawings describe the minimum requirements that must be met for the installation of work as shown on the drawings and as specified hereinunder.

C. Shop drawings.

D. Field acceptance testing.

E. Specific Work

1. Provide storm, sanitary and specialty drain piping, fittings, piping network, branches and connections to piping, as shown on the drawings and as specified complete.
2. Provide new connections to existing systems.
3. Relocate existing stacks and rainwater leaders.
4. Removal of existing systems.

1.02 RELATED SECTIONS

A. Examine drawings and criteria sheets and other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1. Section 220500 – Basic Plumbing Materials and Methods
2. Section 220529 – Hangers and Supports
3. Section 220548 – Plumbing Vibration Controls and Seismic Restraints
4. Section 220553 – Plumbing Identification
5. Section 220584 – Through Penetration Firestop Systems
6. Section 221110 – Plumbing Valves
7. Section 221120 – Plumbing Distribution Piping
8. Section 221140 – Plumbing Specialties
9. Section 223000 – Plumbing Equipment
10. Section 224000 – Plumbing Fixtures
11. Section 226000 – Laboratory Plumbing Systems
12. Section 227000 – Medical Plumbing Systems

1.03 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1.	ANSI	American National Standards Institute ANSI B16.1, B16.2, B16.5, B16.4, B.16.9: Cast Iron Fittings & Flanges ANSI B16.3: Malleable Iron Fittings
2.	ARI	American Refrigeration Institute
3.	ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
4.	ASME	American Society of Mechanical Engineers
5.	ASTM	American Society of Testing Materials ASTM A-888: Cast Iron Piping
6.	AWS	American Welding Society
7.	CS	Commercial Standards, U.S. Dept. of Commerce
8.	FM	Factory Mutual
9.	FS	Federal Specification, U.S. Government
10.	MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
11.	UL	Underwriters Laboratories, Inc.
12.	OSHA	Occupational Safety and Health Act
13.	CISPI	Cast Iron Soil Pipe Institute CISPI 301 Cast Iron Pipe and Fittings
14.	ASPE	American Society of Plumbing Engineers

1.04 SUBMITTALS

A. Refer to Section 220500 and General Conditions for additional requirements.

B. Submittals: The following documents shall be provided:

1. Pipe and fittings for each system.

1.05 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing pipe and fitting products specified in this section, with documented experience.

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

1.06 CROSS AND INTER-CONNECTIONS

A. Refer to Section 220500.

1.06 DELIVERY, STORAGE AND HANDLING

A. Accept pipe and fittings on site in shipping containers with labeling in place. Inspect for damage.

PART 2 PRODUCTS

2.01 PIPING, FITTINGS AND JOINTS

A. Hubless Cast Iron Soil Pipe and Fittings

1. Aboveground Soil, Waste, Vent and Rainwater Piping

a. Hubless Cast Iron Soil Pipe: No-hub pipe with Husky SD-4000 soil pipe coupling manufactured by Anaheim Foundry, 4-band clamp or Clamp-All Hi Torq 125 2-band clamp. Sealing gasket shall be neoprene in accordance with ASTM C564, CISPI 301-75.

B. Hub and Spigot Cast Iron Soil Pipe and Fittings

1. Below Ground Soil, Waste, Vent and Rainwater Piping

a. Asphaltum coated, service weight, cast iron pipe and fittings with resilient neoprene push-on or lead and oakum joints, ASTM A72, ASTM C564-70.
b. Resilient Neoprene gaskets for 4” and smaller shall be lubricated as per manufacturer’s recommendations and for 5” and larger on adhesive type lubricant shall be used.

2. Above Ground Soil, Waste, Vent and Rainwater Piping

a. Service weight cast iron pipe and fittings with resilient neoprene push-on joints. ASTM A72, ASTM C564-70.

C. Copper Tubing and Fittings

1. Waste and Vent Systems 2" and Smaller

a. Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead free solder.
b. Shall not be used for urinal waste piping which shall remain cast iron.

D. Polypropylene Piping

1. Above Ground Laboratory Waste and Vent (Smaller than 3”)

a. Schedule 40 fire retardant, ASTM D4101, mechanical joint system as manufactured by Orion, Enfield, G.F. Fuseal or Asahi.

2. Above Ground Laboratory Waste and Vent (3” and Larger)

a. Schedule 40 flame retardant ASTM D4101, fusion joint system as manufactured by Orion, Enfield, G.F. Fuseal or Asahi.

3. Below Ground Laboratory Waste and Vent

a. Schedule 40 fire retardant, ASTM D4101, electrofusion or socket fusion system as manufactured by George Fischer, Orion or Enfield.

E. Durion Piping

1. Laboratory Waste and Vent

a. Piping shall be high silica content Durion or approved equal. Joints shall be made with stainless steel compression mechanical joints or hub and spigot with lead and acid resistant packing.

F. Borosilicate Glass Piping

1. Laboratory Waste and Vent

a. Piping and fittings shall be borosilicate glass conforming to ASTM C-1053-85. System shall be installed in accordance with manufacturer's recommendations. Kimax U.L. listed piping or approved equal. Joints shall be compression type bead to bead or bead to plain end coupling #6650 and 6651. Coupling outer shell, bolt and nut shall be 300 series stainless steel. Bead to plain end coupling outer shell must encapsulate compression liner.

2.02 AIR VENTING AND DRAINAGE

A. Sanitary vent piping shall be graded so that airflow to the outside will be continuously upward and so that all low points will be drained.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Inspect site conditions in areas where piping and equipment will be installed and verify the impact of the installation before fabricating systems to be installed.

B. Notify the Architect immediately regarding any substantially different conditions than those shown in the Contract Documents.

3.02 SOIL, WASTE, VENT AND RAINWATER PIPING INSTALLATION

A. Pipes shall be plumb and parallel to building walls, beams, and columns. All horizontal lines are to be evenly pitched and properly secured with iron or steel hangers. A pitch of 1/4" per lineal foot shall be maintained on all soil, waste, and conductor lines, wherever possible. Where long runs of piping require less pitch due to space restrictions, a less pitch shall be allowed on main lines 4" and over in size, but in no event should any pipeline have a slope less than 1/8" per lineal foot.

B. No hub cast iron pipe couplings shall be installed as follows:

1. Place gasket on the end of the pipe and the stainless steel clamp assembly on the end of the other pipe.

2. Firmly seat the pipe ends against the integrally molded shoulder inside the neoprene gasket.
3. Slide the clamp assembly into position over the gasket and tighten the bands using a properly calibrated torque wrench, set at 60 inch pounds or as required by manufacturer. Tighten the bands alternately and firmly, first the inner bands, then the outer bands.
4. Horizontal pipe and fittings 5” and larger shall be suitably braced to prevent horizontal movement. Bracing shall be provided at every branch connection or change of direction in accordance with manufacturer’s recommendations.

C. Service weight cast iron piping below ground shall be installed as follows:

1. Piping laid in trenches shall be continuously supported on undisturbed or compacted earth. Hand excavate at the bell to allow barrel to bear loading, not the bell.
2. Lay pipe to a straight line and uniform grade between point where changes in grade or alignment occur. Check line and grade frequently. Keep a stopper in the pipe end when pipe laying is not in progress. Commence at lowest point in the system and work upwards.
3. Carefully clean interior joint surfaces before joining sections. Firmly insert spigot end into bell completely.
4. Excavation and backfill are specified elsewhere. It shall be the plumbing subcontractor’s responsibility to insure that the backfill shall be carefully packed around the piping as it is being laid, and that the backfill operation is carried in 6" tamper layers to a point at least 12" above the piping.

D. All soil and waste pipes shall be carried out full size through the roof or connected to a common vent above the fixture and as shown on the drawings.

E. Threaded joints shall have American National taper screw thread with graphite and oil compound applied to the male threads.

F. Piping to be run straight and plumb and all offsets shall be made at an angle of not less than 45° and all threaded joints shall be as specified above.

G. Carefully lay out the work in advance so that the pipes will pass through the opening and permit the proper pitch to the pipelines. Due to the extensive system of ventilation and lighting systems, it will be necessary for all trades to properly coordinate their work with the work of other trades so as to avoid the necessity of taking down work installed without prior checking. Flush out and clean all existing soil and waste piping buried within the existing building prior to making any new connections.

H. Provide and connect cleanouts with brass caps and screws same size as pipe up to 6" and not less than 6" for larger piping at the ends of all branches on soil and waste piping, and in such other portions of the piping where run is over 50’-0". Underfloor cleanouts shall be installed as detailed. All cleanout installations shall comply with the Connecticut State Plumbing Code as well as local jurisdiction.

I. Where stacks enter drains near walls or piers causing difficult access to end cleanouts, there shall be a vertical cleanout on the stack just above the floor with a 1/4 bend fitting at the foot of the stack.

J. Where such conditions occur in walls or partitions, the cleanout cover shall be accessible through an opening left in the wall and covered with the flush chrome plated brass plate or access panel securely fastened in place.

K. Brass cleanouts shall be solid nut construction.

L. Provide the Owner with wrench for removing cleanout plugs.

M. Where test tees are installed at the base of the stack, or on the stack, they may be used as a cleanout.

3.03 CONNECTIONS TO EXISTING SYSTEMS

A. Sanitary, Vent and Rainwater Conductor Systems

1. Verify all points of connection to existing underslab and above floor piping prior to fabrication. In accordance with the "shutdown" section of this Specification, coordinate the tie-in of that system with the Owner. Any piping cut, but not immediately connected to shall be made gastight.

3.04 TESTING OF PIPING SYSTEMS

A. General

1. All piping systems shall be subjected to testing with water, gas or air as noted and shall hold tight at the pressure head stated for the time interval required without adding air or water. While any system is being tested, required head or pressure shall be maintained until all joints are inspected. All systems tested in the existing building shall be tested with air before water.
2. All tests shall be witnessed by the inspector having jurisdiction and the Architect/Engineer, with 48 hour notice given these authorities.
3. All equipment, material and labor required for testing any of the various systems or any part thereof shall be furnished by this Contractor.

B. Sanitary, Waste and Vent and Rainwater Systems: Water test shall be applied to drainage systems either in their entirety or in sections as required, after piping has been installed. If applied to the entire system, all openings in the piping system shall be tightly closed, except the highest opening, and the system filled with water to point of overflow. If the system is tested in sections, each opening shall be tightly closed except the highest opening in the section under test, and each section shall be filled with water but no section shall be tested with less than a 10’-0" head of water. In testing successive sections at least the upper 10’-0" of the next preceding section shall be tested so that no joint of piping in the building, except the uppermost 10’-0" of the system, shall be submitted to a test of less than a 10’-0" head of water. The water shall be kept in the system for at least (30) minutes before inspection starts.

1. Any points of the drainage systems to be tested with air instead of water shall be made by attaching an air compressor testing apparatus to any suitable opening and after closing all other inlets or outlets, forcing air into the systems until there is a uniform gauge pressure of 5 psi or sufficient to balance a 10" Hg high column. This pressure shall be held without the introduction of additional air for a period of at least (30) minutes.

C. Defective Work: If inspection or tests show defects, such defective work or material shall be replaced and inspection and tests shall be repeated. All repairs to piping shall be made with new materials. No caulking of screwed joints or holes will be acceptable.

3.05 FIXTURE ROUGHINGS

A. Install rough plumbing, including fixture carriers and supports, valves and water hammer arrestors within chase tolerances. Supply roughing through finish walls and at hose bibs and shower heads shall be secure and free of movement. Locate valves and water hammer arrestors within 12" of approved access panel location.

B. Align exposed waste and supply pipe roughings with fixture connections within 1" tolerance. Provide flush valves in alignment with the fixture, without vertical or horizontal offsets. Obtain fixture manufacturer roughing data sheets for recommended roughing dimensions.

C. Provide fixture templates for casework Contractor for counter mounted sinks and lavatories.

D. Secure fixture supports to floor slab construction with lag bolts and metal expansion shields to support at least 1,000 lbs. (water closets) and 250 lbs. (all other fixtures) for (5) minutes.

E. Provide fixture rough-in piping connection sizes in accordance with the drawing schedule.

3.06 LABORATORY WASTE AND VENT PIPING INSTALLATION

A. Install laboratory waste and vent piping system entirely separate from other sanitary systems. The waste and vent piping shall be of the same material as specified. The system shall drain by gravity to the existing waste treatment system. Install, support and protect piping as directed by the product manufacturer. The installation shall allow for expansion and contraction. Plastic piping shall not be installed at temperatures lower than 60°F.

1. Horizontal piping 3" and smaller shall be pitched at 1/4" per foot. Piping 4" and larger shall pitch at 1/8" per foot.

B. Trenches shall be wide enough to assemble the pipe joints. The trench bottom shall be stable enough to support the complete barrel of the pipe. Holes shall be provided at each joint or coupling to allow for continuous support of the barrel along the trench.

C. Piping to be run straight and plumb and all offsets shall be made at an angle of not less than 45°.

D. Carefully lay out the work in advance so that the pipes will pass through the openings and permit the proper pitch to the pipelines.

E. Provide and connect cleanouts with caps and screws same size as pipe up to 6” and not less than 6” for larger piping at the ends of all branches on laboratory waste piping and in such other portions of the piping where run is over 50’-0”.

F. Where stacks enter drains near walls or piers causing difficult access to end cleanouts, there shall be a vertical cleanout on the stack just above the floor with a 1/4 bend fitting at the foot of the stack.

3.07 IDENTIFICATION OF SYSTEMS

A. Refer to Section 220500.

END OF SECTION

SECTION 221140

PLUMBING SPECIALTIES

PART 1 GENERAL

1.01 WORK INCLUDED

A. The work shall include labor, materials, tools, equipment, transportation, insurance, temporary protection, supervision and incidental items essential for proper installation and operation, even though not specifically mentioned or indicated on the drawings but which are usually provided or are essential for proper installation of systems related to this Section, as indicated on the drawings and specified herein.

B. The specifications and drawings describe the minimum requirements that must be met for the installation of work as shown on the drawings and as specified hereinunder.

C. Shop drawings.

D. Field acceptance testing.

1.02 RELATED SECTIONS

A. Examine drawings and criteria sheets and other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1. Section 220500 – Basic Plumbing Materials and Methods
2. Section 220529 – Hangers and Supports
3. Section 220548 – Plumbing Vibration Controls and Seismic Restraints
4. Section 220553 – Plumbing Identification
5. Section 220584 – Through Penetration Firestop Systems
6. Section 221110 – Plumbing Valves
7. Section 221120 – Plumbing Distribution Piping
8. Section 221130 – Drainage and Vent Piping
9. Section 223000 – Plumbing Equipment
10. Section 224000 – Plumbing Fixtures
11. Section 226000 – Laboratory Plumbing Systems
12. Section 227000 – Medical Plumbing Systems

1.03 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. Material standards shall be as specified or detailed hereinafter and as follows:

a. ANSI American National Standards Institute
b. ASME American Society of Mechanical Engineers
c. ASTM American Society of Testing Materials
d. ASTM B88-78: Wrought Copper Fittings

e. AWS American Welding Society
f. CS Commercial Standards, U.S. Dept. of Commerce
g. FM Factory Mutual
h. FS Federal Specification, U.S. Government
i. MSS Manufacturers Standardization Society of the Valve and Fittings Industry
j. UL Underwriters Laboratories, Inc.
k. OSHA Occupational Safety and Health Act
l. ASPE American Society of Plumbing Engineers

1.04 ALTERNATES

A. Refer to Section 10230 - ALTERNATES.

1.05 SUBMITTALS

A. Refer to Section 220500.

B. Submittals: The following documents shall be provided:

1. Hangers and supports
2. Insulation
3. Access panels
4. Shock absorbers and trap primers
5. Pressure gauges
6. Thermometers
7. Hose bibbs
8. Backflow preventers and vacuum breakers
9. Floor drains and roof drains
10. Cleanouts
11. Flanges and unions
12. Sleeves and firestopping
13. Water filters
14. Heating cable
15. Vibration isolation and seismic restraints

1.06 QUALITY ASSURANCE

A. Refer to Section 014000 – QUALITY REQUIREMENTS.

PART 2 PRODUCTS

2.01 FLANGES AND UNIONS

A. Flanges

1. Flanges shall be companion type, faced and drilled for not less than 125# steam working pressure complete with necessary adapter, and shall be of size and material of adjacent piping.

B. Unions

1. Provide union connections to fixtures and equipment. Union connections include compression fittings, grooved couplings, and flared fittings.

a. Unions on copper piping shall be bronze minimum working pressure of 200 psi.
b. Unions on steel and iron shall be ferrous ground joint brass to iron, rated for the working pressure of the system.

C. Dielectric Fittings

1. Provide separation between copper and ferrous piping systems such as nipples, unions or flanges. Components shall be equal to Watts or Clearflow.

D. Solder

1. Domestic water, waste and vent: 95-5 lead free, ASTM B32.

2.02 HANGERS AND SUPPORTS

A. Refer to Section 220529.

2.03 SLEEVES AND PLATES, ESCUTCHEONS, FIRESTOPPING AND SMOKESTOPPING

A. Refer to Section 220500.

2.04 ACCESS PANELS

A. Group together valves, traps, cleanouts, etc., concealed in suspended ceilings, walls and furred spaces to reduce the number of access panels, but all valves must be freely accessible for maintenance.

B. Furnish access panels of proper size to service all concealed traps, valves and cleanouts, but in no case less than 18" by 12" for valves, traps or cleanout, and 24" by 12" for (2) valves, traps or cleanouts, or more. Panels shall be of the proper type for material in which they occur to be furnished by this Contractor and turned over to the trade in which they occur for installation by the particular trade Contractor. The exact number of panels shall be determined by the number, location and grouping of traps, valves and cleanouts which must be accessible for servicing and maintaining the plumbing systems. Panels below ceilings shall be key operated.

C. Panels shall have flush doors with #14 USCG steel door and trim #16 USCG steel frame, metal wings for fitting into construction, concealed hinges, and screwdriver operated stainless steel cam lock. Panels shall be shop coated with (1) coat of zinc chromate primer. Valves above removable ceilings shall have tiles marked with tile clips by this Contractor for identification, properly labeled. Panels in toilet rooms adjacent to urinals shall be Type 302, 18 gauge, stainless steel. All locks shall be universal with all building access panels locks.

2.05 INSULATION

A. Scope: The following piping, fittings, and valves shall be insulated:

1. All interior water piping.
2. Equipment, including heat exchangers and cold water chiller.

3. Aboveground horizontal rain water piping past the elbow, down the vertical, including drain bodies.
4. Water, rainwater waste piping in exterior furred ceiling spaces and overhangs.
5. All piping insulation disturbed or removed as a result or renovation work.
6. All horizontal waste piping receiving cold water condensate.

B. Materials: The following materials are specified:

1. Pipe Insulation: Fiberglass similar to Owens Corning, Manville, Certain-Teed.
2. Fittings and Valves Insulation

a. Moulded or fabricated fitting covers of equal thickness and identical in composition to adjacent pipe insulation, equal to Zeston pre-molded covers. At fittings and valves, the insulation vapor barrier shall be continuous and unbroken.

3. Heat Exchangers / Chillers

a. Fiberglass pipe insulation, blanket insulation on ends.

4. All materials, including vapor barrier jackets, adhesives, etc., shall be fire retardant.

C. Insulation Thickness

1. The piping, fittings, and valves shall be insulated with the following minimum thicknesses:

a. Hot water and circulation piping: 1" thick
b. Cold water piping: 1/2" thick
c. Rainwater Piping: 1/2" thick
d. Water heaters, storage tanks, heat exchangers/chiller: 2" thick

D. Finish

1. Concealed or Exposed: All service vapor barrier jacket (ASJ Fiberglass 24) on all conductor and water piping, except where flexible tubing insulation is used which requires no vapor barrier. Fittings shall be finished with pre-molded fitting covers.

E. Handicapped Lavatories

1. Truebro Handi Lav-Guard or Brocar Products Trapwrap #C-500R insulation kit, 3-piece interlocking for "P" trap assembly and 2-piece kit for water supplies shall be white flexible vinyl insulation secured with nylon fasteners supplied.

2.06 HOSE BIBBS AND WALL HYDRANTS

A. Hose Bibb for Toilet Rooms: Chicago 952, chrome plated brass, 3/4" with vacuum breaker and loose tee handle.

B. Hose Bibb in Mechanical Areas: Chicago 7T, 3/4" inlet and threaded outlet, rough brass, loose tee handle.

2.07 BACKFLOW PREVENTERS

A. Acceptable Manufacturers and requirements

1. Provide units approved by the authorities having jurisdiction, the following specified type is utilized to establish quality.
2. This Subcontractor shall make application in the name of the Owner for the installation of the backflow preventers and pay any resultant fees.

B. Reduced Pressure Backflow Preventers

1. 2" and Smaller: Watts #009S-U-QT, Conbraco #40-201-A4 or approved equal bronze body, stainless steel check seats, unions, strainer and shutoff valves.
2. 2 1/2" and Larger: Watts #909W-S-OS&Y, Conbraco #40-201-03 or approved equal bronze seats and stainless steel trim, flanged, strainer and shutoff valves.
3. Provide an air gap fitting and full size indirect waste to floor drain.

C. Provide test kit and spare parts for each type of installed unit. Provide inlet and outlet pressure gauges on units. Test kits shall be by the supplied manufacturer of units.

D. Pressure Vacuum Breaker

1. Finished areas and locations unless otherwise noted: Watts #800MCQT, Conbraco #4V-500 or approved equal compact, chrome plated with integral shutoff valves.
2. Mechanical areas and concealed locations: Watts #800M4QT, Conbraco #4V-500 or approved equal rough brass, replaceable seats with shutoff valves.

E. Vacuum Breaker

1. For Hot or Cold Water: Watts #288A, Conbraco #38-100 or approved equal bronze, atmospheric vent, clean plated in exposed, finished areas.

2.08 TRAP PRIMERS AND WATER HAMMER ARRESTORS

A. Zurn Z-1700 Series or approved equal - stainless steel "shoktrols" shall be installed on water supply lines to flush valves and to plumbing connected equipment equipped with fast acting valves to control water hammer. They shall be sized and selected in accordance with PDI Standard WH201 with access through approved access panels. Examples of such locations are as follows:

1. Flushometer valves
2. Self-closing, metering and electronic faucets
3. Prior to all pressure reducing valves
4. Prior to all in-line solenoid valves
5. Emergency showers
6. Hose spray pre-rinse
7. Top of all risers

B. Trap Primers

1. Individual fixtures shall be primed by Precision Plumbing products, Inc., model Prime Rite, or approved equal. Device shall be machined brass with no springs or diaphragms. Mount 12” above trap to be primed.
2. Multiple fixtures shall be primed by Precision Plumbing Products, Model PT-4 through 30 and rated for quantity of traps to be served. The priming manifold shall be capable of supplying 2 oz. of water per trap supply at 20 psig every 24 hours. The device shall be factory assembled and prepiped complete with ball valve, water hammer arrestor, copper barrel hammer arrestor, copper barrel with piston, solenoid valve and 1/2” trap primer connections. Electronic connections include single point 120V, manual override switch breaker, timer with relay. Unit shall be factory tested and supplied in a wall mounted 16 gauge steel cabinet.

2.09 DRAINAGE SPECIALTIES

A. Before setting any drains, cleanouts or wall plates, obtain from the General Contractor the exact information relative to the finished grades of the top of the drains, equipment locations and partition locations. All drainage specialties shall be of the size noted on the drawings and shall be equal to the figure numbers scheduled below. Drainage specialties may be Zurn, Wade, JR Smith Company, Josam, Watts or approved equal.

B. Cleanouts

1. Cleanouts shall be furnished and installed at all locations required by the Connecticut Plumbing Code and local jurisdiction, in accessible locations, at bottoms of soil and waste stacks, and other locations shown on the drawings and at each change of direction. All cleanouts shall be brought up to finished floor. Outlets shall be caulked or no hub type.
2. Cleanouts occurring in floors finished with quarry, ceramic tile, brick or granite shall be equipped with flush scoriated round bronze as selected by Architect to coordinate with color of flooring covers with round frames, equal to J.R. Smith #4046. Covers shall be adjustable in height.
3. Cleanouts occurring in resilient tile floors or carpeted areas shall be equipped with flush round metal covers with frames, equal to J.R. Smith #4146 for tile and #4026 for carpet, with covers recessed to receive tile or carpet. Covers shall have adjustable height.
4. Cleanouts occurring in floors finished with plain concrete shall be equipped with heavy duty flush scoriated round cast iron covers with round frame equal to J.R. Smith #4226. Covers shall be adjustable in height.
5. Where cleanouts occur under the floors in unexcavated areas, they shall be brought up flush with the finish floor and fitted with a cover equal to J.R. Smith #4226 series, cast iron top.
6. Cleanouts occurring in floors protected with membrane waterproofing shall be same as above, except with integral clamping collar.
7. Cleanouts occurring in walls shall be equipped with flush smooth white metal covers, with 10 inch by 10 inch openings in square frames having anchoring lugs, equal to J.R. Smith #4735.
8. All otherwise exposed or accessible cleanouts shall be equal to J.R. Smith #4420 or #4531 as required to suit the conditions at each point of application.
9. Extension pieces and bodies of cleanouts shall be of cast iron and arranged to suit each condition of application.
10. All metal specified above shall be solid "nickel-bronze" having high nickel content, appearance of satin chrome, and corrosion and wear resistance qualities greater than bronze.

11. Cleanouts shall be the full size of the pipelines to which they are directly connected, but need not be larger than 4 inches for pipe lines up to 10 inches, and shall be at least 6 inches for pipe lines 10 inches and up.
12. Cleanouts occurring in floors finished with plain concrete shall be equipped with heavy duty flush scoriated round cast iron covers with round frame equal to J.R. Smith #4340. Covers shall be adjustable in height.
13. Grade cleanouts shall be Zurn #1456 with inside caulk mounted in cast iron 12" square frame and cover LeBaron #S512.

C. Floor Drains (FD)

1. All floor drains shall be the product of one manufacturer such as Zurn Industries, J.R. Smith, Wade, Josam, Watts or approved equal.
2. Provide "deep seal" traps for all floor drains, of same material as piping systems connected thereto.
3. Drains located in waterproofed floors of composition materials or of other kinds, shall be fitted with all required flanges, clamping devices and trim required to assure watertight conditions, and they shall be made watertight. Provide all other miscellaneous devices, as required, for a complete installation as approved by Architect.

D. Roof Drains (RD)

1. All roof drains shall be the product of one manufacturer such as Zurn Industries, J.R. Smith, Wade, Josam, Watts or approved equal.
2. Provide Zurn ARB-190 vertical expansion joint at every drain location where the drain outlet piping connects directly to a vertical leader or when the horizontal offset is less than 10'.

2.10 HEATING CABLE

A. Provide a complete UL listed system of heaters and components approved specifically for pipe heat tracing, as manufactured by Thermon Manufacturing Co., Item No. 5-FLX-1.

B. The self-regulating system shall consist of (2) nickel-plated copper bus wires embedded in a radiation cross-linked semi-conductive polymer core. The system shall be capable of varying its heat output all along its length, allowing the system to be crossed over itself without over-heating. The system shall be covered by a polyolefin dielectric jacket rated 300 VAC at 105°C and a tinned copper braid, (12 AWG equivalent wire size). Buried piping to ground hydrant shall have an additional covering of a flouropolymer outer jacket for protection from organic chemicals or corrosives. For piping above grade, heating cable shall have an additional polyolefin outer jacket for protection from aqueous inorganics.

C. The system shall operate on live voltage of 110-120 VAC without the use of transformers. The system shall have additional thermostat control.

D. Refer to the manufacturer's freeze protection "Design Guide" for design details, maximum lengths and accessory information.

2.11 THERMOMETERS

A. Thermometers shall be adjustable angle design of the separable well type and shall have a 9" cast aluminum case. The scale shall be white with black figures and graduations embossed on the scale. The column shall be filled with red reading mercury. Thermometers shall be manufactured by Trerice Co. or Taylor Instrument.

B. Thermometers shall be furnished complete with all necessary sockets, wells, connectors and accessories required for installation suitable for the service in which installed. Extension necks shall be furnished for insulated piping.

C. Thermometers shall be furnished with the temperature ranges of 30° to 100°F for cold water, and of 30° to 240°F for hot water systems.

2.12 PRESSURE GAUGES

A. Pressure gauges shall have brass movement, aluminum case, double strength clear glass window with black embossed figures and graduations on a white dial face, with 1% accuracy of scale range. Gauges shall be manufactured by Trerice Co., Taylor Instrument, or Marshaltown Mfg.

B. Gauges shall be furnished with snubbers and needle valve shutoff valves.

C. Gauges shall be 4 1/2" diameter furnished with ranges that will locate the intended pressure at the point of application approximately midpoint on the range scale. Gauges for natural gas, vacuum and similar low pressure systems shall be gauges specifically designed for low pressure applications.

2.13 BUILDING AUTOMATION SYSTEM

A. The building automation system shall be furnished and installed under another Section of these specifications. This Subcontractor shall provide the tees, pipe wells, valves, and caps to allow the connection from the BAS system to the plumbing points required. The pH probes, moisture content meter and resistivity probe shall be provided for BAS tie-in. The following table itemizes the equipment and location of the type of device necessary to connect to the BAS system.

Service or Equipment	**QTY.**	**Pressure**	**Temperature**	**Flow**	**Trouble**	**Location**
Electric Water Heaters	(3)		X			Basement
Dental Vacuum Pumps	(1)	X			X	Basement
Dental Air Compressor	(1)	X			X	Basement
Medical Air Compressor	(1)	X			X	Basement
Medical Vacuum Pumps	(1)	X			X	Basement
Heating Cable	(6)		X		X	First Floor

PART 3 EXECUTION

3.01 BACKFLOW PREVENTERS AND APPROVALS

A. Potable water piping outlets and connections to equipment shall be protected with an airgap or backflow preventer approved by the Department of Environmental Protection Agency or Board of Health. All installations, clearances and equipment shall be in strict accordance with State regulations.

B. Submit plans and obtain approval for each reduced pressure backflow preventer installation. Copies of approvals shall form a portion of the record drawings.

C. All reduced pressure backflow preventers shall be installed with inlet and outlet gauges, strainer and indirect waste through an airgap to a floor drain or receiver.

3.02 INSULATION INSTALLATION

A. Insulation shall be installed in accordance/compliance with the manufacturer's application recommendations by person(s) specializing in this work. Insulation not installed in an acceptable manner will be replaced by this Contractor at no additional cost.

B. All piping systems shall be cleaned, tested and approved prior to installing insulation. Provide continuous vapor barrier on cold water, rainwater, indirect waste and all insulated systems where condensation could occur.

C. Piping: Pipe insulation where vapor barrier jacket is required shall be installed with vapor barrier jackets drawn tight and firmly sealed to assure a positive vaporseal. End joints shall be covered with 4" wide butt strips of material identical to vapor barrier jackets, and they shall be drawn tight and securely sealed. The use of staples, bands, etc., to secure insulation where vapor barrier jacket is required will not be acceptable. Pipe insulation where no vapor barrier is required shall be secured with flare type staples.

D. Fitting and Valves: Molded insulation on fittings and valves bodies shall be same thickness as adjacent covering and finished neatly to match the adjacent pipe insulation.

E. Hangers and Saddles

1. Insulation inserts shall be installed at points of hanger support. Insulation inserts shall be either 180° or 260° and not less than 18" in length. The entire insert shall be covered with a vapor barrier facing of the same appearance and quality as the facing on the adjacent covering.
2. Insulation at hangers, anchors and supports shall be neatly cut and fitted.

3.03 IDENTIFICATION OF SYSTEMS

A. Refer to Section 220500.

END OF SECTION

SECTION 223000

PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 WORK INCLUDED

A. The work shall include labor, materials, tools, equipment, transportation, insurance, temporary protection, supervision and incidental items essential for proper installation and operation, even though not specifically mentioned or indicated on the drawings but which are usually provided or are essential for proper installation of systems related to this Section, as indicated on the drawings and specified herein.

B. The specifications and drawings describe the minimum requirements that must be met for the installation of work as shown on the drawings and as specified hereinunder.

C. Shop drawings.

D. Field acceptance testing.

1.02 RELATED SECTIONS

A. Examine drawings and criteria sheets and other Section of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1. Section 220500 – Basic Plumbing Materials and Methods
2. Section 220529 – Hangers and Supports
3. Section 220548 – Plumbing Vibration Controls and Seismic Restraints
4. Section 220553 – Plumbing Identification
5. Section 220584 – Through Penetration Firestop Systems
6. Section 221110 – Plumbing Valves
7. Section 221120 – Plumbing Distribution Piping
8. Section 221130 – Drainage and Vent Piping
9. Section 221140 – Plumbing Specialties
10. Section 224000 – Plumbing Fixtures
11. Section 226000 – Laboratory Plumbing Systems
12. Section 227000 – Medical Plumbing Systems

1.03 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ANSI American National Standards Institute
2. ASME American Society of Mechanical Engineers
3. ASTM American Society of Testing Materials
   ASTM B88-78: Wrought Copper Fittings
4. AWS American Welding Society

5. CS Commercial Standards, U.S. Dept. of Commerce
6. FM Factory Mutual
7. FS Federal Specification, U.S. Government
8. MSS Manufacturers Standardization Society of the Valve and Fittings Industry
9. UL Underwriters Laboratories, Inc.
10. OSHA Occupational Safety and Health Act
11. ASPE American Society of Plumbing Engineers

1.04 ALTERNATES

A. Refer to Section 220500.

1.05 SUBMITTALS

A. Refer to Section 220500.

B. Submittals: The following documents shall be provided:

1. Water booster pumps
2. Amalgam filtration system
3. Water heaters
4. Hot water circulators

1.06 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing plumbing specialties specified in this section, with documented experience.

PART 2 PRODUCTS

2.01 WATER HEATERS

A. Provide back-up domestic electric water heaters as listed below. All storage vessels shall be constructed in accordance with ASME Code, Section IV, and stamped with the appropriate symbol, hydrostatically tested to 225 psi, operating pressure of 150 psi. All units shall be factory insulated, jacketed and painted. All fitting connections shall be copper. The heaters shall be completely packaged, heat loss shall comply with ASHRAE 90 (1982) standards. Start-up of equipment shall be by factory trained manufacturer's personnel. The final installation shall comply with all authorities having jurisdiction. Nameplate data shall be marked accordingly and clearly visible from the front of the unit.

B. Electric Back-up Domestic Water Heater System

1. Furnish and install where shown on the plans, the number and model of In-Line Electric Water Heaters as indicated below, or on the drawing water heater schedule, as manufactured by the Process Technology.
2. Each heater shall be a factory package with a capacity to heat the specified rating while maintaining the set outlet temperature within 4° F at all flow rates.

3. Each Electric Water Heater shall be furnished with the follow components and features:

   a. TEMPERATURE CONTROL

      1) PID microprocessor based digital thermostat

   b. TEMPERATURE LIMIT

      1) 150° F, depending on operating conditions

   c. TEMPERATURE ACCURACY:

      1) + / - 1° F, depending on operating conditions

   d. PRESSURE RATING:

      1) 100 PSIG (operating)

   e. EFFICIENCY:

      1) > 99%

   f. WETTED SURFACES:

      1) All titanium standard

   g. INLET/OUTLET:

      1) 2" MNPT

   h. STANDARD SAFETY FEATURES:

      1) Grounded construction
      2) EMO emergency stop button
      3) Fluid over temperature detection (J type thermocouple)
      4) Element over temperature detection (bi-metallic snap switches)
      5) Control fusing (primary and secondary)
      6) Surge/transient protection
      7) FM approved over temperature limit controller

   i. HOUSING: NEMA 1 rated, powder coated metal enclosure
   j. STANDARD CERTIFICATIONS: cULus
   k. The following Options shall be furnished:

      1) CE compliance
      2) S2 compliance
      3) PLC control
      4) Remote interface
      5) Ground fault protection (GFP)
      6) Disconnect and circuit breaker
      7) Stainless steel elements and wetted parts
      8) Flanged/sanitary fluid connections
      9) RS remote communications

4. Start Up Policy:

   a. The manufacturer's representative shall supply supervision of the start up of the heaters by the contractor. If the installation deviates from the manufacturer's recommended practice, the representative shall advise the contractor and the design engineer and not proceed with start up until corrective measures are taken.

5. Water Heaters:

   a. Three (3) Process Technology TY-162-480-3-SC electric water heaters for a total flow rate 36.8 GPM with a 90°F Rise. Approved equal shall be Hubbell.

2.02 AMALGAM FILTRATION SYSTEM

A. General

1. The amalgam waste filtration system shall be supplied as a complete, integrated process system by a single supplier, skid mounted, preassembled and pre-tested prior to delivery to the site. The system shall be delivered as a complete skid with all inter connecting piping, signal wiring, and power wiring installed and tested prior to delivery. The system shall be supplied by Practical Applications, Inc., Boston MA.

B. Operation

1. Dental vacuum wastewater shall flow into the basin and automatically be treated through the series of treatment units. The system will operate automatically and have 100% redundancy. Control valves and pressure sensors will provide automatic switching between treatment vessels when one of the two trains requires filter replacement. System will send a single point digital (dry contact) signal to the vacuum control system that the treatment receiving tank is full.
2. System performance shall exceed 98% particulate mercury removal efficiency and treat 1,000 gallons per day of influent waste vacuum water.

C. Equipment Specifications

1. Receiving Basin

Quantity:	One (1) 100 gallon tank
Volume:	120 gallons to invert
Dimensions:	Field coordinate
Material:	Polypropylene, fiberglass, or polyethylene
Wall Thickness:	3/4" Minimum
Nozzles:	2" Inlet Flange, 2" Outlet Flange, 2" Vent Flange
Temperature:	Operating Temperature 210 Deg. F. 220 Deg F max.
Cover:	3/4" Minimum thickness, bolt-down and gasketed
Seals:	The tank is required to operate air tight and all seals must meet a 2 foot hydrostatic water test.

2. Pumps

Quantity:	Two Pumps (2)
Type:	Submersible centrifugal pump, rail mounted
Capacity:	10 gpm at 58 feet of head
Motor:	480 VAC, 60Hz 3-Phase, Oil Filled

Suction/Discharge:	Pumps will be installed with the appropriate isolation valves, check valves, inlet strainers, pressure gauges, and piping to allow for complete automatic & manual control, operation, and maintenance.
Materials:	Pumps wetted parts will be constructed of 304 Stainless Steel, carbon/ceramic seals with Viton, or EPDM. Power cable to be EPDM, PVC or Neoprene jacketed
Controls:	System will provide lead, lag and automatic alternate for the pump pair via three polypropylene floats. A fourth float will provide an audio and visual alarm for high level and energize both pumps
Manufacturer:	Stancor Pumps
Model:	Avenger Series SS200PA

3. Level Control

Quantity:	Two Level Sensors (1 Single Point High Alarm, 1 Continuous)
Type:	RF Capacitance Type
Material:	316SS and/or Teflon Coated
Operating Env.	Max Temp 220 Deg. F, Max Press 50psig
Controls:	24VDC or 120VAC, pump on, pump off, lag pump on, high level
Manufacturer	Drexelbrook

4. Filter Media Unit #1

Quantity:	Two Filter Assembly (1)
Type:	Full High Bag Filter Assembly (7"x 32" bag) with hinged
lid and	perforated stainless steel basket
Material:	316 Stainless Steel with EPDM seals and teflon seats

5. Filter Media Unit #2 and #3

Quantity:	Two Filter Assemblies (2, Unit #2 & #3)
Type:	7 Round 20" Filter Cartridge Housing Assembly with band clamp closure and universal element acceptance
Material:	316 Stainless Steel with EPDM seals and Teflon seats

6. Main Control Panel

   a. The control panel shall be UL Listed, NEMA 4 enclosure, sized to adequately house all necessary instrumentation, fuses, control circuit transformer, circuit breakers, and motor starters, etc. The panel shall be mounted within the System footprint and at a height suitable for accessibility. The panel will include all interconnecting wiring to the pump motors and level sensors. All pre-wiring shall be done in PVC jacketed flexible conduit for a complete NEMA 4 system. Panel will have alarms contacts to connect with a building supervisory remote alarm system. One disconnect shall de-energize all power to the filtration system.
   b. The panel shall incorporate HAND/OFF/AUTO 3 position selector switches with green pilot lights to indicate operational status and provide control of the pumps and control valves. The panel will include an audible and visual alarm and a single point connection for general alarm to the building automation system.

D. Installation

1. Furnish the services of the manufacture's engineering representative for checking the installation, making the necessary adjustments and calibrations, placing the equipment in operation, and performing the acceptance tests. The representative shall be completely familiar with the Waste Filtration System and shall be available for not less than 3 days to instruct operating personnel in the use, operation, and maintenance of the equipment during the initial operating period. Install all Waste Filtration System equipment in accordance with the recommendations of the manufacturer.

E. Startup and Training

1. Supplier shall provide one (1) day of supervised Waste Filtration System start-up and operation oversight. During this time, a factory authorized technician familiar with the System shall instruct the owner regarding start-up, operation and routine maintenance. This instruction shall be consistent with information provided in the Waste Filtration System Operation and Maintenance (O&M) Manual. All instrumentation shall be calibrated with the owner’s personnel present. The supplier shall provide a certified document, Site Acceptance Test (SAT) to the owner that all equipment has passed an operational test and/or calibration. The SAT will also indicate all initial set points and equipment adjustments.

F. Operation and Maintenance Manuals

1. Three (3) copies of the Operation and Maintenance (O& M) Manual, specifically written for the Waste Filtration System, shall be included and will completely describe the installation, operation and maintenance of the System and all of its associated components. Furnish one complete manual prior to the time that equipment tests are performed, and furnish the remaining manuals before the contract is completed. The manual shall include: wiring and control diagrams with data to explain detailed operation and control of each item of equipment; a control sequence describing start-up, operation and shut-down; description of the function of each principal item of equipment; the procedure for starting; the procedure for operating; shut-down instructions; installation instructions; maintenance instructions; lubrication schedule including type, grade, temperature range, and frequency; safety precautions, diagrams, and illustrations; test procedures; performance data; and parts list. The following equipment shall be included in the O&M Manual; Submersible Sump Pump, level sensor, pressure sensors, and control valves.

G. Guarantee

1. All electrical and mechanical equipment shall carry the original manufacturer's warranty. Supplier shall warrant the System free from fabrication defects for a period of one year from date of delivery.

2.03 CIRCULATORS (CONTINUOUS RUN)

A. Circulating pumps shall be in-line with flanged connections. The control shall be as detailed on the drawings. In lieu of an aquastat or timeclock arrangement, it shall be considered a continuous run system. The units shall be all bronze equal to Taco, Bell & Gossett or Grundfos. Provide a shutoff switch for each pump and full size pump bypass.

B. Each hot water circulator shall be capable of 40 gallons per minute at 20’-0" head, 1/2 HP, 460 Volt, 3-Phase.

PART 3 EXECUTION

3.01 CONNECTIONS TO EQUIPMENT

A. Refer to Section 220500.

3.02 IDENTIFICATION OF SYSTEMS

A. Refer to Section 220553.

END OF SECTION

SECTION 224000

PLUMBING FIXTURES

PART 1 GENERAL

1.01 WORK INCLUDED

A. Fixtures and equipment shall be supported and fastened in a satisfactory manner. Where wall hung fixtures are secured to masonry walls or partitions, they shall be fastened with 1/4" through bolts provided with nuts and washers at back. Bolt heads and nuts shall be hexagon, and exposed bolts, nuts, washers, and screws shall be chromium plated brass.

1.02 RELATED SECTIONS

A. Examine drawings and criteria sheets and other Sections of the specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1. Section 220500 – Basic Plumbing Materials and Methods
2. Section 220529 – Hangers and Supports
3. Section 220548 – Plumbing Vibration Controls and Seismic Restraints
4. Section 220553 – Plumbing Identification
5. Section 220584 – Through Penetration Firestop Systems
6. Section 221110 – Plumbing Valves
7. Section 221120 – Plumbing Distribution Piping
8. Section 221130 – Drainage and Vent Piping
9. Section 221140 – Plumbing Specialties
10. Section 223000 – Plumbing Equipment
11. Section 226000 – Laboratory Plumbing Systems
12. Section 227000 – Medical Plumbing Systems

1.03 TOILET ACCESSORIES

A. Attention is directed to Section 10800 of the General Specifications. Toilet room accessories, including grab bars, shall be furnished under Section 10800 of the Specifications. The labor for installing toilet room accessories and all back-up material of wood, fasteners, hangers, brackets, etc. shall be by the Contractor. Reference shall be made to Architectural Specifications and drawings for exact quantity, type and locations of toilet accessories. Accessories must be properly fastened with special attention given handicapped persons grab bars which must be anchored in accordance with manufacturers' instructions. Store accessories until required on job.

1.04 ALTERNATES

A. Refer to Section 01230 – ALTERNATES.

1.05 SUBMITTALS

A. Refer to Section 220500.

B. Submittals – The following documents shall be provided:

1. Plumbing fixtures and trim.

1.06 QUALITY ASSURANCE

A. Refer to Section 001400 – QUALITY REQUIREMENTS.

PART 2 PRODUCTS

2.01 FIXTURES AND TRIM

A. Acceptable Manufacturers: Submit manufacturers not listed below for review and approval as specified for substitutions in Section "Quality Assurance" in this specification.

B. Fixture Trim and Accessories: Provide fixtures complete with fixture carrier, faucet, drain outlet, tailpiece, P-trap, and stops and supplies.

1. Finish: All trim exposed to view shall be polished chrome plated.
2. P-Traps: Cast brass adjustable P-trap with cleanout plug, ground joint and 17 gauge minimum weight extension with escutcheon. Provide Chicago or McGuire #8090 1 1/4" by 1 1/2" on lavatories and #8098 1 1/2" by 1 1/2" on sinks.
3. Drain Outlets: Provide drain outlet of the same manufacturer as the fixture or faucet trim with chrome plated cast brass plug with 17 gauge minimum weight tailpiece. Provide 1 1/4" tailpiece on lavatories and 1 1/2" on sinks.
4. Stops and Supplies: Chrome plated, brass with stop, Chicago or McGuire #170-LK, escutcheon flexible riser. Refer to other Sections herein for information on transition between materials.
5. Joints between wall mounted fixtures and wall shall be sealed with caulk to match fixture color.
6. All faucets, water coolers and drinking fountains shall be constructed of a lead free brass alloy and where applicable, shall be certified to comply with NSF 61 Section 9 Drinking Water Standard.

C. Water Conservation: Provide water conserving fixtures and trim compliance with the following maximum water use requirements. Provide variable pressure flow controls on showers, sinks and lavatory faucets.

1. Public Lavatories: 0.5 gpm
2. Sinks: 1.5 gpm
3. Showers: 2 gpm
4. Water Closets 1.6 gpf
5. Urinals: 0.125 gpf
6. Clinic Sinks: 1.6gpf

D. Fixture Supports

1. Acceptable Manufacturers: J.R. Smith, Zurn, Wade, or Josam
2. Provide floor mounted fixture support carriers for wall mounted fixtures including, but not limited to, water closets, lavatories, scrub sinks and clinical sinks. Fixture support shall support at least 1,500 lbs. (water closets) and 250 lbs. (all other fixtures) for (5) minutes. Furnish complete with foot piece, all necessary bolts, nuts, washers and gaskets.

The adjustable nipple for the water closets between the cast iron fitting and closet bowl shall be threaded cast iron. Secure all foot pieces to floor slab using four bolts per foot.

3. Close coordination is required between the plumber and tile subcontractor in closet installation. Maintain 1/16" clearance between finished wall and back of closet and follow manufacturer's details in installing couplings to ensure tight seal at closet outlet. Closet hanging templates must be used.

E. Water Closets

1. Refer to schedule on drawings for fixture types and model numbers.

   a. Water closets shall be elongated, wall hung vitreous china, 1.1/1.6 gpf siphon jet with 1-1/2" top spud equal to American Standard, Kohler or Toto.
   b. Flushometer valve shall be exposed chrome plated, 1" I.P.S. screwdriver angle stop, protective cap with set screw, adjustable tailpiece, vacuum breaker and spud coupling, set screw escutcheon at wall equal to Sloan, Zurn or Toto.
   c. Seats shall be heavy duty, institutional, solid plastic seat for elongated bowl, open front less cover with self-sustaining check hinge equal to Kohler, Bemis or Olsonite.
   d. Fixtures designated for handicapped use shall be installed in accordance with the Americans with Disabilities Act as well as state and local codes.

F. Urinals

1. Refer to schedule on drawings for fixture types and model numbers.

   a. Urinals shall be wall hung, vitreous china, 0.125 gpf siphon jet with 3/4" top spud equal to American Standard, Kohler or Toto.
   b. Flushometer valves shall be exposed, chrome plated, 3/4" I.P.S. screwdriver angle stop, protective cap with set screw, adjustable tailpiece, vacuum breaker and spud coupling, set screw escutcheon at wall equal to Sloan, Zurn or Toto.
   c. Fixtures designated for handicapped use shall be installed in accordance with the Americans with Disabilities Act as well as state and local codes.

G. Lavatories

1. Refer to schedule on drawings for fixture types and model numbers.

   a. Lavatories shall be vitreous china, self-rimming or wall hung with 2" chrome plated escutcheons as required and 8" faucet centers. Equal to Kohler, American Standard, Kohler or Toto.
   b. The faucets shall be chrome plated, combination faucet, 4" wrist blade handles or electronic control aerator and ceramic operating cartridges. Equal to Chicago, Symmons or Water Saver.
   c. Drains shall be chrome plated, cast brass grid drain. Equal to manufacturer of supplied fixture.
   d. Fixtures designated for handicapped use shall be installed in accordance with the Americans with Disabilities Act as well as state and local codes.

H. Sinks

1. Refer to schedule on drawings for fixture types and model numbers.

a. Sinks shall be Type 304, 18 gauge stainless steel, with sound deadening undercoating. Equal to Elkay, Acorn or Just.
b. The faucets shall be chrome plated, combination faucet, 4” wrist blade handles, or electronic controls aerator and ceramic operating cartridges. Equal to Chicago, Symmons or Water Saver.
c. Drains shall be chrome plated, cast brass grid drain. Equal to manufacturer of supplied fixture.
d. Fixtures designated for handicapped use shall be installed in accordance with the Americans with Disabilities Act as well as state and local codes.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Inspect existing site conditions in areas where piping and fixtures will be installed and verify existing systems and the impact of the proposed modifications before fabricating systems to be installed.

B. Notify the Architect immediately regarding any substantially different conditions than those shown in the Contract Documents.

3.02 DEMOLITION

A. Obtain existing record drawings of existing systems from the Owner. Identify existing piping which is to remain, serving fixtures and equipment outside the scope of this project.

B. Disconnect existing fixtures and equipment to be demolished, stacks and riser in partitions to be demolished. Remove existing plumbing systems back to remaining supply piping, waste, soil, etc. Plug or cap plumbing systems to remain gas and water tight.

C. Active piping to remain in demolished walls shall be offset to adjacent walls and chases, to within architectural enclosures. Coordinate with Architect for acceptable location.

3.03 CONNECTIONS TO EQUIPMENT

A. Refer to Section 220500.

3.04 FIXTURE ROUGHINGS

A. Install rough plumbing, including fixture carriers and supports, valves and water hammer arrestors within chase tolerances. Supply roughing through finish walls and at hose bibbs and shower heads shall be secure and free of movement. Locate valves and water hammer arrestors within 12" of approved access panel location.

B. Align exposed waste and supply pipe roughings with fixture connections within 1" tolerance. Provide flush valves in alignment with the fixture, without vertical or horizontal offsets. Obtain fixture manufacturer roughing data sheets for recommended roughing dimensions.

C. Provide fixture templates for casework Contractor for counter mounted sinks and lavatories.

D. Secure fixture supports to floor slab construction with lag bolts and metal expansion shields to support at least 1,000 lbs. (water closets) and 250 lbs. (all other fixtures) for (5) minutes.

E. Provide fixture rough-in piping connection sizes in accordance with the drawing schedule.

END OF SECTION

SECTION 226000

LABORATORY PLUMBING SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 220500 and other Division 1 Specification sections, apply to this section.

1.02 WORK INCLUDED

A. The work shall include labor, materials, tools, equipment, transportation, insurance, temporary protection, supervision and incidental items essential for proper installation and operation, even though not specifically mentioned or indicated on the drawings but which are usually provided or are essential for proper installation of systems related to this Section, as indicated on the drawings and specified herein.

B. The specifications and drawings describe the minimum requirements that must be met for the installation of all work as shown on the drawings and as specified hereinunder.

C. Shop drawings.

D. Field acceptance testing.

E. Installation of Laboratory trim furnished by others.

F. Piping valves and fittings for laboratory services.

G. Compressed air system including all associated piping and valves.

H. Vacuum system including all associated piping and valves.

I. Relocation of existing systems.

J. Removal of existing systems.

K. New and temporary connections to existing systems.

1.03 RELATED SECTIONS

A. Examine drawings and criteria sheets and other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1. Section 220500 – Basic Plumbing Materials and Methods
2. Section 220529 – Hangers and Supports
3. Section 220548 – Plumbing Vibration Controls and Seismic Restraints
4. Section 220553 – Plumbing Identification
5. Section 220584 – Through Penetration Firestop Systems
6. Section 221110 – Plumbing Valves
7. Section 221120 – Plumbing Distribution Piping
8. Section 221130 – Drainage and Vent Piping

9. Section 221140 – Plumbing Specialties
10. Section 223000 – Plumbing Equipment

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as following:

1. ANSI American National Standards Institute
2. ASME American Society of Mechanical Engineers
3. ASTM American Society of Testing Materials ASTM B88-78: Wrought Copper Fittings
4. AWS American Welding Society
5. CS Commercial Standards, U.S. Department of Commerce
6. FM Factory Mutual
7. FS Federal Specification, U.S. Government
8. MSS Manufacturer's Standardization Society of the Valve and Fittings Industry
9. UL Underwriters Laboratories, Inc.
10. OSHA Occupational Safety and Health Act

1.05 SUBMITTALS

A. Refer to Section 220500.

B. Submittals: The following documents shall be provided;

1. Laboratory system pipe materials and valves.
2. Laboratory fixtures and trim.
3. Valve box.

1.06 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the type of products specified in this section, with minimum ten (10) years of documented experience.

B. Installer-company specializing in performing work of the type specified in this section with documented experience.

C. All equipment requiring electrical power connections including pumps, control panels and packaged skids shall be UL or ETL Listed as a complete assembly.

PART 2 PRODUCTS

2.01 FIXTURES AND TRIM

A. Lab Outlets

1. Refer to schedules on drawings for fitting types and model numbers.

a. Lab fittings shall be chrome plated, indexed for specific service, pressure rated to meet requirements of specific service. All natural gas turrets shall be supplied with an integral check valve. Equal to Chicago, Water Saver or T&S Brass.

2. Furnish and install the following sink fittings, laboratory outlets, fixtures, etc."

a. C - Cold Water Outlet - Peninsula Bench - CS – Drop
Chicago No. 937-E22 non-domestic cold water outlet
b. A - Compressed Air Outlets - Peninsula Bench – Drop
Two Chicago No. 907 compressed air outlets - back to back
c. C1 Cold Water Faucet - Wall Bench - CS – Deck Mounted
Chicago 928-VB water faucet
d. A1 Compressed Air Outlet - Wall Bench – Deck Mounted
Chicago No. 980 WS-907 single compressed air outlet
Chicago No. 981 WS-907 double compressed air outlet

2.02 PIPING, FITTINGS AND JOINTS

A. Polypropylene Piping

1. RODI Water System

a. Piping shall be SDR11 Series wall thickness conforming to ASTM-2837 with butt fusion joints rated for 150 psi at 68°F as manufactured by George Fischer, Asahi or SimTech.

b. If alternate manufacturer is submitted, it shall be the Contractor's responsibility to verify pipe sizes, pressure losses and velocities within the system. The Contractor will be required to submit his design prior to installation for review and approval.

B. Laboratory and Specialty Gas Pipe and Fittings

1. Use for Lab Air

a. All piping shall be seamless copper tubing, Type L hard temper, ASTM Designation B88 for assembly with braze joint fittings.
b. Fittings for connecting copper tubing shall be standard weight, wrought copper, brass or bronze type. Fittings for copper tubing shall be wrought copper fittings, deep socket, designed expressly for brazing at temperature greater than 1000°F or may be brass or bronze.
c. Brazing Alloy: For assembling braze-joint fittings shall be Aircoils 45 or other silver brazing alloy of equivalent melting point and physical properties and shall conform to ANSI/AWS A5.8.
d. All pipe shall be prewashed expressly for oxygen use and delivered washed and capped. Piping shall be installed with a constant nitrogen purge.

C. Copper Tubing and Fittings

1. Lab Vacuum Piping

a. Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88 and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead free solder.

2.03 VALVES

A. General:

1. All systems under this Section shall be provided with valves to permit complete and/or sectional control of the system. They shall be located to permit easy operation, replacement and repair. They shall be installed where shown on the drawings, at the base of all risers, at each branch takeoff from the riser or as herein specified. They shall be the product of the specified manufacturer.
2. All equipment shall be installed with isolation valves for service shut off. Equipment shut off valves shall be screwed ends or flanged. If screwed ends are provided, a union between equipment and valve shall be provided.

B. RODI Water Valves (Polypropylene)

1. Diaphragm Valves: 1/2" to 2", polypropylene, allowable working pressure of 150 psi at 68°F water, spigot ends, EPDM diaphragm, position indicator, George Fischer Type 315PP, Asahi or SimTech.
2. Diaphragm Valves: 2-1/2" and larger, polypropylene, allowable working pressure of 150 psi at 68°F water, flanged ends, ANSI Class 150, EPDM diaphragm, position indicator, George Fischer Type 317PP, Asahi or SimTech.

C. Specialty Gas Shutoff Valves (Lab Air)

1. Ball valves shall be three piece bronze or brass body with chrome plated bronze or brass ball, Teflon seats and stem seal, full port designed with extension ends for brazing.
2. All valves except for vacuum shall be prepared for oxygen service. Valves to be rated for 400 psi and activated by 90 degree turn to full-on to full-off position, Watts B-6801or Apollo.

D. Compressed Air Pressure Regulating Valve

1. High capacity diaphragm operated regulator with zinc body, aluminum spring cage, adjustment mechanism capable of maintaining a constant outlet pressure with wide variation in flow similar to Watts Model R-119.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Inspect site conditions in areas where piping and equipment will be installed and verify systems and the impact of the proposed equipment before fabricating systems to be installed.

B. Notify the Architect immediately regarding any substantially different conditions than those shown in the Contract Documents.

3.02 TESTING OF PURIFIED WATER PIPING SYSTEMS

A. General

1. All piping systems shall be subjected to testing with water, gas or air as noted and shall hold tight at the pressure head stated for the time interval required without adding air or water. While any system is being tested, required head or pressure shall be maintained until all joints are inspected. All systems tested in the existing building shall be tested with air before water.
2. All tests shall be witnessed by the CM having jurisdiction and the Architect/Engineer, with 48 hour notice given these authorities.
3. All equipment, material and labor required for testing any of the various systems or any part thereof shall be furnished by this Contractor.

B. High Purity Water Piping Systems: Upon completion of these piping systems, including cooling for a minimum of (1) hour and the system empty of water, a test using compressed nitrogen gas N.F. or clean dry air can be done with the pressures not to exceed 5 psi to determine any obvious leaks. A hydrostatic test shall be done by filling the system with product water and opening valves and vents to purge the system of any air. Begin pressurizing the system in 10 psi increments up to 100 psi and holding the pressure for a minimum of 2 hours and up to a recommended 12 hours. Due to the natural creep effects of plastic pipe, the pressure should be checked after 1 hour. If the drop is less than 10 psi, pump the pressure back up. At this time, the system may be pressurized to the system pressure. If the pressure decreases more than 10% and ambient temperatures have been maintained, consider the test a failure. If the pressure drops less than 10 psi after 1 hour, pump the pressure back up to system pressure. After 2 or 3 hours the pressure holds, the test will be considered a success. Refer to manufacturer's recommendations and procedures for additional information.

C. Defective Work: If inspection or tests show defects, such defective work or material shall be replaced and inspection and tests shall be repeated. All repairs to piping shall be made with new materials. No caulking of screwed joints or holes will be acceptable.

3.03 IDENTIFICATION OF SYSTEMS

A. Refer to Section 220500.

3.04 LABORATORY PLUMBING EQUIPMENT CONNECTIONS

A. Furnish and install domestic and laboratory waste and vents, non-potable hot and cold water, domestic cold and hot water, vacuum, compressed air, CO_2, nitrogen, oxygen and RO/DI water piping as required including pipe stands and trim and all final connections to laboratory sinks, cup sinks, fume hoods and equipment. Roughing for this equipment shall be as indicated on the drawings.

B. Furnish and install shutoff valves at each piece of equipment. Obtain exact roughing in dimensions from manufacturers of all service locations before connecting to or roughing for equipment.

C. Laboratory equipment shall be furnished and set under another Section of the Specifications. Roughing for and final connections to including piping shall be provided by this Contractor.

D. Fume hood plumbing trim furnished by Others shall be unpackaged and installed by this Contractor.

E. Coordinate casework and sink units with Casework Contractor.

F. Extreme care must be taken in the sealing of all pipe penetrations through the walls, floors and ceilings in the laboratory areas.

3.05 SPECIALTY GAS AND COMPRESSED AIR SYSTEMS

A. Cleaning: Before erection, all interior pipe, tubing, valves and fittings (except those expressly cleaned for carbon dioxide, compressed air, vacuum, nitrogen, oxygen and mixed gas services by manufacturers) shall be thoroughly cleaned of all oil, grease, or other combustible materials by washing in hot solution of sodium carbonate or trisodium phosphate mixed in equal proportions of one pound to three gallons of water. Pipe and fittings to be capped at all times to prevent contamination. Scrubbing and continuous agitation of the parts shall be employed where necessary to remove all deposits and insure complete cleansing. After washing, all materials shall be rinsed thoroughly in clean hot water. After cleansing, great care must be exercised in the storage and handling of all materials and in the condition of tools used in cutting or reaming to prevent oil or grease being introduced into the tubing. Where such contamination is known to have occurred, the materials affected must be rewashed and then rinsed.

B. Pipe and Tubing Joints: All joints in the pipe and tubing, except those at equipment requiring screwed connections, shall be made with braze joint type wrought fittings. Suitable adapters shall be employed for the installation of equipment provided with threaded connections. All brazed connections shall be made with the type of brazing alloy and flux specified in “Piping Materials”. The joining process shall be those recommended by the manufacturer of the pipe and tubing and the fittings. Brush flux back over entire end of the fitting all around. This prevents oxidation of the end. Wash joints with hot water after assembly to crack and wash off flux. Use a wire brush, if necessary.

C. Furnish and install any and all valves including purge valves, required to isolate sections of the piping systems extending into areas for construction at a later date. Provide all valves to properly test each system with respect to the construction phasing and as essentially indicated on the drawings. Remove all main and branch line valve handles at completion of work and as directed by the Owner. Provide all required adapters, valves, and interconnecting tubing required to perform the specialty gas testing as required by the Owner. Identify all isolation and phasing valves as such and indicate on tag or plastic sign that valve is to remain open and that facilities department is to be notified if closed.

D. Bends: All changes in direction requiring turns or offsets or radiuses less than five times the pipe or tubing outside diameter shall be made by Walseal or braze-type wrought fittings.

3.06 TESTING OF LABORATORY GASES, COMPRESSED AIR AND VACUUM SYSTEMS

A. General

1. This Contractor shall provide testing of the complete installation of all laboratory gases, compressed air and vacuum systems from their cylinders, compressors, pumps or points of new pipe line connections to new and existing equipment and outlets.
2. This Contractor is to provide purge valves and isolation valves at all dead ends and points of connections to piping systems or at all phasing break points for the proper execution of the testing, blowing out and purging. Purge valves to consist of 3/8-inch ball valves with a threaded end capped adapter.

3. All tests shall be observed by a representative of the Owner. This Contractor shall be responsible for supplying the bottled gas, gauges, adapters, analyzer and all other necessary equipment to conduct these tests. Final testing, outlet flow analysis, outlet concentrations, pressure verification and overall system operation shall be performed and certified by an independent approved gas testing laboratory. This Contractor to submit test report and results to Architect/Engineer or his representative for verification. Also, this Contractor is to submit to the Architect for approval, the testing laboratory he intends to use for the gas certification. The submission is to include a complete listing and sequence of the proposed testing procedure to be used including which standards are to be followed, which order the outlets are to be tested, the parameters of the flow tests, and the equipment to be used to perform the tests.

B. Blowdown

1. After installation of the piping, but before installation of the outlet valves and gauges, the line for each installed gas system shall be blown clear of particulate contamination by means of oil free dry Nitrogen.

C. Pressure Test

1. Before attachment of system components, such as pressure actuating switches for alarms, manifolds, pressure gauges, relief valves, etc., but after installation of the laboratory gas, terminations and compressed air and vacuum outlets, with rest caps in place, and before closing of the walls and ceilings, each piping system shall be subjected to a minimum test pressure of 150 psig with oil free dry air or nitrogen. This test shall be maintained until each joint has been examined for leakage by means of soapy water or other equally effective means of leak detection safe for use with oxygen.
2. Leaks, if any, shall be repaired and the section retested.

D. Final Pressure Test

1. After testing of each individual system as specified above, the assembled station outlet valves and all other system components such as pressure actuating switches for alarms, manifolds, pressure gauges, relief valves, shall be installed and all laboratory gas piping systems shall be subjected to a 24-hour standing pressure test at 20% above normal line pressure.

E. Final Tests

1. The following tests shall be performed after installation of all gas systems is complete and shall provide final testing and certification of the systems.

F. Labeling

1. All gas outlets and gauges shall be verified to incorporate proper labeling for gas and vacuum service, function and room or area control.

3.07 RO/DI WATER DECONTAMINATION

A. This Contractor shall be responsible for final decontamination of the complete RO/DI system including existing loop piping. Decontamination method shall be in accordance with Owner's requirements.

B. The chemical disinfectant "Minncare" or equal shall be used. The dilution dosage shall be 0.5% minimum to 3.0% maximum. The dilution must be calculated and recorded on log sheets. The contact time shall be 24 hours.

C. Contractor shall perform microbiological testing prior to decontamination.

D. The mixed bed deionizers shall be bypassed or disconnected.

E. The ultra-violet sterilizers shall be turned off.

F. Contractor shall change filters and clean housing.

G. Add the appropriate amount of disinfectant to the storage tank to circulate the disinfectant through the loop. All use points shall be opened briefly to expose decontamination solution. Minncare shall be verified at each point of use by using a test strip.

H. Shut down the distribution pump and isolate the loop to maintain solution contact time.

I. After 24 hours, the tank shall be drained and rinsed. The loop return shall be diverted to drain and the rinse water shall be checked for positive oxidant response.

J. Tank shall be filled with RO water and the mixed beds connections shall be flushed with clean RO water.

K. The mixed beds shall be recommended to the system only after no decontamination solution is detected.

L. The pumps and the UV sterilizers shall be turned on and the loop shall be slowly pressurized.

M. All use points shall be flushed clean.

N. The loop return diverted to drain shall be run until it is free of decontamination solution and then reconnected to the tank. After the system is running for one hour, all use points shall be flushed.

3.08 FINAL ADJUSTMENTS AND BALANCING

A. Upon completion of installation and equipment start-up, adjust systems to within operation parameters, temperatures, pressures and flows. Include adjustments to pressure relief valves, pressure regulating valves, temperature control valves for water systems, and verify normally closed/open valve positions.

B. The RODI distribution system control valves (pressure regulating and back pressure regulating) shall be adjusted to assure that all design pressures and flows are met. Multiple points of use shall be open simultaneously on each floor to assure that adequate pressure and flow are met at each system point of use. The distribution pump pressure shall also be adjusted to meet the total building flow and pressure demands.

END OF SECTION

SECTION 227000

MEDICAL PLUMBING SYSTEMS

PART 1 GENERAL

1.01 WORK INCLUDED

A. The work shall include labor, materials, tools, equipment, transportation, insurance, temporary protection, supervision and incidental items essential for proper installation and operation, even though not specifically mentioned or indicated on the drawings but which are usually provided or are essential for proper installation of systems related to this Section, as indicated on the drawings and specified herein.

B. The specifications and drawings describe the minimum requirements that must be met for the installation of all work as shown on the drawings and as specified hereinunder.

C. Shop drawings.

D. Field acceptance testing.

E. Medical compressed air, including all piping, fittings, valves and equipment.

F. Medical vacuum system, including all piping, fittings, valves and equipment.

G. Oxygen system, including all piping, fittings and valves.

H. Zone valve boxes.

I. Medical gas alarm panels, including all wiring, switches and sensors.

J. Medical gas outlets.

K. Dental vacuum system, including all piping, fittings, valves and equipment.

L. Medical gas system testing and certification.

M. Dental air system in piping, fittings, valves and equipment.

N. Connections to existing medical gas systems.

O. Removal of existing systems.

P. Relocation of existing systems.

1.02 RELATED SECTIONS

A. Examine drawings and criteria sheets and other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1. Section 220500 – Basic Plumbing Materials and Methods
2. Section 220529 – Hangers and Supports
3. Section 220548 – Plumbing Vibration Controls and Seismic Restraints

4. Section 220553 – Plumbing Identification
5. Section 220584 – Through Penetration Firestop Systems
6. Section 221110 – Plumbing Valves
7. Section 221120 – Plumbing Distribution Piping
8. Section 221130 – Drainage and Vent Piping
9. Section 221140 – Plumbing Specialties
10. Section 223000 – Plumbing Equipment
11. Section 224000 – Plumbing Fixtures

1.03 REFERENCES

A. Refer to Section 220500.

1.04 ALTERNATES

A. Refer to Section 220500.

1.05 SUBMITTALS

A. Refer to Section 220500 and General Conditions for additional requirements.

B. Product Data: Provide product description and list of materials for each system component for the following:

1. Medical vacuum system
2. Medical air system
3. Medical gas pipe materials and valves
4. Dental air system
5. Dental vacuum system
6. Medical gas outlets/inlets
7. Medical gas alarms
8. Compressed air system
9. Zone valve boxes

C. Installer Certification: The following installer qualifications shall be submitted for review and approval:

1. State Certification of ASSE 6000 Compliance.

1.06 QUALITY ASSURANCE

A. Qualifications

1. Manufacturer: Company specializing in manufacturing the type of products specified in this section, with minimum ten (10) years of documented experience.

1.07 EXTENT OF WORK

A. This section pertains to all other labor, equipment and services necessary for and incidental to the oxygen, medical air, medical vacuum, nitrogen, nitrous oxide, WAGD, instrument air, equipment air and carbon dioxide systems as shown on the drawings and specified herein.

B. Provide source equipment, alarms, valves, outlets and inlets, piping and fittings and all associated components and materials required for complete systems as shown on the drawings, specifications and manufacturer's instructions as listed herein.

C. The bulk oxygen system shall be supplied and installed under separate contract. This Contractor shall be responsible for all medical gas work from the bulk system point of connection to the facility and the low voltage electrical connections from the bulk oxygen alarm pressure switches to the facilities new master alarm panels.

D. Contractor shall make all necessary connections to Owner furnished equipment.

E. Install all piping as shown on drawings, as described herein and as described in NFPA 99, 2002 Edition, ASSE 6010 and Section 220500, BASIC MECHANICAL MATERIALS AND METHODS, using methods of fabrication, grading, testing, repairing, cleaning and other procedures as described.

F. High voltage (>115VAC) electrical wiring for ceiling columns, alarms, vacuum pump, air compressor, manifolds and modular accessories associated with the system(s) shall be part of the electrical contract. Any equipment supplied by Mechanical/Plumbing Contractor that requires additional electrical services other than the specified products shall be the responsibility of the Mechanical/Plumbing Contractor to supply these services.

G. Retain a qualified installer (ASSE 6010 Qualified) as specified and per NFPA 99, 2002 Edition. The installing company shall be pre-approved by the Owner.

H. Finished medical gas and vacuum systems shall be complete, compliant with NFPA 99, 2002 Edition in every material respect and ready to be put into operation. All materials used shall be new and comply with NFPA 99, 2002 Edition requirements for materials and workmanship shall be first class in every respect. Contractor shall be responsible for compliance with all Local, State or Federal codes.

I. This Contractor shall retain the services of an on-site factory trained Engineer or authorized representative to inspect, adjust and place in operating condition the medical plumbing systems. Refer to 230500, 1.24 for additional requirements.

1.08 COORDINATION

A. Coordinate with the Owner or agent, and his/her on-site representative, to shut down all or portions of the active medical gas and vacuum system.

B. Medical gas installing contractor and medical gas verification contractor shall coordinate with one another and other vendors and contractors as necessary to insure correct and timely installation and avoid conflicts and interference.

C. Coordinate layout of medical gas systems in spaces and identify piping in accordance to NFPA 99, 2002 Edition.

D. This Contractor shall supply and install the master alarm system and area alarm systems, including the signal wiring. The Electrical Contractor shall provide power wiring to each alarm panel, source equipment and manufactured assemblies. This Contractor is responsible for proper termination, testing and labeling. (This Contractor and Owner's Representative shall coordinate and agree on the identification labeling of the area being monitored by the alarm panels).

E. Coordinate with Owner to ensure that the medical gas supplied equipment to the facility includes medical gas outlets compatible with the facilities existing outlet connections.

PART 2 PRODUCTS

2.01 PIPING, FITTINGS AND JOINTS

A. Medical Gas and Vacuum Pipe and Fittings

1. All pipe and fittings shall be specially cleaned and prepared for medical oxygen service by the manufacturer or by a cleaning service company and received sealed on the job. Each length of tube shall be permanently labeled and delivered plugged and capped. Fittings shall be sealed and marked. The Contractor shall furnish documentation certifying that all piping materials comply with the requirements of this paragraph.
2. Medical gas (air, oxygen, nitrous oxide, dental air, carbon dioxide) piping and medical vacuum (patient, medical, surgical, WAGD) piping shall be ASTM B819 Type "L" hard drawn seamless copper tube.
3. Dental vacuum shall be Polyvinyl Chloride (PVC) with DWV fittings. Refer to Section 221120 – Plumbing Distribution.
4. Medical gas and medical vacuum pneumatic alarm connections (3/8" O.D. tubing) shall be ASTM B819 type "L" hard drawn seamless copper tube.
5. Medical air, dental air system intakes, medical vacuum exhausts and dental vacuum exhausts shall be ASTM B88, B280 or B819 Type "L" hard drawn copper tube.
6. Fittings: for copper tubing shall be wrought copper fittings, deep socket, designed expressly for brazing at temperature greater than 1000°F and comply with ANSI B16.22. Cast flare or compression fittings shall not be used for brazed joints. Bent tubing shall not be used in place of fittings.
7. Brazing Alloy: for assembling braze-joint fittings shall be Copper-Phosphorus or Copper-Phosphorous-Silver Brazing (BCuP series) filler metals and comply with ANSI/AWS A5.8. Flux shall not be used.

2.02 VALVES

A. Medical Gas Valves

1. Zone or Section Valves

a. All valves and tubing shall be specially prepared for oxygen service and shall conform in all particulars to NFPA 99, 2002 Edition.
b. All valves shall be 3-piece ball type with teflon "O" ring stem seal, rated at not less than 300 psig actuated from full "ON" to full "OFF" for 90° turn of valve handle.
c. Valves shall be provided with Type-K copper tube extensions with 1/8” NPT gauge port.
d. Color-coded gas identification labels shall be provided with each valve. Pressure/vacuum gauges shall be located immediately adjacent to each shut-off on the patient side.
e. Valves shall be packaged in polyethylene bag.
f. Shut-off valves shall be labeled to identify the medical gas/vacuum service, rooms or areas served and a caution not to close (or open) except in an emergency.
g. All main, riser, isolation and sectional valves shall include lockable handles and shall be locked open unless noted otherwise.

2. Main, Riser, Isolation and Section Valves

   a. ½" through 2" shall be Beacon Medaes 6-211XXX-00, Amico or Ohio Medical, full port (3) piece ball valve, lockable handles, extensions and gauge port.
   b. 2½" through 4" shall be Beacon Medaes 6-230XXX-00, Amico or Ohio Medical, full port (3) piece ball valve, lockable handles and extensions.
   c. All main, riser, isolation and sectional valves shall be locked open unless noted otherwise.

3. Medical Gas Zone Valve Boxes (ZVB)

   a. Valve boxes shall be constructed of 18-gauge sheet steel white epoxy finish and provided with two galvanized steel brackets that anchor the box to the wall.
   b. Anchor brackets shall be designed to permit box assemblies to be ganged together in a vertical stack.
   c. Factory installed tubing shall extend at least 3” beyond the box and the valve body shall be swung out of line of heat transfer, permitting joint to be brazed without obstruction or heat damage to valve. Open ends of tubing shall be capped to avoid pre-installation contamination.
   d. The zone valve box shall be provided with an anodized aluminum trim capable of adjusting to variations in wall thickness up to 1” below flush.
   e. The zone valve box assembly shall have a sliding, opaque door with pull ring and clear gauge window. The door shall be capable of sliding to the right or left to facilitate installation requirements. In an emergency, the door shall SNAP-OUT by pulling the pull ring forward without exposing sharp edges.
   f. The window shall conceal exposed piping and valves within the box and shall be labeled “Caution – Medical Gas Shutoff Valves – Close Only in Emergency”.
   g. Clear gauge window shall be to display the gas service and the area controlled by the valve. Placement of the valve handle within the box shall be such that the plastic pull out window cannot be replaced with the valve handle in the off position.
   h. The zone valve box assembly shall be supplied with color-coded gas identification labels. All boxes shall be labeled for rooms served by valves.
   i. Medical Gas Zone Valve Boxes (ZVB) shall be Beacon Medaes Model 6-150XXX-00, Amico or Ohio Medical.
   j. Refer to documents for orientation and location.

4. Purge Valves

   a. Shall be 1/4" (3) piece ball valve with threaded connections.

5. Gauges

   a. Main line pneumatic gauges shall be Beacon Medaes or Allied, Bourdon Tube Gauge, cleaned for oxygen use and installed with gauge cock. Gauge face shall read 0-100 PSI for all pressure gases except Nitrogen and instrument air and vacuum. Nitrogen and instrument air gauge face shall read 0-400 PSI, vacuum gauge face shall read 0-30" Hg.

2.03 MEDICAL AIR SYSTEM

A. Furnish and install per plans and specifications one (1) BeaconMedaes, Model # SAS07D-080V-D-SPL, Duplex Medical Compressed Air System. System to be comprised of two (2) 7.5 HP scroll compressor modules, each driven by a 7.5 HP motor, each rated for 25.2 CFM @ 50 psig. The system shall be of a single point connection with the exception of dual electrical feeds, base mounted design consisting of two (2) stack mounted compressor modules, duplex dryer package, 80 gallon receiver tank and duplex control panel. Piped fittings to be flanged in lieu of threaded and use of anodized aluminum drilled blocks wherever possible to be incorporated throughout air stream design to reduce leak points. Package to be designed and manufactured with ISO 13485 processes and be completely tested prior to shipment. Approved equal shall be Ohio Medical and Amico.

B. The compressors shall be a continuous duty rated scroll type, single-stage and air-cooled. Each compressor shall have one fixed and one orbiting scroll sealed with PTFE tip seals between the scroll halves. The compressor module must have field replaceable tip seals, dust and contamination protection from two part face seal, grease filled orbiting bearing and pin crank bearings that are grease filled with a maintenance interval of 8,000 hours, integral cooling fan, totally enclosed belt guard to protect V-Belt Drive and fully adjustable motor mounting base to achieve belt tensioning.

C. The motor shall be a NEMA rated, ODP, 3600 RPM, with a 1.15 service factory suitable for 208V or 230/460V electrical service. Each compressor shall have a piped intake manifold with one inline inlet air filter with isolation valve and a high inlet vacuum switch to protect the compressor. Each compressor shall be equipped with an integral air-cooled aftercooler designed for a maximum approach temperature of 15 deg. F, complete with integrated drain trap with automatic solenoid drain valve. Each compressor discharge line must include a heat-shielded flex connector, safety relief valve, isolation valve and check valve. The discharge piping of each compressor shall incorporate an integral valve to provide load-less starting and rapid air evacuation between the check valve and scroll discharge at shutdown. Each compressor must be equipped with a wired high discharge air temperature shutdown switch.

D. The compressor module shall be fully isolated from the system base by means of a four-point, heavy duty isolation system for a minimum of 95% isolation efficiency. Where required by local or state regulation, seismically restrained isolators shall be provided.

E. The vertical air receiver shall be corrosion resistant, ASME Coded, National Board Certified, rated for a minimum 150 PSIG design pressure and must include a liquid level gauge glass, safety relief valve, manual drain valve, and a zero loss electronic drain valve.

F. The Duplex Dryer System shall be comprised of two (2) twin tower desiccant dryers, pre-filters, afterfilters, regulators, safety relief valves, and integral purge saving control system within a four-valve bypass arrangement. This dryer/filter package shall be sized to handle full system capacity. Each dryer shall be capable of producing a - 12 deg. C (10 deg. F) pressure dew point at 100 psig. Dryer purge flow shall be minimized through an integral demand based purge saving control system that shall include a 441 transfer valve utilizing 2 ceramic slide plates that is covered by a 5-year factory warranty. The inlet to each dryer shall include a mounted pre-filter rated for 0.01 micron with automatic drain and element change indicator. Fully duplexed final line filters rated for 0.01 micron with element change indicators and duplexed final line regulators with duplexed safety relief valves shall be factory mounted and piped.

G. The Duplex mounted and wired TotalAlert Embedded control system is to be UL labeled and be a registered BACnet device. This control system shall provide automatic lead/lag sequencing and automatic lead/lag sequencing and alternation of all compressors based on first-on/first-off principle with provision for simultaneous operation if required. Control panel to include:

1. Circuit breaker disconnects for each compressor module with external operators (including controls for future pump)
2. full voltage motor starters with overload protection
3. 24V control circuit for safety

H. The touch screen controls feature one 5.7” master screen and a 3.5” operating screen for each compressor. Screen displays and functions are to be as follows:

1. Service alerts, runtime hour meters, system status, system pressure level, dew point level, CO level.
2. Visual/audible alarm indications with isolated contacts for all standard remote alarms
3. Event log recording alarms and system activity
4. Event log recording service warnings and service history
5. Trend graphs for outlet pressure, Dew Point, CO and ambient temperature
6. Ethernet connectivity and embedded web page for remote monitoring
7. Integral connectivity to the TotalAlert medical gas network via Ethernet

I. Manufacturer must have factory authorized service representation in the area and start up and owner training as part of the system offering. The system warranty must be no less than two (2) years from date of shipment or 2-1/2 years from date of start-up, whichever occurs first.

2.04 MEDICAL VACUUM PUMP SYSTEM

A. Furnish and install per plans and specifications one (1) BeaconMedaes Model VHS-10D-200V - SPLduplex oil-less rotary claw medical vacuum system with Variable Speed Controls. Approved equals shall be Ohio Medical and Amico. The package is to consist of two (2) 10 HP oil-less rotary claw vacuum pumps, each rated for 87 SCFM @ 19” HgV, complete with a duplex control panel all mounted on a common base frame. The common base must be separable for transport through standard 34.5” doorway. System is to be designed and manufactured with ISO 13485 processes, each system is completely tested prior to shipment and is to include:

1. Two (2) oil-less claw rotary vacuum pumps with motors.
2. Integral pre-wired control panel with variable speed drive inverter.
3. Individual power feeds for each motor circuit.
4. Vertical Air receiver with full size three-valve bypass system sized for appropriate demand

B. The 200 Gallon Vertical vacuum receiver tank is to be ASME-coded and have a three-valve bypass system to allow for draining of the receiver without interrupting the vacuum service. A manual drain is to be provided on receiver. Each pump and the receiver is connected to a common intake manifold. A single point of connection to the intake of the system is provided. A single point of connection to the electrical panel of the system is also required. The package must be completely tested prior to shipment.

C. Each pump is to be direct driven by a 10 HP motor and feature a non-contacting claw capable of operating down to 25.5” HgV continuous duty @ sea level. The pumping chamber is to be oil-free.

The pump must be completely air-cooled with no water requirements. The pump is to have an inlet air filter and be equipped with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, high discharge temperature switch, oil drain valve and oil sight glass.

D. The motors are to be continuous duty, NEMA rated, C-face, TEFC, 3450 RPM with a 1.15 service factor suitable for 480V-3PH-60HZ, 3-phase electrical service.

E. Each vacuum pump is to have a factory piped intake with integral flex connector, isolation valve, and check valve. Interconnecting piping is to consist of powder-coated steel tubing and flanges.

F. The vacuum receiver tank is to be a 200 gallon ASME code stamped and rated for a minimum of 150 psig design pressure.

G. Each vacuum pump is to be factory piped to an exhaust manifold with integral flex connector, isolation valve and drip leg with ball valve and condensate drain Interconnecting piping to consist of powder-coated steel tubing and flanges. An exhaust muffler is shipped loose. The duplex mounted and wired TotalAlert Embedded control system is to be U.L. labeled and be a registered BACnet device. The control system is to provide automatic lead/lag sequencing and automatic alternation of vacuum pumps based on first-on/first-off principle with provision for simultaneous operation if required. Automatic activation of reserve unit, if required, will activate an audible alarm as well as a visual alarm on the display screen. Additional components will include:

1. single variable speed
2. circuit breaker disconnects with external operators for each vacuum pump
3. full voltage motor starters with overload protection
4. Individual power feeds for each motor circuit.
5. 24V control circuit

H. A touch screen control which features one 5.7” master screen and a 3.5” operating screen for each vacuum pump to be included. Screen displays and functions to include:

1. Service Alerts, runtime hourmeters for each pump, system status, system vacuum level
2. Visual/audible alarm indications w/ isolated contacts for all standard remote alarms
3. Event log recording alarms and system activity
4. Event log recording service warnings and service history
5. Trend graphs for vacuum level, pump operations, and ambient temperature
6. Ethernet connectivity and embedded web page for remote monitoring
7. Electronic notifications of alarms and warnings.
8. Integral connectivity to the TotalAlert medical gas network via Ethernet

I. System shall be warranted to be free of defects in material and workmanship under normal use for a period not to exceed thirty (30) months from date of shipment, or twenty-four (24) months from date of start-up.

2.05 TRIPLEX DENTAL VACUUM SYSTEM (ORAL EVACUATION)

A. General

1. The system shall be a central high volume type oral evacuation system for dental use, designed to remove liquids and debris generated during dental treatment procedures. The equipment and controls specified herein shall be as manufactured by The Spencer Turbine Company (local office (508) 839-6157). The equipment and controls contained herein shall be installed as shown on the plumbing drawings.

B. System Components

1. The central high volume evacuation system will generally consist of the following:

   a. Three (3) - Vacuum Producer Units (VP1, VP2 and VP3) & Electro-Mechanical Accessories
   b. Recommended Spare Parts
   c. One (1) - Central Liquid/Air Separator with Auto Discharge Pump Assembly
   d. One - Electronic Modulating Air-Bleed Assembly (Anti-Surge System)
   e. One (1) - Master Control Panel
   f. Four (4) - Combination Starter Panels
   g. Piping System
   h. Level Switch for Amalgam Holding Tank
   i. Non-invasive totalizing liquid flow-meter

C. Design

1. The system shall be capable of supporting one hundred sixty one (161) total point-of-use inlet ports (each port equivalent to a 9.0 mm or 0.34 open orifice). Each vacuum producer shall have a designed performance rating of 1,050 SCFM (1,433 ICFM) at 8.0" Hg vacuum as measured at the vacuum producer air inlet when handling air at 1.0 specific gravity, 36% relative humidity, 68º F and discharge pressure of 14.7 PSIA.
2. The three (3) vacuum producers shall be connected in parallel, with each vacuum producer capable of handling 50% of the required demand as outlined above, thus assuring complete standby capability in the event (1) unit should be out of service. The electronic and mechanical controls shall be designed and arranged as to enable the vacuum producers to alternate in service.

D. Detailed Description

1. Vacuum Producer

   a. Each Multistage Centrifugal Vacuum Producer shall be a Spencer Turbine Power Mizer Model No. CS32R26. Impellers shall be mounted on one shaft supported on each end by bearings mounted in the outboard bearing housings. The vacuum producers shall be built from parts cast in patterns from which previous units have been built and tested. Vacuum producers shall be of domestic origin and of manufacturer’s standard design.

2. Casing

   a. The casing shall consist of cast iron sections held securely between cast iron inlet and outlet heads with steel tie rods. The casing shall be constructed of high strength ASTM A48, Class 30 cast iron, suitably ribbed to withstand the stresses and strains of normal service at full operating pressure. The Inlet and Outlet connections shall be 8-inch diameter ANSI 125 lb. drilled and tapped flange pattern and shall be an integral part of the heads.

3. Impellers

   a. The impellers shall be one-piece cast aluminum with the spacing hubs an integral part of the impeller casting. The impellers shall be keyed to the shaft with a one-piece key which extends the entire length of the impeller hub. Impellers shall be individually machine balanced, and shall be individually replaceable without requiring dynamic rebalancing of the entire rotating assembly to maintain factory vibration specifications. Vibration shall not exceed 1.25 mils in the vertical plane when measured at the vacuum producer bearing housing.

4. Diffusers

   a. The diffuser sections, which receive air from the impeller and guide the air into the next impeller shall be provided with diffusing vanes and shall be an integral part of the section casting.

5. Shaft

   a. The vacuum producer shaft shall be AISI 1045 steel or better, accurately machined and ground to size. The shaft shall be of ample size to carry the loads imposed under continuous service. Where the shaft passes through the inlet and outlet head, seals shall be provided to prevent leakage. Seals shall be labyrinth type or carbon rings and shall be replaceable. Interstage shaft seals shall be provided to insure minimum leakage between stages.

6. Bearings

   a. The vacuum producer shall be provided with oil-lubricated anti-friction bearings of ample size to carry the loads imposed under continuous service without overheating. Bearings shall be of sufficient size to have a minimum B-10 life in accordance with AFBMA standards of 75,000 hours under normal conditions of operation. Bearing housing shall be designed so that the complete rotating element can be lubricated, inspected or replaced without disconnecting any piping or disassembling the blower.
   b. Lubrication shall be accomplished by means of constant level oilers on the bearing housing. For protection of bearings during shipment and installation, the bearings shall be properly processed with Esso Standard Oil Company “Rust Bane” or equal. Labyrinth type seals shall be provided between the bearings and the shaft seals to prevent lubricant leakage and to prevent the air from being contaminated by the lubricant.

7. Coupling

   a. The vacuum producer shall be directly connected to the drive motor by means of a flexible gear type coupling rated for continuous service. The coupling shall be covered by an OSHA-Approved coupling guard.

8. Motor

   a. Each motor shall be of the horizontal squirrel cage induction type and shall be built in accordance with latest NEMA, IEEE, ANSI and AFBMA standards where applicable. The motor rotation shall be coordinated with the vacuum producers specified above.
   b. The motor shall have a premium efficiency rating, be suitable for operation at 460 volts, 3 phase, 60 Hz and shall have a 1.15 service factor with Class F insulation. Each motor shall be rated 40-HP at the full load speed of 3600 RPM and shall include an internal high motor temperature switch with leads contained in the exterior connection box. The motor enclosure shall be TEFC.
   c. The motor frame and end shields shall be heavy fabricated steel or cast iron of such design and proportions as to hold all motor components rigidly in proper position and provide adequate protection for the type of enclosure specified. Lifting lug “O” type bolts shall be supplied and the nameplates shall be stainless steel.
   d. The shaft shall be made of high-grade machine steel or steel forging of size and design adequate to withstand the load stresses normally encountered in the motors of this particular rating.
   e. Bearings shall be of the grease lubricated ball type with an AFBMA B-10 minimum life of 75,000 hours.

9. Baseplate and Mounting Pads

   a. A common baseplate fabricated from ASTM A36 structural steel shall be provided for the vacuum producer/motor assembly. The baseplate shall be constructed to support the full weight of the vacuum producer, motor and accessories. Suitable resilient foundation mounting pads shall be provided.

E. Vacuum Producer Mechanical Accessories:

1. Flexible Connectors

   a. An 8-inch flanged flexible connector shall be provided for each Vacuum Producer Inlet and Outlet. Flexible connectors are designed to alleviate stresses caused by thermal expansion and contraction in the piping system, and shall be capable of withstanding the pressure under all operating conditions and temperatures to 250°F. The expansion joint connectors shall be equipped with full-faced flanges, having ANSI 125 lb. drilling.

2. Throttling/Isolation Valves

   a. Butterfly-type valves shall be provided for the inlet and outlet of each vacuum producer with inlet adapter spool (one (1) spool per vacuum producer, if required). Valves and spools shall be of 8-inch diameter. Valves shall have a corrosion resistant shaft, steel or cast iron shutter, a resilient seat with cast iron lug body designed for air-tight service, hand-operated locking lever. They shall enable both throttling and positive isolation of the vacuum producer. Each valve shall be rated for a minimum of 15 PSIG and 250º F.

3. Check Valves

   a. An 8-inch diameter flanged check valve shall be provided for each vacuum producer inlet. Each valve shall consist of a full- aluminum discs, hinge post & clamp and flexible sealing member. The valve discs shall be designed such that when there is no flow, the discs shall be held tightly against the interior wall of the valve body, providing an airtight seal to prevent reverse flow.

4. Silencer

   a. A discharge air noise silencer shall be provided for the discharge of each Vacuum Producer. The silencer shall be an absorptive type with double wall steel housing, acoustic packing and ANSI 125/150 drilled flanged ends of the same diameter as the vacuum producer discharge.

5. Acoustical Jacket

   a. The complete Vacuum Producer exterior casing shall be blanketed with a removable “tailor-fitted” Acoustical Jacket constructed of flexible sound abating materials.
   b. Vacuum Producer & Motor assembly as equipped shall have an estimated noise level of 86 dB(A) when measured at a distance of three (3) feet in a free-field environment.

6. Bearing Temperature Monitors

   a. A Spencer Bearing Temperature Monitor shall be provided for each vacuum producer. The monitor shall shut down the vacuum producer in the event that either the inboard or outboard bearing should reach a temperature determined to be injurious to the bearing life span. During shut down a light on the master control panel shall indicate which bearing caused the shutdown. The control shall be such that the blower will not restart until the bearing has cooled, or has been replaced, and the reset button is activated. A heat sensitive 100 ohm platinum RTD shall be mounted on the inboard and outboard bearing housing of each vacuum producer with electronic controls contained in the Master Control Panel.

7. Vibration Monitor

   a. A vibration transmitter with 4-20 mA output shall be mounted on inboard and outboard VP bearing housings to monitor the overall vibration level of each VP bearing housing with electronic controls contained in the Master Control Panel.

8. Surge Control

   a. One (1) Electronic Modulating Air-Bleed Assembly (EMBC) common to all vacuum producers shall be provided. The EMBC shall include a motor-actuated full port ball valve, inline-mounting tee, air inlet noise silencer with rubber sleeve, safety screen, necessary components to join these components and electronic controls to be contained in the Master Control Panel.

F. Central Air/Liquid Separator:

1. The Central Air/Liquid Separator shall be a cylindrical shaped vessel capable of withstanding the maximum system vacuum. The separator shall be constructed of a non-metallic, inert, fiberglass reinforced plastic (FRP) with a premium grade vinyl ester resin bonded to the interior. The separator bottom shall be convex with a drain connection located at the apex. The Separator shall be supported by four bolted carbon steel legs and have a white gel coat with UV inhibitor exterior finish.

2. The vessel shall have a dished shaped bottom with a centered 4-inch flanged stub, flanged elbow, pipe extension with 1-inch male pipe stub, 4-inch hand operated discharge valve sandwiched between two flanges, terminating with 4-inch FPT, four welded legs with feet raising the vessel off the floor for ease of discharge pipe fitting connections. The separator shall be 50-inch diameter, have a maximum capacity of (307) gallons and shall have a 12inch diameter inspection port, 10-inch diameter flanged tangential inlet, 10-inch diameter flanged top axial outlet, wash down assembly with outside connection for provided solenoid valve and domestic water supply, liquid level sight glass with liquid sampling port, radial connection terminating to a funnel with a valve assembly for insertion of disinfectants to the vessel at shut-down, 3-probe-style level switch for high-level discharge pump activation, low-level pump shut-off and High Separator Level Alarm (three level probes shall be housed in a separate vessel having a field adjustable mounting bracket that will mate to receiving bracket on separator exterior), a mechanical ball float shut-off positioned at the air outlet, Inlet/outlet vacuum taps for “Separator Blockage Alarm” vacuum switches. Also included shall be a ¾-HP, 460 volt, 3-Phase, 60 Hz, 3500 RPM, TEFC motor driven pump rated for 60 GPM @ 10 ft. of head with necessary components including a check valve for automatic discharging of collected liquids upon high level collection. The pump assembly shall be field installed. A non-invasive totalizing flow-meter shall be supplied for field installation on pump discharge piping. The flowmeter shall provide visual indication of liquid volume discharge (gallons) and shall include a counter and 4-20 mA output for facility BMS.

G. Vacuum Piping System:

1. Piping

   a. Refer to Section 221120 – Plumbing Distribution Piping
   b. Sizing shall be in accordance with the plumbing drawings (by others).

2. Fittings

   a. Refer to Section 221120 – Plumbing Distribution Piping
   b. Fittings should be of long sweep design and of same material as the piping. 90 degree elbows are not permitted.

3. Joining Method

   a. Refer to Section 221120 – PLUMBING DISTRIBUTION PIPING

H. Starter and Control Panels:

1. Four (4) Combination Starter Panels shall be provided and shipped loose for field installation by contractors. These Starter Panels will provide power to three (3) Vacuum Producers and one (1) Separator Effluent Discharge Pump. The Starter Panels will be powered from facility 480 volt, 3 phase, 60 Hz power supply.

2. One (1) Master Control Panel shall be provided. It will include 120 VAC controls only designed to control operation of the above Combination Starter Panels in addition to all other Spencer-supplied System Components & Controls. This Master Control Panel will be powered from facility 120 volt, single phase, 60 cycle power supply.
3. Electrical power and interfacing wiring between all system components to be provided and installed by electrical contractor (wiring schematic to be provided by Spencer).
4. Provide one (1) Spencer NEMA-12 UL-Listed Control Panel designed to control operation of three (3) Vacuum Producers (VP1, VP2, & VP3), and one (1) Central Air/Liquid Separator as equipped.
5. The control panel shall be manufactured by the vacuum equipment manufacturer to be built in accordance with UL508A Standards for Industrial Control Panels and shall include:

    a. One (1) - OSHA type lock-out/tag-out disconnect circuit breaker for 120 volt, single-phase ,60 Hz supply power
    b. Provisions for controlling START/STOP of two (2) Spencer Remote Starter Panels, each containing a Motor Starter and circuit breaker disconnect with auxiliary contact for a 40-hp, 460 volt, 3 phase, 60 Hz Vacuum Producer (VP)
    c. Provisions for controlling START/STOP of one (1) Spencer Remote Starter Panel containing a Motor Starter and circuit breaker disconnect with auxiliary contact for a ¾-hp, 460 volt, 3 phase, 60 Hz VP Motor Separator Effluent Discharge Pump
    d. One (1) - OFF / VP1 / VP2 / VP3 / AUTO - Selector Switch

        OFF - Off
        VP1 - Enables manual start/shutdown of Vacuum Producer (VP1) via local start/stop push buttons
        VP2 - Enables manual start/shutdown of VP2 via local start/stop push buttons
        VP3 - Enables manual start/shutdown of VP3 via local start/stop push buttons
        AUTO - Enables automatic controlling of the all VPs based on the Auto-Mode Selector Switch (AMSS) setting.

        “Auto-Intermittent” Setting - The system will “start” and “shutdown” based on preset “start/shutdown” times/days of operation as set in the 24/7/365 field programmable clock controller (ie: System to run Monday through Friday, from 7:00 A.M. to 5:00 P.M.). Alternation of VPs shall occur upon each start/shutdown sequence.

        “Auto-Continuous” Setting - The system shall run continuously (24/7) without interruption.

        Alternation of VP’s shall occur at a preset time/day in the local “Alternation Clock-Controller” (ie: VP alternation to occur every Monday at 7:00 A.M.). When VP alternation occurs in the “24/7” setting, the sequential stand-by VP shall start and the previously on-line VP shall have a delayed shutdown to allow the new on-line VP time come up to speed, thus providing the required vacuum and flow to insure uninterrupted service.

        In either Auto-Mode Setting, a stand-by VP shall start when the maximum capacity of the on-line VP is reached, thus enabling both VPs to share the increased load. The sequential VP will shut down after a minimum “run time’ when the additional capacity is no longer required. This insures that the increased demand shall be met up to 100% of designed demand.

    e. One (1) - Set of Start/Stop/Reset push buttons
    f. Provisions to alternate VPs based when in any Auto-Mode Setting

g. Provisions to enable operator setting of day and time for auto operation of Separator overhead wash down cycling
h. Provisions to start stand-by VP when maximum capacity of on-line booster is reached and shutdown the sequential VP when added capacity is no longer required
i. One (1) - Visual Setpoint Electronic Modulating Air Bleed Controller, with visual display of current draw in amperes, calibrated flow in SCFM of each on-line VP motor and provision for manual control of the EMBC Valves for start-up and test procedures (current transformers contained in remote VP Starter Panels)
j. Provisions for display of each VP motor current and calibrated volume in SCFM
k. One (1) - H-O-A Selector Switch for Separator discharge pump

H - Hold to RUN Pump/Spring Return to STOP
O - OFF
A - Automatic Pump Operation – Pump will activate via HIGH LEVEL probe/switch mounted on Separator. Pump will then RUN at field selectable ON/OFF TIME durations (adjustable via Panel OIT) until Separator reaches low level probes. Minimum OFF TIME intervals (ie: 20 minutes) must be maintained to prevent short-cycling of pump motor. This will enable smaller volume batches of effluent feed to downstream amalgam separator (amalgam separator provided by others).

l. Provisions to start/stop the Central Air-Liquid Separator discharge pump per high/low level signaling from level control when Separator H-O-A Switch is in the AUTO position
m. One (1) - Level Controller to monitor liquid level in separator, start stop pump and energize warning light and horn for pump failure.
n. Provisions for remote liquid flow meter to provide visual indication of liquid volume discharge (gallons) and shall include a counter and 4-20 mA output for facility BMS.
o. Provision to start/stop separator wash down at preset time intervals
p. One (1) - H-O-A Selector Switch for Separator Overhead Auto-Washdown (enables manual controlling)

1) Activates overhead washdown system

a) O -OFF
b) A - Enables AUTO controlling of washdown cycling

q. Provisions remote level switch to energize a warning light and sound local alarm in the event of “High Liquid Level” in AMALGAM Holding tank
r. Provisions to energize a warning light and sound local alarm in the event of “High Liquid Level” in Central Air/Liquid Separator.
s. Provision to immediately start stand-by VP, energize a corresponding VP “Start Fault” warning light and sound local alarm if the targeted VP fails to start upon “start command”
t. Provisions to immediately start stand-by VP, energize a corresponding “VP Motor Failure” warning light and sound local alarm upon any VP motor failure
u. Provisions to immediately start stand-by VP, energize a corresponding “VP High Inboard or Outboard Bearing Temperature” warning light and sound local alarm upon detection of any high VP bearing temperature
v. Provisions to immediately start stand-by VP, energize a corresponding “VP High Inboard or Outboard Bearing Vibration” warning light and sound local alarm upon detection of any high VP bearing vibration
w. Six (6) Setpoint controllers to accept (6) inboard and outboard bearing RTD’s to energize warning light, alarm horn and shutdown the vacuum producer on “High Inboard Bearing Temp” and “High Outboard Bearing Temp” two per machine.

x. Six (6) Setpoint controllers to accept (6) inboard and outboard bearing Vibration Transmitters to energize warning light, alarm horn and shutdown the vacuum producer on “High Inboard Bearing Vibration” and “High Outboard Bearing Vibration” two per machine.
y. Panel Display lights for:

1) Power "ON"
2) VP1/VP2/VP3 - "RUNNING"
3) VP1/VP2/VP3 - Start Fault
4) VP1/VP2/VP3 - Motor Failure
5) VP1/VP2/VP3 - High VP Inboard Bearing Temperature
6) VP1/VP2/VP3 - High VP Outboard Bearing Temperature
7) VP1/VP2/VP3 - High VP Inboard Bearing Vibration
8) VP1/VP2/VP3 - High VP Outboard Bearing Vibration
9) VP1/VP2/VP3 - High Motor Temperature
10) High Liquid Level in Separator
11) High Liquid Level in AMALGAM Holding tank
12) Separator Discharge Pump “ON”

z. One (1) - Lamp Test push button to energize all pilot lights for a lamp test
aa. Provide dry output contacts (field selectable NO/NC) for Common Local Alarm signaling to Facility BMS
bb. One (1) - Alarm horn, mounted in panel door with reset and silence push buttons
cc. Provisions for three (3) elapsed “run time” hour meters
dd. Miscellaneous components and hardware to assure proper functioning

I. Combination Starter Panels:

1. Provide four (4) Spencer Remote NEMA-12 UL-Listed 460 volt, 3 phase, 60 Hz Spencer Combination Starter Panels (CSP) to be built in accordance with UL508A Standards for Industrial Control Panels.

2. CSP1, CSP2 & CSP3 will provide facility power to three (3) Vacuum Producers (VP1, VP2 & VP3) and CSP4 will provide facility power to the Spencer Air-Liquid Separator Effluent Discharge Pump. All four (4) Starter Panels will be powered from facility 480 volt, 3 phase, 60 Hz power supply.

3. CSP1, CSP2 & CSP3 will each include:

a. One (1) – OSHA type lock-out/tag-out power disconnect circuit breaker with auxiliary contact to indicate position and contact to indicate tripped.
b. One (1) – ATL magnetic, non-reversing motor starters auxiliary contact for on/off and one for tripped for one (1) 40-HP/460/3/60 Motor
c. One (1) Current Transformer for continuous current draw monitoring of VP Motor
d. One (1) – Set of start/stop push buttons
e. One (1) – Power ON light
f. One (1) – VP RUNNING light
g. One (1) – HAND-OFF-AUTO Selector Switch with auxiliary contacts to indicate selector position

1) HAND - Enables manual start/shutdown of VP via local panel start/stop push buttons
2) OFF - Off
3) AUTO - Enables automatic operation of VP via control settings in the Master Control Panel

h. CSP4 will include:

1) One (1) – OSHA type lock-out/tag-out power disconnect circuit breaker with auxiliary contact to indicate position and contact to indicate tripped.
2) One (1) – ATL magnetic, non-reversing motor starters auxiliary contact for on/off and one for tripped for one (1) ¾-HP/460/3/60 Motor
3) One (1) – Set of start/stop push buttons
4) One (1) – Power ON light
5) One (1) – Pump RUNNING light
6) One (1) – HAND-OFF-AUTO Selector Switch with auxiliary contacts to indicate selector position

a) HAND - Enables manual start/shutdown of Pump via local panel start/stop push buttons
b) OFF - Off
c) AUTO - Enables automatic operation of Pump via operational settings in the Master Control Panel

J. Operation And Maintenance Manuals

1. Prior to delivery of equipment the manufacturer shall furnish handling, installing and operating instruction manuals that shall include the following information:

a. Guide to “trouble shooting”
b. Assembly, installation, and alignment instructions.
c. Operating instructions.
d. Maintenance instructions including schedules of routine maintenance and lubrication checks.

K. Spare Parts

1. The following spare parts shall be provided:

a. One (1) set Blower Bearings
b. One (1) set Blower Gaskets
c. One (1) ea. Shaft Coupling

L. Surface Preparation And Shop Painting

1. Surface preparation and shop priming shall be manufacturer’s standard.

M. Factory Testing

1. Each vacuum producer shall be given a factory test to assure mechanical integrity. In addition each vacuum producer will be subjected to a performance test which shall monitor the vacuum developed and power consumption as a function of the flow rate. A certified performance curve of the actual test data shall be made available. In addition, a vibration check shall be made to ensure the vibration amplitude shall not exceed 1.25 mils. If either test indicates hat adjustments are necessary to insure conformance to the manufacturer’s standards, such adjustments shall be made prior to shipment.

2. Start-Up

a. Contractor shall provide start-up service of the system by manufacturer's factory service technicians and factory-trained manufacturer's representative. Start-up service shall include inspection of overall installation, laser alignment of all Vacuum Producer mechanical couplings, setting & adjustment of all controls, initial start-up and running of the system, confirmation of all automated and alarm functions, vacuum test, and operational and maintenance instruction of owner's designated personnel.

N. Warranty:

1. Manufacturer shall warranty to replace or properly repair equipment and materials in which defects develop within a period of or eighteen (18) months from the date of shipment or twelve (12) months from date of start-up, whichever occurs first.

2.06 DENTAL AIR SYSTEM

A. Furnish per plans and specs a BeaconMedaes Model ZTM-55D-D400-TCV Duplex rotary tooth compressed air system furnished as a modular base mounted package comprised of two (2) 75 HP compressor modules, each with a variable speed drive arrangement, a dryer control module and air receiver module. Each module is fully compliant with the latest edition of NFPA 99. System NFPA rated capacity to be 88-303 CFM with one pump in reserve.

B. The compressor modules are fully enclosed with a sound attenuated steel panel with full access doors for maintenance and inspection. Each compressor module includes the compressor, drive motor and variable speed drive, oil system and compressor control system. The compressor intake is equipped with an air intake filter and integral shut off/unloading valve.

C. Unloading is carried out by closing the intake valve. Loading or unloading of the unit is controlled by a pressure transducer which will activate the loading solenoid valve. The air discharge for the compressor module has a pulsation damper, check valve, and manual isolation valve. Ventilation for the module is supplied by a radial fan with a separate motor. The control system will display the runtime hours, temperature readouts, pressure readouts, service indicators, safety warnings, and safety shutdowns for the compressor module.

D. The compressor is a two-stage oil free compressor block, consisting of a separate low and high pressure rotary tooth compressor element, flanged to a common step-up gearbox. The compressor elements are air cooled. The high and low compressor elements are supplied with safety relief valves. The first stage air is cooled by an intercooler with moisture trap and automatic drain valve. The second stage air is cooled by an after cooler with moisture trap with manual and automatic drain valve. The gearbox oil system includes an oil sump, oil filter, by-pass valve, drain connection, sight glass and cooler.

E. Compressor shall be direct driven. Torque is transmitted from motor to compressor through a flexible shaft coupling. The motor shall be flanged mounted, high efficiency motor, 3600 RPM, with a 1.15 service factor suitable for 230 or 460 Volt, 60 Hertz, 3 Phase electrical service.

F. Compressor and motor shall be fully isolated from main module base by means of heavy duty isolation system for a minimum of 95% efficiency.

G. Dryer/Control module shall include a central control system to control multiple compressors and a duplexed desiccant drying system with a dew point hygrometer. Each dryer includes inlet filters, final line filters and regulators. All of above shall be factory piped and wired and include valving to allow complete air receiver by-pass and air sampling port.

H. Each desiccant dryer must be individually sized for peak calculated demand and capable of producing -40 deg. F pressure dew point. Dryer purge flow shall be minimized through an integral demand based purge saving control system. The inlet to each dryer shall include 1 micron coalescing filter and .01 micron high efficiency coalescing filter with auto drains. The duplex final line filters consist of a 1 micron particulate filter and one active carbon filter, a duplex final line regulator, single oil indicator and duplex safety relief valves to be factory mounted and piped. All filters shall have element change indicators.

I. The mounted and wired central control system shall be a NEMA 12 UL labeled panel and rated for 115 Volt single phase electrical service. The control system shall provide automatic lead/lag sequencing, visual and audible reserve unit alarm with isolated contacts for remote alarm. Automatic alternation of all compressors based on first on/first off principle with provisions for simultaneous operation if required, automatic activation of reserve unit if required, visual and audible alarm indication for high discharge air temperature shutdown with isolated contacts for remote alarm shall be included.

J. Dryer/control module to incorporate a dewpoint/CO transmitter that is mounted and wired. Dew Point/CO will be displayed on the central control system.

K. A vertical 400 gallon air receiver to be ASME coded, National Board Certified , galvanized, rated for a minimum of 150 psig design working pressure to be included, complete with liquid level site glass, pressure gauge, safety relief valve, manual drain valve and automatic solenoid drain valve.

L. System to be factory warranted for a period of up to 30 months from date of shipment.

2.07 MEDICAL GAS OUTLETS AND CONNECTIONS

A. Medical gas station outlets/inlets shall be UL listed, and compliant with NFPA 99, 2002 Edition, recessed, non-interchangeable interlocking stainless steel faceplate, complete with rough-in box, washed and capped Type "K" copper pigtail, and secondary check valve. Provide vacuum slide at each vacuum outlet. All outlets shall be as scheduled and oriented in accordance with the schedule on the documents and in accordance with the architectural headwall elevations.

1. Quick Connect:	Beacon Medaes	Amico	Ohio Medical
a. Oxygen:	6-121020-00		
b. Nitrous Oxide:	6-121021-00		
c. Air:	6-121022-00		
d. Vacuum:	6-121023-00		
e. WAGD:	6-121029-00		
f. Slide Bracket:	6-120978-00		

B. Medical Support Gas: Nitrogen Control Panel and Outlet

1. Nitrogen control panels shall be designed to deliver variable pressures to power pneumatic surgical tools.

2. Located immediately upstream of this gauge shall be a supply line shut-off valve, rated at not less than 300 psig. A quarter turn of the valve handle shall be required to obtain a fully “open” or “closed” position.
3. An adjustable self-relieving type pressure regulator, with an operating range of 12 to 250 psig shall provide required pressure to the service outlet.
4. The control panel shall be pre-piped internally requiring only external supply line connections. Additional outlets in the same room may be connected to the remote outlet pigtail furnished in the control panel. Remote outlets shall be regulated by the adjustable pressure regulator within the panel and shall match the nitrogen control panel outlet.
5. The control panel shall be available in horizontal or vertical orientation.
6. Nitrogen control panel shall be Beacon Medaes Model 6-120276-4-00, Ohio Medical or Amico, with DISS outlet, inlet and outlet pressure gauges, ¼-turn shutoff valve and pressure regulator mounted in a rough-in assembly complete with cover plate.
7. Instrument air control panel shall be Beacon Medaes Model 6-120274-00, Ohio Medical or Amico with DISS outlet, inlet and outlet pressure gauges, 1/4 turn shut-off vale and pressure regulator mounted in a rough-in assembly with cover plate.

2.08 MEDICAL GAS AND MEDICAL VACUUM ALARMS

A. Medical Gas (Air, Oxygen, Nitrous Oxide, Nitrogen, Air) and Medical Vacuum (Patient, Medical) shall be alarmed. The electrical contractor shall provide necessary 120 volt wiring from the life safety branch of the emergency power system and conduit for the operation of all medical gas alarm panels. Control and interlocking wiring and conduit shall be furnished and installed by this Subcontractor, including wiring of pressure switches, gas manifolds, tanks farms and equipment to master alarm panels and wiring of pulse sensors/transducers to area alarm panels.

1. The medical gas alarm system shall be Beacon Medaes TotalAlert™ Alarm Network System, Series 6819, Amico or Ohio Medical and shall comply with NFPA 99 2002 Edition.
2. The Alarm Network shall be a fully electronic monitoring system. It monitors and displays the status of all piped gas and vacuum systems that are in a typical healthcare facility by using Master Alarms, Area Alarms, and Local Alarms that monitor the following:

   a. Medical gas and vacuum supplies; Mainline pressure and vacuum; Area zone pressure and vacuum, selected compressor operating conditions, selected vacuum pump operating conditions, selected manifold operating conditions, and other source equipment conditions per the drawings.

3. The Alarm Network shall provide the capability to browse, download, configure, and troubleshoot Master Alarms and Area Alarms using the facility’s terminals and/or a personal computer that is connected to the facility’s Ethernet. The alarm’s Web pages are built-in; no additional software or setup is required.
4. The alarm system shall be capable of, when any alarms or events occur on the network, display the message, sound its alarm, and save the information in an event log. This event log can be downloaded to a computer file for tracking data and troubleshooting.
5. The alarm system shall be capable of, when there is an alarm condition, sending up to five electronic messages (page, e-mails, etc.) to notify the appropriate personnel whenever an alarm occurs.

B. Master Alarms

1. Shall be capable of continuously monitoring either 30 or 60 input signals, being supervised for open circuits.
2. Shall be capable of interfacing with conventional building automation equipment by using dry-contact, normally open or normally closed relay contacts. Alarm shall include Building Automation System N2 mapping.
3. Power requirements shall be 120 VAC, 60 Hz, critical branch.
4. Accessory Components: Appropriate signals (required by NFPA 99) shall be provided.
5. Alarm system shall be complete with the needed remote sensing switches and gauges. DISS Demand Checks are required for both switches and main line gauges.
6. The master alarms shall be configurable (3) ways: via the front panel of the alarm; with a computer directly connected to the alarm; or through the facility's Ethernet system.
7. Signal cabling requirements are: maximum distance – 10,000 feet; signal cable-stranded, 22-gauge, shielded, twisted-pair; signal power – 20 V DC. 20 mA maximum.
8. Master Alarm Points

ALARM		SENSING DEVICE	DEVICE LOCATION
Medical Air	Low Line Pressure Main	Contacts	Outlet Side Source Valve
Medical Air	High Line Pressure Main	Contacts	Outlet Side Source Valve
Medical Air	Dewpoint High	Contacts	Control Panel
Medical Air	Carbon Monoxide High	Contacts	Control Panel
Medical Air	Lag Compressor in Use	Contacts	Control Panel
Medical Vacuum	Low Vacuum Main	Vacuum Switch	Inlet Side Main Valve
Medical Vacuum	Lag Pump in Use	Contacts	Control Panel
Medical Vacuum	Inlet Temperature High	Contacts	Control Panel

C. Area Alarms

1. The Area Alarm shall continuously display the actual pressure or vacuum of the type of gas being monitored, unless there is an alarm error. In that case, the error code displays.
2. The alarm shall provide separate Normal, High and Low LED indicators on each module: a green LED is used for Normal Conditions and red LED's are used for High and Low alarm conditions. An audible alarm is mounted on the P.C. Board inside the front panel.
3. During normal operation, the Test Key on each module starts a self-diagnostic routine of the seven segment displays, the LEDs, and the audible alarm.
4. Gas-specific transducers remotely monitor pressure and vacuum lines. The transducers are provided with the Area Alarm, are gas specific and include DISS gas specific demand valve installed at the factory.
5. Transducers shall transmit a digital signal to their respective gas-specific Area Alarm Modules at a distance up to 4500'. Signal cable shall be stranded, 22-gauge, shielded, twisted-pair. Transducers shall receive their power from their respective Area Alarm Modules.
6. Transducers shall be housed in a transparent enclosure and have an LED inside the housing used to indicate proper function.

7. Transducers not connected to the appropriate gas-specific Area Alarm Module shall transmit an error message to the Area Alarm Module display.
8. Transducers not performing properly shall transmit an error message to its respective Area Alarm Module display.
9. The alarm shall be configured to the NFPA-99 standard values at the factory, but are field adjustable for high and set-points. Pressing the increment/decrement keys displays the pressure set-points.
10. The Area Alarm has as an optional network communications board that interfaces with the facility's Ethernet via switch or hub. This allows a user to browse and configure the Area Alarm by using a local terminal or personal computer that is logged onto the facility's Ethernet. Area alarm can also be configured from face of unit without the use of a computer.
11. The Area Alarm can be an independent or an integral component of the TotalAlert™ Alarm Network.

D. Combination Alarm: The combination alarm shall be as specified for Master and Area Alarms above, provided in one common housing for both systems.

E. Local Alarm

1. The Local Alarm shall provide connections for monitoring up to 16 signals from source equipment. There shall be individual alarm indicators for each signal. When an alarm condition occurs, the Local Alarm shall provide both an audible and visual indication.
2. The front panel shall have a Test key and a Silence key. Pressing the Test key shall test the LED indicators and audible alarm. Pressing the Silence key shall silence the audible alarm. The LED indicator shall remain lit until the alarm condition is eliminated.
3. Signal cable shall be stranded, 22-gauge, shielded, twisted-pair.
4. The Local Alarm is a stand-alone component of the alarm network.

F. Pressure Switches

1. Pressure medical gas mains shall be equipped with UL listed high/low switch, Beacon Medaes Model 6-129020-01, Ohio Medical or Amico, and shall be controlled by a copper diaphragm type pressure capsule and gas specific check valve.
2. Vacuum mains shall be equipped with a UL listed vacuum switch, Beacon Medaes Model 6-129022-01, Ohio Medical or Amico. The switch shall be a single pole, double throw, snap action type wired to signal either increasing or decreasing vacuum levels and controlled by a copper bellows vacuum sensing element.
3. Nitrogen mains shall be equipped with a UL listed switch, Beacon Medaes Model 6-129021-01, Ohio Medical or Amico with an adjustable range of 0 to 250 psig, adjustable differential of 3 to 30 psi and a maximum pressure rating of 900 psig.
4. Switches and gages shall be fully accessible. Provide access panel where installed above hard ceilings.
5. Provide gas specific demand check valves between pipeline and switch, sensor or gage.

PART 3 EXECUTION

3.01 EXAMINATION / PREPARATION

A. Inspect existing site conditions in areas where piping and equipment will be installed and verify existing systems and the impact of the proposed modifications before fabricating systems to be installed.

B. Notify the Architect immediately regarding any substantially different conditions than those shown in the Contract Documents.

3.02 SYSTEM SHUTDOWN

A. The shutdown of any system shall be coordinated with the Owner's representative, at least (10) days in advance of the proposed shutdown.

B. Provide temporary services to maintain active systems during extended shutdowns as required for demolition, service tie-ins and phasing. Operation of existing shut-off valves shall be by the Owner.

C. Pre-Testing

1. Before any existing medical gas piping is breached, the contractor shall perform a purge (particulate) and concentration test on the existing systems shown being connected to. The test procedure shall be as outlined in these specifications with the exception that the purge test shall be performed with the gas of system designation. Test results shall be recorded and submitted as outlined in these specifications.

3.03 DEMOLITION

A. Refer to Section 220500.

3.04 CORE DRILLING

A. All core drilling required for the installation of the plumbing system is to be done by the Plumbing Subcontractor. This contractor shall carry all costs for core drilling. The General Contractor will not be responsible for any circular penetrations required for the proper installation of the plumbing system. Locate all required openings prior to coring, coordinate the opening with the General Contractor and all other trades. Do not disturb the existing systems. Thoroughly investigate the existing conditions in the vicinity of the required opening prior to coring. This Subcontractor shall be responsible for damages to the building and its systems from the coring operations. Disturbances from coring shall be kept to a minimum.

3.05 MEDICAL GAS PIPING SYSTEMS INSTALLATION

A. The entire medical gas and medical vacuum system shall be installed in accordance with NFPA 99-2002 edition and ASSE 6000 except where amended by these specifications. All tests shall be performed in accordance with NFPA 99 Section 5.1.12 and shall be certified by a qualified 3rd party inspector.

B. The installation of equipment and individual components shall be made in accordance with the instructions of the manufacturer. These instructions shall be submitted to the owner and made part of the operation and maintenance manuals.

C. All piping, valves, fittings and components for medical gas and medical vacuum use shall be supplied cleaned, capped or bagged and prepared and certified for medical oxygen service by the manufacturer and be received sealed on the job.

D. Piping

1. Pipe shall be cut square with a tubing cutter with sharp cutting wheels. All burred ends of all piping and tubing shall be reamed to full bore of the pipe or tube and all chips shall be removed. Piping shall not be bent. Provide fittings for all changes in direction. Tools used in cutting and reaming shall be kept free from oil, grease or other lubricants not suitable for medical oxygen service. All cuts shall be cleaned and restored to original pipe dimensions. Where contamination has occurred, the items affected shall be recleaned in accordance with NFPA 99. Joints shall be brazed within one hour of being cleaned. Two or more medical gas or vacuum systems shall not be interconnected at any time during installation or testing.
2. All brazing shall be performed according to ANSI/AWS C3.4 and by installers certified under ASSE 6010. Brazed joints shall be considered Class B brazed joints. While brazing, all joints shall be continuously purged with nitrogen N.F. Flux shall not be used. Final connections of new piping to existing (in-use) piping shall be made without a nitrogen purge.
3. During and after installation, openings in the piping shall be kept capped by an external cap, except that during brazing, a discharge hole (holes) shall be provided to allow the discharge of purge gas. During brazing, the purge gas flow rate shall be maintained at a level that will not produce excessive positive pressures in the piping system. The flow of purge gas shall be maintained until the joint is cool to the touch. After brazing, the discharge hole (holes) shall be sealed with a nitrogen atmosphere maintained.
4. All joints in the piping shall be made with silver bearing copper-phosphorus (BCuP) brazing alloy (melting point at least 1000 degrees F). The use of flux is prohibited. The outside of the tube and fittings shall be cleaned by washing with hot water and a stainless steel brush after brazing.
5. Each brazed joint shall be visually examined after cleaning. The following conditions shall be considered unacceptable:

    a. Flux or flux residue.
    b. Excessive oxidation.
    c. Presence of unmelted filter metal.
    d. Failure of the filler metal to be clearly visible all the way around the joint at the interface between the socket and the tube.
    e. Cracks in the tube or component.
    f. Cracks in the braze filler metal.
    g. Failure to hold the test pressure.

6. Defective brazed joints shall be repaired or replaced in accordance with NFPA 99. No joint shall be repaired more than twice. Cracked joints or joints exhibiting excessive oxidation shall be replaced.
7. Threaded joints shall be kept to a minimum. Liquid sealants are prohibited.
8. Identify and permanently mark all piping as it is installed with pre-approved labels and direction arrows. Labeling shall be applied at intervals of not more than 20 feet, at least once in each room and at each story traversed by the pipe. All labels must be positioned to be easily seen and read.

9. Piping shall be supported from the building structure in accordance with MSS Standard Practice SP-69, Piping Hangers and Supports - Selection and Application. Hangers and supports shall comply with MSS Standard Practice SP-58, Piping Hangers and Supports - Materials, Design and Manufacture. Portions of hangers in contact with copper tube shall have a copper finish or other protection against galvanic corrosion. Maximum support spacing shall be as follows:

a.	3/8 in. nominal	5 ft. (Alarm/gage tubing only)
b.	1/2 in. nominal	5 ft.
c.	3.4 in. nominal	5 ft.
d.	1 in. nominal	5 ft.
e.	1-1/4 in. nominal	6 ft.
f.	1-1/2 in. nominal and larger	10 ft.

g. Where a single pipe is to be supported, an adjustable steel clevis hanger (MSS Type-1) shall be used.
h. Where pipe is to be supported on racks, a U-bolt (MSS Type-24) shall be used.

10. After installation of the piping, but before installation of the outlet valves, the lines shall be blown down (purged) by means of dry nitrogen. NOTE: Large lines should be purged before small lines are attached.
11. Changes of direction in medical vacuum piping shall be made with T-fitting and cleanout plug. The cleanout shall be made with a cast brass street female adapter with brass plug. The cleanout shall be accessible for rodding. Medical vacuum piping changes of direction (½" & ¾") from vertical to horizontal shall be made with long sweep 90 degree bends.
12. Manifold relief vents shall be vented to atmosphere.
13. Buried piping from bulk tanks shall be protected from freezing, corrosion and damage. Minimum depth of bury is 36”. Provide continuous tape or marker at approximately 1/2 the depth of bury.
14. Piping shall not be installed in kitchens or electric rooms.
15. Drops to individual outlets or inlets shall not be less than 1/2” for medical gases and 3/4” for vacuum and WAGD.
16. Branch take-offs and run-outs from horizontal piping shall be taken off the centerline of the main or branch pipe and rise vertically or at an angle of not less than 45 degrees from vertical.

E. Valves and Gauges

1. Furnish and install any and all valves including purge valves, required to isolate sections of the piping systems extending into areas for construction at a later date. Provide all valves to properly test each system with respect to the construction phasing and as essentially indicated on the drawings. Provide all required adapters, valves and interconnecting tubing required to perform the medical gas testing as required by the Hospital. Identify all isolation and phasing valves as such and indicate on tag or plastic sign that valve is to remain open and that anesthesia department is to be notified if closed.
2. Install isolation valves on laterals adjacent to risers.
3. Lock in open position all main, section, and riser valves.
4. Zone valves services shall be in the following top to bottom sequence: air, oxygen, carbon dioxide, nitrous oxide, nitrogen, WAGD and medical vacuum. This sequence shall be maintained where two zone valve boxes are required for a given location.

F. Pre-Testing

1. Before any existing medical gas piping is breached, the contractor shall perform a purge (particulate) and concentration test on the existing systems shown being connected to. The test procedure shall be as outlined in these specifications with the exception that the purge test shall be performed with the gas of system designation. Test results shall be recorded and submitted as outlined in these specifications.

3.06 MEDICAL GAS TESTING

A. Scope

1. This Contractor shall provide performance testing of the complete installation of all medical gases of new pipe line and connections in accordance with NFPA 99, latest edition.

a. This Contractor shall provide purge valves and isolation valves at all dead ends and points of connections to piping systems or at all phasing break points for the proper execution of the testing, blowing out, purging and certification. Purge valves to consist of 3/8" ball valves with a threaded end capped adapter. This subcontractor shall be responsible for supplying the bottled gas, gauges, adapters, analyzer and all other necessary equipment to conduct the testing and certification.
b. All tests shall be observed by a representative of the Hospital and Medical Gas Equipment Supplier. This Contractor shall be responsible for supplying the bottled gas, gauges, adapters and all other necessary equipment to conduct these tests.
c. Testing shall be performed in the following manner and sequence and shall be completed prior to use of the system for patient care:

1) Installation Tests

a) Initial Blow DownTest
b) Initial Pressure Test
c) Final Pressure Test
d) Cross Connection Test

2) Verification Tests

a) Operational (Standing) Pressure Test
b) Cross Connection Test
c) Valve Test
d) Master and Area Alarm Test
e) Purge Test
f) Purity Test
g) Gas Source Test
h) Outlet Test
i) Final Tie In Test
j) Concentration Test

2. All installation tests shall be performed by the installer or representative prior to the verification tests. Test gas shall be nitrogen N.F.

3. All verification tests shall be performed and certified by an independent (not the installation contractor) medical gas testing contractor/laboratory. The testing (verification) Contractor shall have a minimum of 5 years' experience in the testing of medical gases and shall meet the requirements of ASSE Standard 6030 and be MGPHO credentialed. The testing laboratory used shall be state certified. The choice of testing (verification) Contractor shall be pre-approved by the Owner. The testing contractor shall submit a shutdown management plan before any work is begun. Test gas, up to and including the purity test, shall be nitrogen N.F. The balance of verification tests shall be with the gas of system designation.
4. This Subcontractor shall submit installation test reports and results to the architect/engineer or his representative for review. Installation test reports shall note date, time and pressure readings for tests sections as well as results of blow down, purge and cross-connection tests for tested sections, valves, alarms and outlets. Verification test reports, certified by the independent laboratory, shall note date and time of tests on a room-by-room, outlet-by-outlet, valve-by-valve, alarm-by-alarm format.
5. Installation Tests

   a. Initial Blow Down Test

      1) After installation of the piping, but before installation of the outlet/inlet, alarm panels and gauges, the line for each installed gas system shall be blown clear of particulate contamination by means of nitrogen N.F. at 200 psi.

   b. Initial Pressure Test

      1) Before attachment of system components such as pressure actuating switches for alarms, pressure gauges, etc., but after installation of the station outlets/inlets, with test caps in place, and before closing of the walls and ceilings, each piping system shall be subjected to a minimum test pressure of 1.5 times the working pressure with nitrogen N.F. After the piping system is filled with the test gas, the supply valve and all outlets/inlets shall be closed and the source of test gas disconnected, the piping system shall remain leak-free for 24 hours. Each joint shall be examined for leakage by means of soapy water or other equally effective means of leak detection safe for use with oxygen.
      2) Leaks, if any, shall be located, repaired and the section retested.
      3) The source shut-off valve shall remain closed during these tests.

   c. Final (Standing) Pressure Test

      1) After testing of each individual system as specified above, the assembled station outlet valves and all other system components such as pressure actuating switches for alarms and pressure gauges shall be installed and all medical gas piping systems shall be subjected to a 24 hour standing pressure test at 20% above normal line pressure. System shall remain pressurized during drywall installation/repair to monitor system integrity. Check system at beginning and end of each work day.
      2) Leaks, if any, shall be located and repaired or replaced and the section retested.

d. Cross Connection Test

1) Once labeling is in place, prior to closing walls, each system shall be separately tested to determine that no cross connections of piped system exists.
2) Each piping system shall be reduced to atmospheric pressure.
3) Source of testing gas shall be disconnected from all piping systems except for the one being tested.
4) System to be tested shall be charged with 50 psi nitrogen N.F. Individual outlets/inlets shall be checked to determine if test gas is being dispended.
5) Each outlet shall be purged with an intermittent high volume flow of test gas.

6. Verification Tests

a. Operational (Standing) Pressure Test

1) Each medical gas system shall be tested at operational pressure for 10 minutes, with all system hardware installed to verify there are no leaks within the systems. Test shall be conducted on a by-zone basis. Results of this test shall be reported in terms of LPM leakage to the nearest 0.02 lpm.

b. Cross Connection Testing

1) Once the system is complete, the systems shall be tested to ensure that there is no cross connection of gas and vacuum systems. Each system shall be separately pressurized with nitrogen and the outlet type verified.

a) All system labeling shall be verified.

c. Valve Test

1) Certify that system valves are operating properly and identified according to the suite/rooms.

d. Alarm System

1) All medical gas alarm systems shall be tested to verify operation within the limits required.

e. Labeling

1) All gas outlets, gauges, alarms and zone valves shall be verified to incorporate proper labeling for gas service, function and room or area control.

f. Piping Purge/Particulate Test

1) Each positive pressure medical gas system shall be purged to eliminate the solid particulate contaminants that may be present in the systems.

2) Each positive pressure terminal outlet shall be tested using a 0.45 micron filter for evidence of solid particulate contamination. A minimum flow of 3.5 scfm, minimum volume of 35 cu.ft. with no discoloration, and no more than 0.1 mg of matter at the most remote outlet from the source at each supply branch. Each outlet shall be tested with the outlet most remote from the zone valve to be the last outlet tested.

g. Piping Purity Test

1) Samples of the source gases for each positive pressure system intended for patient application shall be tested for contaminants. Samples shall be taken from a location as close to the source as possible without creating a disruption of the gas services. Medical air samples shall be taken downstream of the medical air dryer and filters. Test parameters shall be for the following:

a) Total Hydrocarbons
b) Halogenated Hydrocarbons
c) Carbon Monoxide
d) Dewpoint
e) Particulates

h. Final Tie-In Test

1) Prior to the final connection being made to any existing system, the following tests shall be conducted:

a) Operational Pressure Test
b) Cross Connection Test
c) Valve Test
d) Alarm Test
e) Purge Test
f) Piping Purity Test

2) After connection to the existing system and before use of the new system for patients, the following tests shall be conducted:

a) Operational Room Test
b) Concentration Test
c) Gas Source Analysis

i. Operational Pressure Test

1) The applicable gas for each system shall be introduced into the respective piping systems. Each installed outlet shall be purged to remove any of the nitrogen N.F. test gas present during previous testing and any remaining particulate contamination:

a) Oxygen and Air: 3.5 scfm at 50 psig
b) Vacuum: 3.5 scfm at 12" Hg

2) Each piping system shall be tested to confirm the supply sources are set to deliver gas at the pressure levels as defined by NFPA 99:

a) The testing (verification) agency shall provide testing of the complete installation of all new or modified medical gas systems as documented in NFPA 99C, 4.5.1.3 and as follows:

(1) Final Tie-In Test
(2) Cross Connection Test
(3) Piping Purge/Particulate Test
(4) Valve Test
(5) Flow Test
(6) Piping Purity Test
(7) Operational Pressure Test
(8) Concentration Test
(9) Alarm Testing
(10) Identification and Labeling
(11) Gas Source Analysis Test for establishing baseline values of source systems

j. Concentration Test

1) After completion of the above, each positive pressure outlet shall be analyzed to confirm the delivery of the proper gas at the proper concentration level. Minimum allowable concentration levels are defined by the United States Pharmacopoeia and Compressed Gas Assn. Gas Commodity Specifications and as follows:

a)	Oxygen:	99%
b)	Air:	19.5 to 23.5% Oxygen
c)	Nitrous Oxide:	99%
d)	Nitrogen:	99%
e)	Other Gases:	As specified by label
f)	Instrument Air:	19.5 to 23.5% Oxygen

k. Medical Air Purity Test

1) Medical air outlets shall be tested for concentration of contaminants. The basis for comparison for allowable concentrations shall be as follows:

a)	Dewpoint:	39°F @ 50 psig
b)	Carbon Monoxide:	10 ppm
c)	Carbon Dioxide:	500 ppm
d)	Gaseous Hydrocarbons as Methane:	25 ppm
e)	Halogenated Hydrocarbons:	2 ppm

2) The installed points of use shall be compared with source and any discrepancies noted in the report and brought to the attention of the Owner and Engineer. The Contractor's installation shall not adversely affect the quality of the existing systems.

B. Installer Tests, Manufacturer's Start-up Tests and Verifiers Test

1. Documentation shall be provided upon completion of all testing to include test results, names of individuals performing work on this project, detailed procedures followed for tests and a certification that all results of tests were within limits specified.
2. The inspection and testing reports from the installer, manufacturer and verifier shall be submitted directly to the party that contracted for the testing, who shall submit the report to the Owner's Representative.
3. The Medical Gas Installer will perform the Installer Performance Test of the Medical Gas and Vacuum System.
4. The manufacturer will provide factory authorized representatives to review installation and perform initial start-up of the Medical Gas and Vacuum Systems.
5. The MGPHO credentialed Medical Gas Verifier shall submit a final verification report that indicates the completed systems and components as indicated on the drawings and specifications herein are tested and verified to NFPA 99, Latest Edition and this specification. The report shall include a verification of the integrity of the medical gas and vacuum delivery system, quality of delivered gases and the proper operation of peripheral devices of the central supply systems.

3.07 CONNECTIONS TO EXISTING SYSTEMS

A. Medical Gas System

1. Field verify the existing systems affected by the renovation and isolate those systems by closing the closest upstream system valve. Test the system valve by opening a downstream port to atmospheric pressure. Install a gauge at downstream location and monitor pressure for (2) hours to verify that the system valve is not leaking.
2. Continuously purge with nitrogen N.F. through the new connection while brazing.
3. Connection to the existing system shall be made after the 200 psi blowdown test has been conducted after the new piping system has been roughed, prior to outlet installation.
4. All gas outlets affected by the shutdown and tie-in of the new piping systems shall be tested and recertified as outlined in "Medical Gas Testing" Section.

3.08 CONNECTIONS TO EQUIPMENT

A. Refer to Section 220500.

3.09 IDENTIFICATION OF SYSTEMS

A. Refer to Section 220500.

END OF SECTION

DIVISION 23

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SECTION 230500

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 PROVISIONS INCLUDED

A. Include General Conditions.

B. Supplementary General Conditions

C. Division 0 “Procurement and contracting Requirements”.

D. Division 01 “General Requirements”.

E. Division 02 “Existing Conditions”.

F. See Division 21 for Fire Protection

G. See Division 22 for Plumbing.

H. See Divisions 26, 27 and 28 for Electrical.

I. Section 019113 - Building Commissioning Requirements for Commissioning and requirements which may affect the work of this Section.

J. Examine all other Sections of the specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

K. Coordinate work with that of all other Trades affecting, or affected by work of this Section. Cooperate with such Trades to ensure the steady progress of all work under the Contract.

1.02 DEFINITIONS

A. Words in the singular shall also mean and include the plural, wherever the context so indicates and words in the plural shall mean the singular, wherever the context so indicates.

B. Wherever the terms "shown on drawings" are used in the specifications, they shall mean "noted", "indicated", "scheduled", "detailed", or any other diagrammatic or written reference made on the drawings.

C. Wherever the term "provide" is used in the specifications it will mean "furnish" and "install", "connect", "apply", "erect", "construct", or similar terms, unless otherwise indicated in the specifications.

D. Wherever the term "material" is used in the specifications it will mean any product", "equipment", "device", "assembly", or "item" required under the Contract, as indicated by trade or brand name, manufacturer's name, standard specification reference or other description.

E. The terms "approved", or "approval" shall mean the written approval of the Architect.

F. The term "specification" shall mean all information contained in the bound or unbound volume, including all "Contract Documents" defined therein, except for the drawings.

G. The terms "directed", "required", "permitted", "ordered", "designated", "prescribed" and similar words shall mean the direction, requirement, permission, order, designation or prescription of the Architect. The terms "approved", "acceptable", "satisfactory" and similar words shall mean approved by, acceptable or satisfactory to the Architect. The terms "necessary", "reasonable", "proper", "correct" and similar words shall mean necessary, reasonable, proper or correct in the judgment of the Architect.

H. "Piping" includes in addition to pipe or mains, all fittings, flanges, unions, valves, strainers, drains, hangers and other accessories relative to such piping.

I. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction or in crawl spaces.

J. "Exposed" means not installed underground or "concealed" as defined above.

K. "Invert Elevation" means the elevation of the inside bottom of the pipe.

L. "HVAC, Plumbing, and/or Fire Protection Contractor" shall refer to the Contractor or his Subcontractors responsible for furnishing and installation of all work indicated on the HVAC, Plumbing, and/or Fire Protection drawings and specifications, as applicable and or referenced to each Trade in the Architectural and/or Structural documents.

M. "Mechanical Contractor" shall refer to the Fire Protection, Plumbing, HVAC and ATC Contractors, as applicable.

N. "Architect" shall refer to the Architect "ARC and Svigals + Partners" and/or Engineer "Bard, Rao + Athanas Consulting Engineers, LLC" and/or Owner.

O. "Owner" shall refer to the designated representatives of the Project Owner.

P. "General Contractor" shall refer to the Contractor(s) performing work under other sections of the Contract Specifications.

Q. "Construction Manager" shall refer to the Construction Manager (CM) "Fusco Corporation" for this project.

R. “Commissioning Agent (CA)” shall refer to the party employed by the Owner to witness the demonstration of all systems according to the commissioning plan. Refer to Section 019113 - Building Commissioning Requirements.

1.03 CODES, STANDARDS AND REFERENCES

A. All materials and workmanship shall comply with all applicable Codes, Specifications, Local and State Ordinances, Industry Standards and Utility Company Regulations, latest editions.

B. In case of difference between Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations and the Contract Documents, the Mechanical Contractor, as applicable, shall promptly notify the Architect in writing of any such difference.

C. In case of conflict between the Contract Documents and the requirements of any Code or Authorities having jurisdiction, the most stringent requirements of the aforementioned shall govern for budgetary purposes. However, no work will proceed until the Architect determines the correct method of installation.

D. Should any Contractor, as applicable, perform any work that does not comply with the requirements of the applicable Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations, he shall bear all costs arising in correcting the deficiencies, as approved by the Architect.

E. Applicable Codes and Standards shall include all State Laws, Local Ordinances, Utility Company Regulations and the applicable requirements of the following accepted Codes and Standards, without limiting the number, as follows:

1. National Electrical Code (NEC)
2. Environmental Protection Agency (EPA)
3. CT Environmental Air Quality Protection Agency
4. CT Energy Code
5. International Building Code (Latest Adopted Edition), including all adopted CT Supplements
6. CT Fire Prevention Regulations and Elevator Regulations
7. Local Ordinances, Regulations of the Local Building Department and Fire Department
8. Guidelines for Construction and Equipment of hospital and Medical Facilities, as published by A.I.A. Press, ISBN 1-57165-002-4, U.S. Dept. of Health and Human Services
9. Recommendations of the National Fire Protection Association (NFPA), latest applicable edition adopted, in general and in particular:

    a. Life Safety, NFPA 101
    b. HVAC, NFPA 90A, 90B
    c. Hospitals, NFPA 99

10. Recommendations of ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers), including:

    a. ASHRAE 90.1
    b. ANSI/ASHRAE 62-Ventilation for Acceptable Indoor Air Quality
    c. ANSI/ASHRAE 15-Safety Code for Mechanical Refrigeration
    d. ANSI/ASHRAE 110-Method of Testing Performance of Laboratory Fume Hoods
    e. ANSI/ASHRAE 55-Thermal Environmental Conditions for Human Occupancy

F. In these specifications, references made to the following Industry Standards and Code Bodies are intended to indicate the accepted volume or publication of the Standard. All equipment, materials and details of installation shall comply with the requirements and latest revisions of the following Bodies, as applicable:

1.	AMCA	Air Moving and Conditioning Association
2.	ANSI	American National Standards Institute
3.	ARI	American Refrigeration Institute
4.	ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
5.	ASME	American Society of Mechanical Engineers
6.	ASTM	American Society of Testing Materials

7.	AWS	American Welding Society
8.	CS	Commercial Standards, U.S. Department of Commerce
9.	FM	Factory Mutual
10.	FS	Federal Specification, U.S. Government
11.	MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
12.	NEMA	National Electrical Manufacturers Association
13.	SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
14.	UL	Underwriters Laboratories, Inc.

G. Each Contractor for the work under his charge, shall give all necessary notices, obtain and pay for all permits, pay all governmental taxes, fees and other costs in connection with his work; file for necessary approvals with the jurisdiction under which the work is to be performed. Each Contractor shall obtain all required Certificates of Inspection for his work and deliver same to the Architect before request for acceptance of his portion of work and before final payment is made.

H. All equipment shall be installed per manufacturer's recommendations and requirements. The Contractor shall notify the Engineer in writing when they intend to deviate from manufacturer's installation guidelines. The Engineer shall advise if the installation is acceptable prior to installation.

1.04 SUBMITTALS

A. Submit detailed shop drawings or brochures for approval of equipment and material proposed to be used on this project. Furnish the number of copies required by General Conditions.

B. Documents submitted shall show the following:

1. Principal dimensions and details of construction.
2. Operating and maintenance clearances.
3. Weights of principal parts and total weights with information required for the design of supports and foundations.
4. Sizes and location of piping and connections.
5. Performance data, including pump and fan curves; sound data including sound power dB levels in 1/3 octave bands.
6. Data on electric motors, including brake horsepower of driven equipment, nameplate ratings and classes, sound data, starting and running full load currents, required starter size and recommended overload heater ratings.
7. Approval stamp of Underwriters' and other authorities having jurisdiction of Contract Drawings requiring such approval.
8. Certified performance guarantees.
9. Calculations and details for refrigeration for field assembled systems including description of specialties and pressure drops, layout of piping with lengths fittings, and refrigerant specialties, and capacity curves for evaporator and compressor showing balance points.
10. Minimum scale for sheet metal plans and piping plans shall be ¼ inch equal 1 foot.

C. Submit brochures that contain only that information which is relative to the particular equipment or materials to be furnished. Do not submit catalogs that describe several different items other than those items to be used unless irrelevant information is marked out and relevant material is clearly marked.

D. Specifications Compliance Statement

1. The manufacturer shall submit a point by point statement of compliance with the specifications.
2. The statement of compliance shall consist of a complete copy of the project specifications with a line by line compliance statement.
3. Where the proposed system complies fully, such shall be indicated by placing the word “comply” opposite the line or paragraph number.
4. Where the proposed system does not comply, or accomplishes the stated function in a manner different from that described, a full description of the deviation shall be provided.
5. Where a full description of a deviation is not provided, it shall be assumed that the proposed system does not comply with the paragraph in question.
6. Submissions which do not include a point by point statement of compliance as specified shall be disqualified.

1.05 GUARANTEE

A. Attention is directed to provisions of the General Conditions and Supplementary General Conditions regarding guarantees and warranties for work under this Contract.

B. Manufacturers shall provide their standard guarantees for work under this Contract, unless specified otherwise. However, such guarantees shall be in addition to and not in lieu of all other liabilities which the manufacturer and CM may have by Law or by other provisions of the Contract Documents. In any case, such guarantees and warranties shall commence when the Owner accepts the various systems, as applicable and as determined by the Architect. The guarantees and warranties will remain in effect for a minimum period of (1) year thereafter except where longer periods are specifically stated and specified.

C. All materials, items of equipment and workmanship furnished under HVAC, shall carry the warranty against all defects in material and workmanship. Any fault due to defective or improper material, equipment, workmanship or design which may develop shall be made good, forthwith, by and at the expense of the Contractor responsible, including all other damage done to areas, materials and other systems resulting from this failure.

D. Each Contractor shall guarantee that all elements of the systems provided under his Contract, are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated on the drawings.

E. Upon receipt of notice from the Owner of failure of any part of the systems or equipment during the guarantee period, the affected part or parts shall be replaced by the responsible Contractor.

F. Each Contractor shall furnish, before the final payment is made, a written guarantee covering the above requirements.

1.06 COMMISSIONING

A. The TBA Contractor must also include sufficient man-hours within their bids, for their participation with the Commissioning Team and the rebalancing/readjusting/resetting all device setpoints, as required. For additional work, refer to Section 019113 - Building Commissioning Requirements.

B. The facility is to remain occupied during the extent of the renovations. Due to the phased method of renovations (and many supply and exhaust fan systems being constant volume, the TBA Contractor will be required to re-balance and adjust all air and water systems at the end of each phase that has been modified. (Note; Existing fan systems support multiple phases and will require their air flow re-balancing to be revisited at the end of each phase and possibly multiple times within each phase.))

1. Scope is to include maintaining a general overall building positive pressurization during each phase.
2. Scope is to include air flow balancing adjustments as required to maintain the any existing occupied space's pressurization relationships to accommodate that program's use. Existing spaces that remain occupied with an existing positive pressurization shall remain positively pressurized (and negatively pressurized spaces shall remain negatively pressurized.)

1.07 THE CONTRACTOR

A. Each Contractor shall base his bid on site examinations performed by him. This requirement is mandatory. Each Contractor shall visit the proposed site where work is scheduled to be performed and ascertain the amount of work required to fulfill the intent of his Contract and the complexity of the installation. Each Contractor shall not hold the Architect, his Consultants, agents or employees responsible for or bound by, any schedule, estimate or for any plan thereof. Each Contractor shall study all Contract Documents (HVAC, Plumbing, Fire Protection, Electrical, Communications, Architectural, Structural), etc., included under each Contract, to determine exactly the extent of work to be provided under each Section, and in installing new equipment and systems and coordinating the work with the other Trades and existing conditions.

B. Each Contractor shall faithfully execute his work according to the terms and conditions of the Contract and specifications and shall take all responsibility for and bear all losses resulting to him in the execution of his work.

C. Each Contractor shall be responsible for the location and performance of work provided under his Contract as indicated on the Contract Documents. All parties employed directly or indirectly by each Contractor shall perform their work according to all the conditions as set forth in these specifications.

D. Each Contractor shall furnish all materials and perform all work in accordance with the project specifications and any supplementary documents provided by the Architect. The work shall include every item shown on the drawings and/or required by the specifications as interpreted by the Architect. All work and materials furnished and installed shall be new and of the best quality and workmanship. Each Contractor shall cooperate with the Architect so that no error or discrepancy in the Contract Documents shall cause defective materials to be used or poor workmanship to be performed.

1.08 COORDINATION OF WORK

A. Each Contractor shall compare his drawings and specifications with those of other Trades and report any discrepancies between them to the Architect and obtain from the Architect written instructions for changes necessary in the mechanical or electrical work, to ensure that all work is installed in coordination and cooperation with other Trades installing interrelated work.

Before installation, each Contractor shall make proper provisions to avoid interferences in a manner approved by the Architect. All changes required in the work of each Contractor caused by his negligence, shall be corrected by him at his own expense, to the Architect's satisfaction.

B. Locations of piping, ductwork, conduits and equipment shall be adjusted to accommodate the new work with interferences anticipated and encountered during installation. Each Contractor shall determine the exact routing and location of his systems prior to fabrication or installation of any system component. Accurate measurements and coordination drawings will have to be completed to verify dimensions and characteristics of the various systems' installations.

C. Lines which pitch shall have the right-of-way over those which do not pitch. For example, waste piping shall normally have the right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed.

D. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings. Each Contractor shall provide manual air vents and drains as required for his work to affect these offsets, transitions and changes in direction, as applicable.

E. All work shall be installed in a way to permit removal (without damage to other parts) of coils, filters, control appurtenances, fan shafts and wheels, filters, belt guards, sheaves and drives and all other system components provided under this Contract requiring periodic replacement or maintenance. All piping shall be arranged in a manner to clear the openings of swinging overhead access doors, ceiling tiles and cleaning access doors in ductwork.

1. Access to any and all components requiring servicing, adjustment, calibration, maintenance or periodic replacement shall be provided so that the Owner's operations personnel can freely gain access without removal of any materials other than the access panel or ceiling tile. Access shall be understood to mean free, clear and unobstructed from the floor up to the device and/or component being serviced. Access panels for VAV/CV boxes shall be 24" x 24" minimum.
2. Fire rated access doors with closers shall be provided for all rated assemblies.

F. The Contract Drawings are diagrammatic only intending to show general runs and locations of piping, ductwork, equipment, terminals and specialties and not necessarily showing all required offsets, details and accessories and equipment to be connected. All work shall be accurately laid out with other Trades to avoid conflicts and to obtain a neat and workmanlike installation which will afford maximum accessibility for operation, maintenance and headroom.

G. Where discrepancies in scope of work as to what Trade provides items, such as starters, disconnects, flow switches, electric control components, etc., exist, such conflicts shall be reported to the Architect prior to signing of the Contract. If such action is not taken, each Contractor, as applicable, shall furnish such items as part of his work, for complete and operable systems and equipment, as determined by the Architect.

H. Where drawing details, plans and/or specification requirements are in conflict and where pipe or duct sizes of same pipe or duct run are shown to be different between plans and/or between plans and sections or details, the most stringent requirement will be included in the Contract. HVAC systems and equipment called for in the specification and/or shown on the drawings shall be provided under this Contract as if it were required by both the drawings and specifications. However, prior to ordering or installation of any portion of work which appears to be in conflict, such work shall be brought to Architect's attention for direction as to what is to be provided.

I. Final location of all air distribution devices, thermostats, heaters, control devices, sprinkler heads, etc., shall be coordinated with the Architectural reflected ceiling plans and/or other Architectural details, as applicable. (**Note**: Sprinkler head locations shall provide the specified coverage rating and water flow density, and shall be in accordance with all applicable Codes and in full compliance with the requirements of the Owner's insurance carrier.) Offsets of ductwork, added sheet metal, fittings, elbows, flexible connections, etc., shall be provided as required to comply with the Architectural reflected ceiling plans and/or installation details. Obtain approval of locations of all devices from Architect in the field, prior to installation.

1.09 COORDINATION DRAWINGS

A. Before materials are purchased, fabricated or work is begun, each Contractor shall prepare coordination drawings for all floors/areas, including buried systems/services (all-Trade-composite at ¼" scale), showing the size and location of his equipment and lines, in the manner described herein under General Requirements.

B. Coordination drawings are for the CM and Architect's use during construction and shall not be construed as shop drawings or as replacing any shop drawings. The coordination drawings, when corrected for actual "as-built" conditions, will be reviewed by the Architect, corrected and become the Record Drawings to be submitted to the Owner for his use.

C. The cost of producing and reproducing the drawings will be included under the Contract of each Trade, including the cost or preparation of the Architectural building outlines. This process may include multiple revisions to these drawings which will be included in the cost. The intent is to provide a fully coordinated set of documents between trades no matter how many times they may have to be redone. The HVAC Contractor shall take the lead to produce the Architectural backgrounds, show all ductwork, piping, etc., and circulate the drawings to any of his Subcontractors and the other Trades (Plumbing, Fire Protection, Electrical), so that they can indicate all their work as directed by the CM and Architect as required, to result in a fully coordinated installation.

D. In addition to the regular coordination drawing review, the mechanical work will also be reviewed by the Architect/Engineer to ensure that the system and equipment arrangements are suitable to provide maintenance access and service as follows:

1. Valves and instrumentation should be grouped where possible and positioned in accessible locations.
2. Valves on pipes of 6" and larger, positioned above 7'-0" in height from the operating level, will be provided with chain operated valve wheels and be located where chains will not interfere with primary access through the mechanical room.
3. Location of control/diagnostic panels shall be shown and identified on the mechanical room coordination drawings.

E. Prepare a complete set of computer based drawings:

1. Format shall be:

   a. REVIT (Latest Version)

2. Scale not less than ¼" scale equals 1'-0", showing basic layout for the structure and other information as needed for preparation of Coordination Drawings.
3. The drawings shall indicate the layout of all specialty tradework as indicated herein and shall be designated as Coordination Drawings.

4. Any drawing provided to assist the contractor will require:

    a. A signed liability release form will be required from the Contractor prior to the release of the disk from the Engineer.

5. For 3-D projects see Section 230510 “3D Building Information” for additional information

F. Highlight all fire rated partitions on the Coordination Drawings for appropriate coordination.

G. The main paths for the installation or removal of equipment from mechanical and electrical rooms shall be clearly indicated on the Coordination Drawings.

H. Each of the specialty trades shall add its work to the base drawings with appropriate elevations and grid dimensions. Specialty trade information shall be required for fan rooms and mechanical rooms, horizontal exits from duct shafts, crossovers and for spaces it the above ceilings where congestion of work may occur such as corridors and, where required, entire floors. Drawings shall indicate horizontal and vertical dimensions to avoid interference with structural framing, ceilings, partitions and other services. Indicate elevations relative to finish floor for bottom of ductwork and piping and conduit 6" greater in diameter.

1. Specialty Trade shall include:

    a. Plumbing system.
    b. HVAC piping and associated control systems.
    c. Electrical.
    d. Sheet Metal Work.
    e. Fire Protection system.
    f. Automatic Temperature Control
    g. Fire Alarm
    h. Security
    i. Telecommunications
    j. Pneumatic Tube
    k. Commissioning

I. Upon completing their portion of the Coordination Drawings, each specialty trade shall sign, date and return Coordination Drawings to the Contractor.

J. Where conflicts occur with placement of materials of various trades, the General Contractor shall be responsible to coordinate the available space to accommodate all trades. Any resulting adjustments shall be initialed and dated by the affected specialty trade Subcontractor. The General Contractor shall then final date and sign each drawing.

K. Fabrication shall not start until Coordinate Drawings have been distributed to all parties as indicated herein.

L. Distribution of Coordination Drawings:

1. The General Contractor shall provide one print of each Coordination Drawing to:

    a. Each specialty trade Subcontractor.
    b. Owner.
    c. General Contractor.
    d. Architect (for record purposes).

M. After distribution:

1. Resolve all interferences not previously identified.

N. Coordination Drawings include but are not necessarily limited to:

1. Structure.
2. Partition/room layout, including indication of smoke and fire resistance rated partitions.
3. Ceiling layout and heights.
4. Light fixtures.
5. Access panels.
6. Sheet metal, heating coils, heat pumps, grilles, diffusers, etc.
7. All heating piping and valves.
8. Smoke and fire dampers.
9. Soil, waste and vent piping.
10. Major water and gases.
11. Major electrical conduit runs, panelboards, feeder conduit and racks of branch conduit. Motor control centers, starters and disconnects.
12. Sprinkler piping and heads.
13. All equipment, including items in the Contract as well as O.F.C.I. and O.F.I. items.
14. Equipment located above finished ceiling requiring access for maintenance and service. In locations where acoustical lay-in ceilings occur indicate areas in which the required access area may be greater than the suspected grid systems.
15. Rainwater Piping.
16. Existing conditions, including, but not limited to, Mechanical, Plumbing, Fire Protection and Electrical items.
17. ATC panels.

O. The Architect’s response to all requests for information (RFI’s) generated by the trade contractors shall be distributed to all other affected trades as if this information was contained in the original contract documents. In other words, the party that issues an RFI is responsible for distributing the information to all affected parties.

1.10 RECORD DRAWINGS

A. Each Contractor shall maintain, current at the site, a set of Contract Drawings for his portion of the work on which he shall accurately show the actual installation of all work provided under his Contract indicating any variation from the Contract Drawings, in accordance with the General Conditions and Supplementary General Conditions. Changes whether resulting from formal change orders, requests for information, or other instructions issued by the Architect shall be recorded. Include changes in sizes, location and dimensions of piping, ducts, equipment, etc.

B. Each Contractor shall indicate progress by coloring-in various pipes, ducts and associated appurtenances exactly as they are erected. This process shall incorporate both the changes noted above and all other deviations from the original drawings whether resulting from job conditions encountered or from any other causes.

C. The marked-up and colored-up prints will be used as a guide for determining the progress of the work installed. They shall be inspected periodically by the Architect and Owner's representatives and they shall be corrected if found either inaccurate or incomplete. This procedure is mandatory. Marked up drawings shall include all flow diagrams, schedules, details and control diagrams.

D. Each Contractor shall meet at a minimum on a monthly basis, with the Owner's representative to transfer the information from his HVAC, Plumbing, Fire Protection, etc., marked-up and colored-up prints to a set which will become the basis for preparation of as-built drawings.

E. Upon completion of the project, each Contractor shall submit his marked-up drawings to the Architect for review and comment. After the Architect reviews and comments on this set of documents, each Contractor shall prepare as-built drawings on CAD using the format specified for coordination drawings. When the work is completed, each Contractor shall provide 2 hard copies to the Architect for submittal to the Owner and disks with all documentation and a set of reproducible drawing plots marked "As-Built" drawings. The Contractor shall bear all costs of producing the CAD "As-Built" drawings, providing all necessary drawing changes and printing the reproducible drawings for the work under his charge.

1.11 GIVING INFORMATION

A. Each Contractor shall keep himself fully informed as to the shape, size and position of all openings required for his apparatus and shall give information to the Architect and other Contractors **[or Subcontractors]** sufficiently in advance of the work so that all openings may be built in advance.

B. The manufacturers listed within this specification have been preselected for use on this project. No submittal will be accepted from a manufacturer other than those specified. Should any Contractor wish to propose a substitution during the bid period, such request shall be made in writing to the Architect, at least (15) working days, prior to bid date. If substitutions are deemed acceptable, such items shall be issued as an Addendum, prior to bid due date. The above requirement is mandatory.

1.12 EQUIPMENT AND MATERIALS

A. Equipment and materials shall be delivered to the site and stored in original sealed containers, suitably sheltered from the elements, but readily accessible for inspection by the Architect until installed. All items subject to moisture damage such as controls, filters, etc., shall be stored in dry, heated spaces.

B. Each Contractor shall have his equipment tightly covered and protected against dirt, water and chemical or mechanical injury and theft. At the completion of the work, equipment and materials shall be cleaned, polished thoroughly and turned over the Owner in a condition satisfactory to the Architect. Damage or defects developing before acceptance of the work shall be made good at each Contractor's **[or Subcontractor's]** expense as applicable.

C. Each Contractor shall make necessary field measurements to ascertain space requirements, for equipment and connections to be provided under his Trade and shall furnish and install such sizes and shapes of equipment to allow for the final installation to conform to the drawings and specifications.

D. Manufacturers' directions shall be followed completely in the delivery, storage, protection and installation of any equipment. Promptly notify the Architect in writing of any conflict between any requirements of the Contract Documents and the manufacturer's directions and obtain the Architect's written instructions before proceeding with the work. Should any Contractor perform any work that does not comply with the manufacturer's directions or written instructions from the Architect, he shall bear all costs arising in correcting any deficiencies that should arise.

E. Each Contractor shall furnish and install all equipment, accessories, connections and incidental items necessary to fully complete the work under his Contract for use, occupancy and operation by the Owner.

F. Where equipment of the acceptable manufacturers requires different arrangement or connections from those shown, it shall be the responsibility of each Contractor to install the equipment to operate properly and in harmony with the original intent of the drawings and specifications. When directed by the Architect, each Contractor shall submit drawings showing the proposed installation. If the proposed installation is approved, each Contractor shall make all necessary changes in all effected related work provided under other Sections including location of roughing-in connections by other Trades, electrical requirements, piping, supports, insulation, etc. All changes shall be made at no increase in the Contract amount or additional cost to the other Trades and/or Owner.

G. Testing Agency Labeling Requirements

1. All equipment and materials required for installation under these specifications shall be new and without blemish or defect.
2. All equipment shall meet OSHA standards.
3. Equipment and materials shall be products which will meet with the acceptance of the Authorities Having Jurisdiction (AHJ) over the work and as specified hereinbefore and below.

a. Where such acceptance by the AHJ of any given product is contingent upon having the FM Global, it shall be provided with an FM Global label and constructed in compliance with FM Global's standards and guidelines.
b. All products shall be listed and labeled by UL or other national testing laboratories such as ETL and the products shall be so labeled.

1) Label of Underwriters Laboratories, ETL or other nationally recognized testing agency acceptable to the Authorities Having Jurisdiction.
2) This Labeling shall include not just the control panel and/or motor but all wiring and devices included in the package as a complete package. Note: Providing a series of individually labeled electrical devices that are then assembled into a package does not meet this requirement, the whole assembly must be labeled as an assembly. The manufacturers have the option of having the equipment inspected and Labeled at the factory or at the site after installation. This requirement shall supersede any other specification language hereinbefore or hereinafter that requires only portions of the equipment to be labeled.
3) Some examples of packaged equipment requiring Labeling:

a) Sump pumpsets
b) Ejector pumpsets
c) Laboratory waste ejector pumpsets
d) Steam condensate pumpsets
e) Duplex air compressor system
f) Air handling units (packaged and custom built-up)
g) Feed water equipment
h) pH Neutralization system skids
i) Laboratory and/or Medical Air compressor skids
j) Vacuum pumpsets
k) Water pressure booster systems

l) Dental Vacuum / Amalgam Separator System

H. All equipment of one type (such as valves, fans, air handling units [packaged or custom built], air terminals, heat pumps, plumbing fixtures, etc.), shall be the product of one manufacturer.

I. Equipment pre-purchased on behalf of the Owner or by the Owner himself, if assigned to any of the Contractors, shall be received, inspected, installed, etc., as if it was purchased by the Contractors as applicable. All guarantees, service contracts, etc., shall be the same as for all other equipment provided under this Contract.

1.13 CUTTING AND PATCHING

A. Each Contractor shall be responsible for all core drilling, as required for work under his Contract, but in no case shall he cut into any structural elements without the written approval of the Architect.

B. All cutting, rough patching and finish patching, shall be provided under this Contract.

C. All concrete and masonry equipment bases shall be provided under this Contract.

1.14 USE OF PREMISES

A. Each Contractor shall confine all of his apparatus, storage of materials and construction to the limits indicated on the drawings and directed by the Architect and he shall not encumber the premises with his materials.

B. In storing materials within areas (structure or ground), or when used as a shop, each Contractor shall consult with the Construction Manager and shall restrict his storage to space designated for such purposes. Each Contractor will be held responsible for repairs, patching or cleaning arising from any unauthorized use of premises.

C. Notwithstanding any approvals or instructions which must be obtained by each Contractor from the Architect in connection with use of premises, the responsibility for the safe working conditions at the site shall remain each Contractor's. The Architect or Owner shall not be deemed to have any responsibility or liability in connection therewith.

D. Air handling unit sections shall not be used for storage of materials. The HVAC Contractor will be responsible for securing, and maintaining the equipment clean. The above requirement is mandatory.

1.15 PROTECTION/CLEANLINESS

A. All materials such as valves, fittings, piping, ductwork, plenums, grilles, registers, diffusers, etc., shall be properly protected from the accumulation of dirt, dust, debris or any other contaminants. All ductwork and piping openings shall be temporarily closed by each Contractor **[or Subcontractor]** installing same, so to prevent obstruction and damage, as a minimum at the end of each working day or more often if required by job conditions. Each Contractor shall take precautions to protect his materials from damage and theft.

B. Each Contractor shall furnish, place and maintain proper safety guards for the prevention of accidents that might be caused by the workmanship, materials, equipment or electrical systems provided under his Contract.

1.16 DAMAGE CORRECTION AND EXTRA WORK

A. Each Contractor shall be held responsible and shall pay for all damages caused by his work to the new and existing building structures and new and existing equipment, piping, duct systems, etc., and all work and finishes installed under this Contract in the new or in existing building. Repair of such damage shall be done as herein before specified, at the expense of each Contractor and to the Architect's satisfaction.

B. Each Contractor shall promptly correct all work provided under his Contract and rejected by the Architect as defective or as failing to conform to the Contract Documents whether observed before or after completion of work and whether or not fabricated, installed or completed. Each Contractor shall bear all costs of correcting such rejected work.

C. No claim for extra work will be allowed unless it is authorized by the Architect in writing before commencement of the extra said work.

1.17 TOUCH-UP PAINTING

A. Each Contractor shall thoroughly clean all equipment and systems provided under this Contract from rust, splatters and other foreign matter or discoloration, leaving every part of each system in an acceptable prime condition. Each Contractor, for the work under his Contract, shall refinish and restore to the original condition all equipment and piping which has sustained damage to the manufacturer's prime and finish coats of paint and/or enamel.

1.18 HOUSEKEEPING PADS

A. Coordinate housekeeping pads for:

1. All equipment indoors or outdoors
2. All floor supports or braces

B. Pads shall be 4" above the finished floor.

C. Each pad shall be a minimum of 6" larger then the equipment, support or isolation base in all directions.

D. Pads shall be formed, poured with concrete, and tooled by the General Contractor.

1.19 DUCT AND PIPE SLEEVES, PLATES AND ESCUTCHEONS, FIRESTOPPING AND SMOKEPROOFING

A. Where piping and/or ductwork pass through masonry or concrete walls or drywall partitions or floors, each Contractor shall provide and set individual sleeves for each pipe or duct and all other work under his charge, as necessary for passage of all pipes and/or ducts. Sleeves shall be of sufficient size to provide 1/2" air space around the pipe or duct passing through (including insulation where pipes or ducts are externally insulated). All openings shall be sealed, smokeproofed and made tight. Each Contractor shall be responsible for the exact location of sleeves provided under his Contract and shall coordinate all requirements for piping and ductwork sleeves.

B. Each Contractor, for work under his charge, shall determine the required inside diameter of each individual wall opening or sleeve before ordering, fabrication or installation.

C. Sleeves and inserts shall not be used in any portions of the building, where their use would impair the strength or construction features of the building. Elimination of sleeves must be approved by the Architect.

D. Provide chrome plated brass escutcheons with set screw for exposed piping, in all areas except in mechanical rooms. In this area use plain brass or cast iron escutcheons suitable for painting. All escutcheons shall be sized to fit the bare pipe or insulation in a snug and neat manner. They shall be of sufficient size to cover sleeved openings for the pipes and of sufficient depth to cover sleeves projecting above floors. Escutcheons shall be as manufactured by Beaton & Caldwell, Dearborn Brass, or Grinnell.

E. Pipe or duct sleeves shall be made of Schedule 40 pipe, 20 gauge galvanized steel or 16 gauge steel as follows:

1. Sleeves on pipes passing through masonry or concrete construction shall be Schedule 40 pipe.
2. Sleeves on ducts passing through concrete construction shall be 20 gauge steel unless required otherwise by item 4 below.
3. Sleeves on pipes or ducts passing through fire rated partitions shall be 16 gauge steel.
4. Sleeves on pipes or ducts passing through non-rated drywall construction shall be 20 gauge galvanized steel.

F. Pipe or duct sleeves shall be set as follows:

1. Set sleeves 1" above finish floor, (except set sleeves, 6" above finish floor at penthouses or mechanical rooms and 6” above finished roof) and flush on each side of walls. Coordinate roof penetrations with roof Subcontractor.
2. Sleeves shall be set securely in place before concrete is poured when placed in concrete construction.
3. Provide sheet metal sleeves for all duct penetrations and cover with sheet metal plates all penetrations after ductwork has been installed through walls/floors.

G. Each Contractor shall fire stop, smoke stop, and/or acoustically seal the space between the sleeves provided under his Contract and piping or ductwork as applicable, as follows:

1. See Specification Section 230584 Through Penetration Firestopping System

1.20 MISCELLANEOUS IRON AND STEEL

A. Each trade shall provide all primary and secondary steel supports and hangers as shown on the drawings and/or as required to support equipment, ductwork, piping, exhaust fans, or any other materials provided under the work of this Section.

B. The work of this Section of designing, furnishing and installing all miscellaneous metal work associated with the system, and related items as indicated on the drawings and/or as specified herein, and includes, but is not limited to the items listed herein below.

C. The scope of work shall include:

1. Exhaust fan support platforms including ship ladders, steel grating for decking, cross-bracing and floor stands.

2. Intermediate beams to hang ductwork and piping from the roof. All piping and ductwork must be hung from beam or supported from the floor. Provide supplemental steel for support of equipment.
3. Support of ductwork and piping in shafts in addition to support provided by structure.
4. Support of ductwork via floor stands as required.
5. Heat exchanger support racks.
6. Piping support in underground concrete trench and manholes.
7. Pipe anchors in the building.
8. Hangers, brackets, angle irons or rods required for the support and protection of HVAC, plumbing and fire protection equipment.
9. Field prime painting of galvanized steel and field finish painting.

D. Shop Drawings for General Miscellaneous Items

1. Submit Shop Drawings of all miscellaneous metal items to Architect for approval, showing sizes and thickness of all members, types of materials, methods of connection and assembly, complete dimensions, clearances, anchorage, relationship to surrounding work by other Trades, shop paint, and other pertinent details of fabrication and installation.

E. The Subcontractor shall engage the services of a Professional Engineer registered within the state wherein the project is located to prepare complete Design Drawings and structural design computations based on, and closely following, the design and details on the Drawings. The Design Drawings and structural design computations, with the Engineer's seal affixed thereto, shall be submitted to the Architect for review. The structural design computations shall provide a complete structural analysis, including anchors and fastening devices, and shall certify as to conformation to governing laws and codes. These submittals, upon review, must be sufficient, when taken in conjunction with this Specification to provide the complete basis of the fabrication and erection.

F. Samples

1. Submit duplicate samples of all materials to be furnished under this Section if, and in size and form, requested by Architect.

G. Do not order materials or begin fabrication until Architect's approval of submittals has been obtained.

H. In addition to the governing laws and codes, the following Specifications and Codes form a part of this Specification:

1. American Iron and Steel Institute applicable standards.
2. American Institute of Steel Construction "Code of Standard Practice for Steel Buildings and Bridges" and "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings".
3. American Welding Society Code: Standard Code for Arc and Gas Welding in Building Construction.

I. All materials shall be new stock, free from defects impairing strength, durability or appearance and of best commercial quality for each intended purpose.

1. Unless other wise specifically called for, work of this Section shall be fabricated of structural steel conforming to ASTM Specification A36.

2. Steel pipe shall be seamless steel pipe conforming to ASTM Specification A53, Schedule 40.
3. Steel tubing shall be seamless steel tubing conforming to ASTM Specifications A500 to A501.
4. Construction specialties such as slotted inserts, wedge inserts, etc., shall be as manufactured by Hohmann and Barnard, Gateway Erectors, Inc., Richmond Screw Anchor Co. or equal approved by Architect.
5. Non-ferrous metals shall be as specified under descriptions of specific items, herein below.

J. Provide all anchors, bolts, sockets, sleeves, and other parts required for securing each item of work of this Section to the construction, including furnishing to concrete workers all required insets and sleeves for use at concrete.

1. All exposed fastenings shall be of the same material and finish as the metal to which applied, unless otherwise noted.
2. Welding rods shall conform to AWS Standards and the recommendation of the welding rod manufacturer.
3. Shop primer for other ferrous surfaces shall be a high-quality, lead-free, rust-inhibitive primer, Tnemec No. 10-99 Metal Primer or equivalent by Devoe and Raynolds Co., Carboline or equal.

K. Metal surfaces shall be clean and free from mill scale, flake, rust and rust pitting. Metal work shall be well formed and finished to required shape and size, true to details, with straight, sharp lines and angles and smooth surfaces. Curved work shall be true radii. Exposed sheared edges shall be eased.

L. Weld all permanent connections. Welds shall be continuous on all exposed surfaces and where required for strength on concealed surfaces. Exposed welds shall be ground flush and smooth, with voids filled with metallic filling compound (metallic filling compound not permitted on surfaces to receive hot-dip galvanizing). Tack-welding will not be permitted unless specifically called for. Do not use screws or bolts where they can be avoided. Where used, heads shall be countersunk, screwed up tight, and threads nicked to prevent loosening.

M. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall give ample strength and stiffness. Joints exposed to weather shall be formed to exclude water.

N. Do all cutting, punching, drilling and tapping required for attachment of anchor bolts and other hardware and for attachment of work by other Trades. All such cutting, punching, drilling, etc., shall be done prior to hot-dip galvanizing of the various components.

O. Live loads shall be not less than the minimum required by law. Where specific live load are not set forth in the laws and codes applicable to this work, and are not given on the Drawings or in this Specification, designs shall be such as to support the live loads which may normally be imposed without failure, without deflection of more than 1/360 of length of any member, and without permanent deformation, all with a factor of safety of not less than 2 1/2 to 1.

P. Shop Painting

1. All ungalvanized ferrous metals under this Section shall be given a shop coat of rust inhibitive primer of type specified above.

    a. Immediately before shop painting, remove all rust, loose mill scale, dirt, weld flux, weld spatter, and other foreign material with wire brushes and/or steel scrapers. Power tool clean in accordance with SSPC SP-3 (Power Tool Cleaning). Remove all grease with oil by use of solvent recommended by paint manufacturer. Sandpaper exposed surfaces as required to produce smooth, even finishes.
    b. Apply paint by spray process in strict accordance with manufacturer's printed instructions to uniform thickness(es) recommended by manufacturer. Apply thoroughly and evenly and work well into corners and joints taking care to avoid sags and runs.
    c. Do not paint surfaces to be embedded in concrete, or to be welded in the field. After field welds are complete, grind smooth and flush, thoroughly clean and then apply specified primer over all unprimed in the field by brush roller.
    d. After erection, sand smooth and retouch all portions of the shop coats chipped or damaged during erection, and coat all field welds and connections with primer equivalent to that used for the shop coat.

Q. Installation

1. All materials shall be carefully handled and stored under cover in manner to prevent deformation and damage to the materials and to shop finishes, and to prevent rusting and the accumulation of foreign matter on the metal work. All such work shall be repaired and cleaned prior to erection.
2. Work shall be erected square, plumb and true, accurately fitted, and with the tight joints and intersections. All anchors, inserts and other members to be set in concrete or masonry shall be furnished loose by this Trade to be built-into concrete and masonry and by those Trades as the work progresses. Later cutting or drilling shall be avoided wherever possible.
3. All metal work shall be rigidly braced and secured to surrounding construction, and shall be tight and free of rattle, vibration, or noticeable deflection after installed.
4. Where members, other than expansion bolts or inserts, are fastened into concrete, set such members in holes formed as specified below, and secure permanently in place by installation of proprietary-type expanding grout manufactured specifically for such purpose, used strictly in accordance with manufacturer's directions. Holes to receive members shall be formed with galvanized sheet metal sleeves, expanded polystyrene foam, or other approved method to provide at least 1/2 inch clearance around entire perimeter. At exposed applications, hold expanding grout back 1/2 inch from finish surface and fill voids with Portland cement grout to match color and texture of surrounding concrete surface.
5. Electrolytic Isolation

    a. Where dissimilar metals are to come into contact with one another, isolate by application of a heavy coating of bituminous paint on contact surfaces in addition to shop coat specified above. Do not permit the bituminous paint in any way to remain on surfaces to be exposed or to receive sealant.

R. Description of Major Items

1. The items described below constitute the major part of the work of this Section, but are not intended or implied to cover each and every item that may be required to properly complete the work. Carefully review the Drawings to determine the full extent of the miscellaneous metal work required.

S. Steel Ladders/Platforms

1. Fabricate and install interior steel ladder at fans, air handling units, filter racks and all equipment requiring service. Ladders shall have a safety cage as required by OSHA regulations.
2. Except as may be otherwise indicated on the Drawings, ladder shall be minimum 16 inches wide, fabricated of minimum 3/8 inch by 2 1/2 inches hot rolled steel rails and minimum 3/4 inches outside diameter steel pipe rungs. Rungs shall be spaced 12 inches on center and shall be continuously welded to the rails. Provide a pair of steel clip angles or wall brackets at bottom and steel anchor plates or wall brackets at top, welded to the rails, as indicated.
3. Exterior steel ladders shall be hot dip galvanized after fabrication as specified hereinbefore. Rungs are to have non-slip surfaces.
4. All shall be OSHA and ANSI compliant.

T. Gratings and Frames

1. Fabricated and install steel gratings and frames at fan platforms.
2. Steel grating frames shall consist of a steel angle perimeter frame constructed of steel angles, at least 4 inches by 4 inches by 3/8 inches carried around perimeter with coped or mitered, full-welded corners. Perimeter frames shall be anchored with 7/16 inch minimum diameter expansion bolts or other suitable devices of adequate capacity, at corners, two (2) per beam end and spaced not more than 2 feet on center around full perimeter.
3. Steel Gratings shall be pressure-locked type, with bearing bars spaced 1 3/16 inch on center and cross-bars spaced 4 inches on center. Sizes of bars shall be as required by manufacturer's loading tables to limit deflection of any member across any span to 1/240th of the span at live load of 100 pounds per square foot. Gratings shall be as manufactured by Borden Metal Products, Co., Irving Subway Grating Co., Reliance Steel Products Co., approved by Architect.
4. All (gratings and) frames shall be hot-dip galvanized after fabrication as specified hereinbefore.

U. Miscellaneous Items

1. Carefully review all Drawings for miscellaneous metal items required but not specifically listed above, such as miscellaneous steel clip angles, miscellaneous steel bracketing, and other miscellaneous metal items as indicated on the Drawings, reasonably implied therefrom, or reasonably necessary for the thorough completion of the work.

2. Provide rigid and secure anchorage of all components whether or not specifically described in complete detail on the Drawings.

V. Piping supports shall be coordinated with the building structure and shall span between roof beams as required.

1.21 WATERPROOFING, FLASHING AND COUNTERFLASHING

A. Unless specifically indicated otherwise on the drawings, each Contractor shall provide all counterflashing and waterproofing of all piping, ductwork and equipment provided by him, which pierce roofs, walls and other weatherbarrier surfaces. All work under this paragraph shall be coordinated with the CM.

B. All work shall be performed in a workmanlike manner to ensure weatherproof installation. Any leaks developed due to each Contractor's work shall be repaired at his expense, to the Architect's satisfaction.

C. Pipes passing through slabs shall have the sleeve extended above floors as hereinbefore specified to retain any water and the space between the pipe and sleeve caulked waterproof fire stopping. The top and the bottom shall be sealed with monolastic caulking compound.

D. All flashing required for ductwork and piping penetrations shall be provided by the CM.

1.22 ELECTRICAL WORK, MOTORS, MOTOR CONTROLLERS

A. See Section 230513 MOTORS AND CONTROLLERS.

B. See Divisions 26, 27 and 28 for Electrical.

1.23 IDENTIFICATION OF MATERIALS

A. See Section 230553.

1.24 VALVE TAGS, NAMEPLATES AND CHARTS

A. See Section 230553.

1.25 PARTS LIST AND INSTRUCTIONS FOR OPERATION AND MAINTENANCE

A. Each Contractor shall thoroughly instruct the representative(s) of the Owner, to the complete satisfaction of the Architect, in the proper operation of all systems and equipment provided by him. Each Contractor shall make arrangements, via the CM as to whom the instructions are to be given in the operation of the basic and auxiliary systems and the periods of time in which they are to be given. The Architect shall be completely satisfied that the representative of the Owner has been thoroughly and completely instructed in the proper operation of all systems and equipment before final payment is made. If the Architect determines that complete and thorough instructions have not been given by each Contractor to the Owner's representative, then each Contractor shall be directed by the Architect to provide whatever instructions are necessary until the intent of this paragraph of the specification has been complied with. All time required for Owner's instruction to satisfy the above requirements shall be included in this Contract. No extra compensation for such instructions will be allowed.

B. Each Contractor, including but not limited to, the HVAC Contractor, shall submit to the Architect for approval, a total of (6) typed sets, bound neatly in loose-leaf binders, of all maintenance and operating instructions for the installation, operation, care and maintenance of all equipment and systems. All data and literature furnished shall be specific for the make and model of the equipment furnished. General non-specific catalog data will not be acceptable. Information shall indicate possible problems with equipment and suggested corrective action.

The manuals shall be indexed for each type of equipment. Each section such as fans, valves, plumbing fixtures, hot water heaters, boilers, air handling units, etc., shall be clearly divided from the other sections. A sub-index for each section shall also be provided. The methodology of setting-up the manuals shall be submitted to the Architect and Owner through the General Contractor for approval prior to final submission of manuals.

C. The instructions shall contain information deemed necessary by the Architect and shall include, but not be limited to, the following:

1. Instructional classes on equipment and systems operation for Owner's representative and maintenance personnel, by engineering staff of each Contractor. Minimum of 48 hours of instruction for minimum of (6) people. Instruction shall include:

    a. Explanation of manual and its use.
    b. Summary description of the HVAC systems.
    c. Purpose of systems.

2. System

    a. Detailed description of all systems.
    b. Illustrations, schematics, block diagrams, catalog cuts and other exhibits.

3. Operations

    a. Complete detailed, step-by-step, sequential description of all phases of operation for all portions of the systems, including start-up, shutdown, adjusting and balancing. Include all posted instruction charts.

4. Maintenance

    a. Parts list and part numbers.
    b. Maintenance, lubrication and replacement charts and manufacturer's recommendations for preventive maintenance, as applicable to his work.
    c. Troubleshooting charts for systems and components.
    d. Instructions for testing each type of part.
    e. Recommended list of on-hand spare parts.
    f. Complete calibration instructions for all parts and entire systems.
    g. Instruction for charging, filling, draining and purging, as applicable.
    h. General or miscellaneous maintenance notes.

5. Manufacturer's Literature

    a. Furnish complete listing for all parts required for models actually furnished.
    b. Names, addresses and telephone numbers of manufacturers and suppliers.
    c. Describe and operation of all models actually furnished.
    d. Furnish all and only pertinent brochures, illustrations, drawings, cuts, bulletins, technical data, certified performance charts and other literature with the model actually furnished to be clearly and conspicuously identified.
    e. Internal wiring diagrams and engineering data sheets for all items and/or equipment furnished under each Contract.
    f. Guarantee and warranty data.

6. Each Contractor shall furnish instructions for lubricating each piece of equipment installed by him. Instructions shall state type of lubricant, where and how frequently lubrication is required. Frame instructions under glass and hang in a location as directed by Architect.

1.26 MANUFACTURER'S REPRESENTATIVE AND COMMISSIONING OF SYSTEMS

A. Each Contractor shall provide, at appropriate time or as directed by the Architect, the on-site services of a competent factory trained Engineer or authorized representative of particular manufacturer of equipment provided under his Contract, such as for the air handling units, automatic temperature controls, building automation system (BAS), fire pump, domestic hot water heaters, boilers, etc., provided under this Contract, to instruct the Owner, inspect, adjust and place in proper operating condition any item provided by him, as applicable.

B. The HVAC Contractor, as applicable, shall commission and set in operating condition all major equipment and systems, such as the condenser water, hot water and all air handling systems, etc., in the presence of the applicable equipment manufacturer's representatives, and the Owner and Architect's representatives. In no case will major systems and equipment be commissioned by any of the Contractor's forces alone, without the assistance or presence of the equipment manufacturers.

C. A written report shall be issued by the particular equipment manufacturer and the Mechanical Contractor summarizing the results of the commissioning and performance of each system for the Architect's record. No additional compensation will be allowed for any Contractor for such services.

D. The Contractor shall prepare and submit to the Architect for acceptance, a schedule of anticipated system commissioning. No system shall be commissioned without prior acceptance of the schedule by the Architect and Owner. No systems shall be commissioned prior to submittal and acceptance of Operation and Maintenance Manuals.

1.27 CONNECTIONS TO EQUIPMENT

A. Each Contractor shall provide all duct and/or pipe connections, condensate traps, drains, overflows, relief valves and vents, power connections, etc., to make equipment operable, as provided under other Sections of the specifications, as shown on the Architectural and/or each Trade's drawings and herein specified, including final connections to equipment to result in a complete system, fully operational. Coordinate location of all equipment with Architect. Obtain installation diagrams and methods of installation of all equipment from manufacturers. Follow instructions strictly. If additional information is required, obtain same from Architect. If equipment is indicated on the Architectural drawings, it shall also be construed and understood by the Mechanical Contractor to be constructed as shown on the HVAC drawings and shall be fully serviced and connected at no extra cost to the Owner.

1.28 SMOKE DETECTION AND FIRE SAFETY SYSTEMS

A. All duct or unit mounted smoke detectors shall be furnished and wired to the building fire alarm system by the Electrical Contractor. All smoke detectors required in units and ducts and for smoke barrier dampers shall be installed in the field by the HVAC Contractor. Refer to the Contractor Coordination Matrix contained under item 1.34 of this section.

B. All smoke dampers, except in built-up air handling units, shall be furnished by the ATC Contractor with electric actuators field wired by the ATC Contractor. Dampers shall be field installed by the HVAC Contractor, except dampers in the air handling units.

C. The Electrical Contractor, when providing smoke detectors, shall include additional contacts, as required and coordinated with the ATC Contractor, to allow for other control functions, as specified hereinafter. Close coordination must be exercised to allow for the provision of contacts.

D. All smoke detectors shall be installed as recommended by the smoke detection system manufacturer in sheet metal ducts or plenums to ensure that the sensing elements are effective and shall coordinate installation of smoke detectors with the Electrical Contractor and detector manufacturer.

E. The HVAC Contractor shall provide access doors to make all such detection heads accessible, and shall provide bracing for smoke detection sampling tubes, as recommended by the detector manufacturer, to properly and securely support such tubes.

F. If duct smoke detectors are required to be installed in ducts that are exposed to outside ambient conditions, they shall be installed in ventilated accessible weatherproof enclosures. See details on HVAC Drawings.

1.29 ELECTRICAL ROOM REQUIREMENTS

A. The HVAC Contractor [or Subcontractors] shall not install any piping, ductwork or equipment in or through electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms, unless piping, ductwork or equipment is intended to serve these rooms. If any Contractor violates this requirement, he shall remove and/or relocate all items as required at his expense and to the satisfaction of the Architect.

1.30 HOISTING EQUIPMENT AND MACHINERY

A. All hoisting equipment and machinery required for the proper and expeditious prosecution and progress of the work under this Contract shall be furnished, installed, operated and maintained in safe condition by each Contractor for his material and/or equipment delivered to the designated hoisting area. All costs for hoisting operating services shall be borne by the Mechanical Contractor for all equipment and work under his charge.

1.31 STAGING

A. All staging, exterior and interior, required to be over 8'-0" in height, shall be furnished and erected by each Contractor for work under his charge and maintained in safe condition by him for proper execution of his work.

1.32 PHASING, DEMOLITION AND MAINTAINING EXISTING SERVICES

A. During the execution of the work, required relocation of existing equipment and systems in the existing areas where new work and connections are scheduled to be made shall be performed by each Contractor as indicated on the drawings, as required by the job conditions and as determined by the CM in close cooperation with the Architect and Owner's designated representative to facilitate the installation of the new systems and completion of this Contract. The Owner will require the continuous operation of all existing systems, while demolition, relocation work of new tie-ins is being performed. Outages required for construction purposes shall be scheduled for the shortest practical periods of time, in coordination with the Owner's designated representative for specific, mutually agreeable periods of time after each of which the interruption shall cease and service shall be restored. This procedure shall be repeated to suit the Owner's working schedule as many times as required until all work is completed.

B. Prior to any deactivation and relocation, capping, valving, tie-in or demolition work, consult the drawings and arrange a conference with the Architect and the Owner's representative in the field to inspect each of the items to be deactivated, removed or relocated. Care shall be taken to protect all equipment designated to be relocated and reused. Give notice to all parties, with a minimum of (5) working days in advance.

C. All draining of existing systems, filling and venting required to remove and relocate existing piping systems shall be included and provided under this Contract as required to perform the various equipment or piping relocations or new tie-ins.

D. Except as otherwise noted, all deactivation, safe capping, valving, etc., of systems designated to be demolished shall be provided by each Trade, as applicable, and all demolition, removal and disposal of demolished materials shall be performed by the CM. All equipment scheduled to be removed shall be inspected by the Owner, and, if he decides that such equipment is to be salvaged, each Contractor shall deliver said equipment to an area within the site boundaries as determined by the Owner and Architect.

E. The phasing of the work shall be performed in strict accordance with the CM construction schedule. The new systems will be installed and completely commissioned prior to occupancy. Coordinate requirements for temporary heat or rerouting of existing services as required to accomplish the construction schedule.

F. It shall be the responsibility of the Contractor and Sub-Contractor to provide temporary provisions related to maintaining MEP/FP/FA/LV services to support program areas that are to remain occupied and in use by the Owner during the phased construction. (Scope to be inclusive of temporary balancing of systems during interim conditions and ensuring building life safety code requirement are always maintained.)

G. The Location and sizes of existing building system, piping, fixtures, devices, outlets and equipment noted and drawing on these documents have been provided by the Owner. The Contractor shall be responsible for obtaining from the Construction Manager a set of the existing plans. The Contractor shall be responsible for verifying all existing conditions and coordinating with all new systems prior to commencing work.

1.33 CONTROL WIRING

A. The ATC Contractor shall provide all control and interlock wiring for all systems provided under the HVAC, plumbing and ATC Contracts.

B. All control wiring shall be installed in conduit and in accordance with the respective equipment manufacturer's requirements, and all connections shall be provided by the Mechanical and/or the ATC Contractor. All conduit and wiring provided by these Contractors shall be installed in accordance with the requirements of Section 26 of the specifications.

1.34 COMPONENT COORDINATION

A. The HVAC, ATC and Electrical Contractors Scope of Work shall be implemented in accordance with the following matrix:

Device	Furnished By	Installed By	Power Wiring	Control Wiring	Fire Alarm Wiring
Smoke Detectors	26	23	26	25	26
Smoke Dampers in or at AHUs	23	23	N/A	N/A	N/A
Smoke Damper Actuators in or at AHUs	Damper Mfr	23	26	25	N/A
Smoke Dampers	23	23	N/A	N/A	N/A
Smoke Dampers Actuators	Damper Mfr	23	26	28	N/A
Fire Dampers	23	23	25	25	N/A
Supply and Exhaust Boxes	23	23	25	25	N/A
Box Flow Pick-Up	Box Mfr	Box Mfr	N/A	Box Mfr	N/A
Box Damper Actuator	25	Box Mfr	25	25	N/A
Box DDC Controller	25	Box Mfr	25	25	N/A
Box Coil Valve	25	23	N/A	25	N/A
Valve Actuator	25	25	N/A	25	N/A
Supply Valve Reheat Coil	23	23	N/A	N/A	N/A
Reheat Coil Valve	25	23	N/A	25	
Sheet Metal Damper	23	23	N/A	N/A	N/A
Sheet Metal Damper Actuators	25	25	25	25	
Energy Meters	25	23	26	25	N/A
Flow Measuring Stations	25	23	N/A	25	N/A
DDC Panels	25	25	26	25	N/A
Air Compressor	25	25	26	25	N/A
Air Dryer	25	25	26	25	N/A
Control Valves	25	23	25	25	N/A
VSDs at Fans	23	23	26	25	N/A

PART 2 PRODUCTS

2.01 NOT USED

PART 3 EXECUTION

3.01 NOT USED

END OF SECTION

SECTION 230510

3D BUILDING INFORMATION MODELING

1.01 OVERVIEW

A. Building Information Modeling (BIM) is the development and use of a 3-dimensional computer model to represent a virtual model of the facility and the process for constructing the facility. Once the model is developed, it can be used to simulate the construction process and to manage the operations of the facility. The Building Information Model can be created by combining many different 3D models from the designers and contractors into a composite model. From this composite model, views and data appropriate to various users' needs can be extracted and analyzed to generate information, to make decisions and to improve the process of delivering the building.

1.02 OUTCOME

A. The purpose of BIM is to create a model that may be used for coordination of all trades throughout the construction process, with the final product being an as-built model of the Project which contains all of the major elements of construction that could be used by the Owner for future operation and maintenance of the building.

1.03 REQUIRED DISCLAIMER

A. All users shall be required to sign a disclaimer as follows:

TERMS OF USE OF 3D COMPUTER MODEL FOR THE UCHC BUILDING C RENOVATION PROJECT ("Project")

*This 3D Computer Model for the Project is provided by ARC and Svigals + Partners (**Architect)** to user (individually, a "User", or collectively, "Users") at the User's request subject to the terms and conditions stated below (the "Terms of Use"):*

The 3D Model is made available to User solely for his convenience and for informational purposes only. The User is not to rely upon the 3D Computer Model and the data and/or information contained therein in preparing any of the coordination documents for the Project. The User acknowledges that the 3D Computer Model is not a part of the Construction or Contract Documents for the Project and that the Architect makes no representations or warranties, express or implied, regarding the 3D Computer Model's, accuracy or completeness or the data and/or information contained therein.

By opening the files provided, the User agrees that these terms apply to the 3D Model in its entirety, together with all of its component parts and data The User acknowledges that the requirements of these Terms of Use apply to all of User's principals, employees and agents.

The User agrees that the use of the 3D Computer Model is solely at the User's risk and that the User assumes full responsibility and liability in connection with the User's use of the 3D Computer Model and the information and/or data contained therein. The User agrees that the Architect has no responsibility for any deficiencies, inaccuracies, errors and/or omissions contained in the 3D Computer Model or the data and/or information contained therein. The Architect has no responsibility for any deficiencies or defects in the User's documents, work and/or services resulting from the User's use of the 3D Computer Model in lieu of the Construction and/or Contract Documents for the Project.

The User acknowledges and agrees a) that the use of the 3D Computer Model is not a substitute for professional judgment; b) that the use of the 3D Computer Model does not relieve the User from applying the appropriate standard of care and skill relevant to the use of the 3D Computer Model and its contents; c) that the 3D Computer Model is only to be used as a tool to assist the User in connection with the Project; d) that the User is solely responsible for verifying the accuracy of all results created with the use of the 3D Computer Model; and (e) the Architect is not responsible or liable for the means and methods of construction and the User's use of the 3D Computer Model shall in no way give rise to such responsible or liable by the Architect or its consultants.

THE ARCHITECT AND ITS CONSULTANTS SPECIFICALLY DISCLAIM ALL WARRANTIES WHETHER EXPRESSED, IMPLIED OR STATUTORY, INCLUDING, WITHOUT LIMITATION, ALL WARRANTIES OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE, CONSTRUCTABILITY, NON-INFRINGEMENT, COMPATIBILITY, SECURITY OR ACCURACY AND USERS' USE OF THE 3D COMPUTER MODEL IS AT ITS OWN RISK. USER ASSUMES FULL RESPONSIBILITY AND RISK OF LOSS RESULTING FROM USE OR INABILITY TO USE THE 3D COMPUTER MODEL OR ITS CONTENT.

The User further agrees that the 3D Computer Model contains information that is confidential and proprietary to the Architect, and that the Architect retains the copyright and all other reserved rights in the work product reflected in the 3D Computer Model that was prepared by the Architect or its consultants for the Project. The Architect grants the User a non-exclusive, non-transferable royalty-free license to use the 3D Computer Model for informational purposes only in connection with the Project in strict accordance with these Terms of Use. The User agrees that the 3D Computer Model will be used solely and exclusively for the Project and that it will not use the 3D Computer Model and the data and/or information contained therein, in whole or in part, for any purpose or project other than the Project. The User further agrees that the 3D Computer Model will continue to be kept confidential by the User, and that it shall not be disclosed in any manner, transferred or exchanged to any third parties by the User without the express written consent of the Architect.

Upon completion of the User's involvement with the Project or at any time upon written request of the Architect, the User shall promptly deliver to the Architect the 3D Computer Model and any other material containing or reflecting any information or data in the 3D Computer Model (whether prepared by the Architect, the User or otherwise) and will not retain copies, extracts or other reproductions, tangible or intangible, in whole or in part of the 3D Computer Model. The User's non-disclosure and non-use obligations set forth herein shall survive the return, destruction or deletion of the 3D Computer Model. If the User becomes legally compelled, by subpoena or court order, to disclose the 3D Model, or any information contained therein, the User shall provide the Architect with prompt notice so that a protective order or other appropriate remedy may be sought by and at the expense of the Architect and/or compliance with the provisions of this Terms of Use may be waived.

User hereby agrees that the Architect shall be entitled to equitable relief, including injunction, in the event of any breach of the Terms of Use, including without limitation its obligations to maintain the confidentiality of the 3D Model, that the granting of such relief will not be opposed and that such relief shall not be the exclusive remedy for such breach. The Architect's failure to insist upon strict adherence to any term of these Terms of Use shall not be considered a waiver thereof or deprive the Architect of the right subsequently to insist upon strict adherence to that term or any other term of this Terms of Use.

The User hereby agrees, to the fullest extent permitted by law, that in no event shall the Architect be liable to User for any damages or losses of any kind including, but not limited to, damages for death or bodily injury to persons, injury to property, and direct, indirect, consequential, special, or incidental damages, resulting from any error, omission, inaccuracy, deficiency or defect in or problem with, the 3D Computer Model or the data and/or information contained therein. Without limiting the foregoing, the User acknowledges that the 3D Computer Model and the data and/or information contained therein may be inaccurate and/or incomplete and that the Architect will have no obligation to update or modify the 3D Computer Model or any of the data and/or information contained in it because the 3D Computer Model was prepared solely for informational purposes and is not part of the Construction or Contract Documents for the Project.

The User agrees that in the event the User, its officers, directors, shareholders, partners, agents, employees, consultants or independent contractors use the 3D Computer Model or the information and/or data contained therein, it shall, to the fullest extent permitted by law, defend, indemnify and hold the Architect and its officers, directors, shareholders, partners, principals, consultants, agents and employees harmless from and against any and all actions, damages, demands, claims, suits, losses, liability, judgments, recoveries, costs and expenses, including, but not limited to, reasonable attorney's fees which any of them may incur in connection with, arising from, resulting from or related to any use of the 3D Computer Model or the data and/or the information contained therein by the User or any third party who receives the 3D Computer Model from the User. Such claims include, without limitation, any claim which may arise due to deletions, omissions or variations of data due to mechanical or technical failure in connection with the transmission of the 3D Computer Model.

The User acknowledges and agrees that it is not in privity of contract with the Architect as of result of these Terms of Use with respect to any claims or causes of action related to or arising out of the Project. The User further agrees to obligate any contractor, consultant or other party who uses the 3D Computer Model to be bound by the terms and conditions contained herein. Any User's use of the 3D Computer Model and the information and/or data contained therein constitutes such User's acceptance of all the terms here specified.

ACCEPTED & AGREED:

Name: _____

Title: _____

Date: _____

1.04 SCOPE OF WORK

A. General Scope Requirements

1. In general, the BIM scope of work for the Project is to create a technically accurate and detailed 3D computer model of the architectural, structural, mechanical, plumbing and electrical systems.
2. The computer model (in Plan View) shall extend to five feet beyond the exterior walls of the building. Vertically, the model shall extend from the lowest extent of the foundations up through and including the roof of the top-most floor. To the extent that the scope includes building systems, those systems will be included to the full horizontal and vertical extents of the model including underground utilities and roof mounted items.

3. The level of detail defined in the Specific Scope Requirements is the minimum level of detail required in the model. Greater detail than the minimum should be incorporated into the model where important details are necessary for communicating information about a system.
4. Each Trade Contractor shall provide shop drawings in both 2D and 3D model format.
5. The 3D model shall be located and oriented to the pre-determined world coordinates for the project to allow easy integration into the BIM for the project.
6. The 3D model shall include the project control grid. This grid should be visible when viewing the model in a true view along the X, Y or Z axis.
7. The 3D model shall be layered and constructed in a manner such that all elements of the model can be converted into a 2D dimensioned drawing for use in the field.
8. The 2d shop drawing scale should be 1'-0" = 3/8" unless specified otherwise or as required for full comprehensible and reviewable details.
9. Each drawing should include a key map referencing the location in the building.
10. In addition to the native file format, the Trade Contractor shall provide translation of the 3D model into a .DWG, CIS/2 or other agreed upon file format that can be viewed using NavisWorks Manager.
11. The following changes shall be promptly incorporated into the drawings and model, on a regular basis:

    a. RFIs, Bulletins and Owner changes
    b. Changes in the sequence of work
    c. Field modifications
    d. Shop drawing review comments
    e. Changes requested by the Construction Manager

12. All revised 3D model or 2D drawing submittals shall have a written narrative to define changes from previous submittals. Typical drafting techniques such as 'clouds' or 'bubbles' are acceptable means of tracking changes on the 2D and 3D drawings.
13. The working 3D model will be shared with the Trade Contractors and design team at least once every two weeks. This will be performed by posting the model to the project FTP site or PrologWeb. The Trade Contractor will post the native file format and an agreed upon file format as defined in Item J above.
14. Pre-detailing meeting:

    a. Shall determine the lead trade.
    b. The order that coordination work will be added to the model.

15. The 3D modeling and workset conventions will be established at a pre-detailing meeting to be attended by:

    a. Concrete Contractor and detailer
    b. Steel Fabricator and detailer
    c. Mechanical Contractors and detailers
    d. Electrical Contractors and detailers
    e. Plumbing Contractors and detailers
    f. Fire protection Contractors and detailers
    g. Other trades.

16. Each Trade Contractor will submit its 3D modeling software and proposed file format(s) for approval prior to proceeding with detailing. The Trade Contractor will also provide a 3D mock-up of a specific portion of the project, to be agreed upon at a future time, in full detail in order to verify the compatibility of the file formats.

17. Each Trade Contractor shall provide viewer licenses only for its specific 3D software to the following:

    a. Owner
    b. Construction Manager
    c. Architect
    d. Engineer of Record

18. Each Trade Contractor and detailers shall have the capability to host and attend web meeting using Microsoft Live Meeting software.
19. Each Trade Contractor shall complete the drawings and model in a time frame capable of meeting the Project Schedule.
20. Each Trade Contractors are advised that the model shall be shared among all trades and shall be the basis of coordination and fabrication. Costs incurred for post-coordination changes caused by unauthorized deviations from the model shall be borne by the Trade Contractor that initially deviated from the model. This determination is at the sole discretion of the Construction Manager.
21. The base architectural BIM will be created using AutoDesk's Revit Building.
22. The 3D modeling effort is intended to augment and assist in the MEP coordination process. Before first submission shop drawings, the elements shall be first pass coordinated in the 3D model. The model is intended to find conflicts before shop drawings are reviewed and approved.
23. In addition to the requirements set forth in the contract documents, final models shall be submitted reflecting true "as-built" conditions.

B. Plumbing Technical Scope Requirements

1. All plumbing piping will be modeled. All plumbing equipment will be modeled to its overall height, width and depth. Pipes will be modeled to the outside diameter of the pipe or the pipe insulation, whichever is greater. Pipe slope will be incorporated in the model.
2. Pipe fittings and connections will not be modeled. All valves, clean outs and accessories will be modeled.
3. Each Trade Contractor to provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
4. Each Trade Contractor shall be prepared to attend weekly coordination meetings to resolve conflicts within the model.
5. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
6. The 3D model is to include access areas for equipment – included as a modeled element such that clash detection and coordination can be accommodated relating to access.
7. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
8. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
9. All items modeled shall have a level of intelligence associated with them, including, at a minimum, material type, size, insulation, etc.
10. All items located within mechanical rooms shall have a level of intelligence associated with them that includes, at a minimum, material type, size, insulation, manufacturer, product numbers, serial numbers, maintenance schedules, operation and maintenance data, etc.
11. All conduits shall be modeled.

C. Electrical Technical Scope Requirements

1. All electrical equipment including switchgear, transformers and panelboards will be modeled to its overall size. All necessary clearances for electrical equipment will be modeled as a separate volume. All conduit 1-1/2" and larger shall be modeled.
2. All light fixtures will be modeled as an overall volume require for that fixture.
3. Each Trade Contractor shall provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
4. Each Trade Contractor shall be prepared to attend weekly coordination meetings to resolve conflicts within the model.
5. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
6. The 3D model is to include access areas for equipment – included as a modeled element such that clash detection and coordination can be accommodated relating to access.
7. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
8. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
9. All panelboards modeled shall have a level of intelligence associated with them that accurately identifies at a minimum the panel schedule.
10. All items located within electrical rooms and closets shall have a level of intelligence associated with them that includes, at a minimum, material type, size, manufacturer, product numbers, serial numbers, maintenance schedules, operation and maintenance data, etc.

D. Fire Protection Technical Scope Requirements

1. All fire protection equipment including pipe, valves, heads, risers and drains will be modeled.
2. All light fixtures will be modeled as an overall volume require for that fixture.
3. Each Trade Contractor to provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
4. This Trade Contractor shall be prepared to attend weekly coordination meetings to resolve conflicts within the model.
5. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
6. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
7. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
8. All items modeled shall have a level of intelligence associated with them that accurately identifies at a minimum the material type, rating, model number, etc.
9. All conduits shall be modeled

E. Mechanical / Sheetmetal Technical Scope Requirements

1. All ducts and air handling equipment will be modeled. Ducts will be modeled to the outside face dimension. Equipment will be modeled to its overall height, width and depth. All piping associated with the mechanical system will be modeled. Pipes will be modeled to the outside diameter of the pipe or pipe insulation (whichever is greater).
2. Pipe hangers and hanger assemblies and dunnage will be modeled for clash detection and coordination. Fittings and connections will not be modeled. The intent of this model is to show the ductwork and piping, etc. in a true representation of the actual condition at construction completion.
3. Pipe fittings and connections will not be modeled. All valves, clean outs and accessories will be modeled.
4. Each Trade Contractor to provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
5. Each Trade Contractor shall be prepared to attend weekly coordination meetings to resolve conflicts within the model.
6. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
7. The 3D model is to include access areas for equipment – included as a modeled element such that clash detection and coordination can be accommodated relating to access.
8. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
9. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
10. All items modeled shall have a level of intelligence associated with them including, at a minimum, the material type, size, insulation, etc.
11. The Basement Level and Level 5 Mechanical Rooms shall have a level of intelligence associated with them that includes at a minimum material type, size, insulation, manufacturer, product numbers, serial numbers, maintenance schedules, operation and maintenance data, etc.
12. Each Trade Contractor shall include in their base bid BIM/Coordination facilities on site. The Construction Manager shall provide a Coordination Trailer for the Construction Team's use throughout the duration of the project. The HVAC Trade Contractor must provide a CAD workstation capable of running the Trade Contractor's CAD software as well as the following BIM software:

    a. NavisWorks Manager (current version)
    b. AutoCAD Revit Architecture Suite (current version)
    c. AutoCAD Revit MEP Suite (current version)

13. Each Trade Contractor shall turn over the above software complete with Licenses at Final Completion for the Owner's use.
14. All conduits shall be modeled.

F. Fire Alarm Technical Scope Requirements

1. All fire Alarm equipment including Fire Alarm conduit sizes/routing and Fire Alarm Panels and associated panels will be modeled.

2. Each Trade Contractor to provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
3. This Trade Contractor shall be prepared to attend weekly coordination meeting to resolve conflicts within the model.
4. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
5. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
6. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
7. All items modeled shall have a level of intelligence associated with them that accurately identifies at a minimum the material type, rating, model number, etc.
8. All conduits shall be modeled.

G. ATC Technical Scope Requirements

1. The ATC equipment including conduit and panels will be modeled.
2. Each Trade Contractor to provide a list of minimum typical clearances for all model components and coordinate necessary clearances within the model. The 3D model is to include clearances for equipment – included as a modeled volume such that clash detection and coordination can be accommodated relating to necessary clearances.
3. This Trade Contractor shall be prepared to attend weekly coordination meeting to resolve conflicts within the model.
4. The 3D models submitted by the Trade Contractor for overall coordination are required to be checked and coordinated with the structure and the Trade Contractor's own work prior to submittal.
5. Coordinated model data is to be distributed weekly and 1 day prior to coordination meetings.
6. Penetrations through building systems shall be identified in the 3D model by means of a modeled sleeve.
7. All items modeled shall have a level of intelligence associated with them that accurately identifies at a minimum the material type, rating, model number, etc.
8. All conduits shall be modeled.

END OF SECTION

SECTION 230513

MOTORS AND CONTROLLERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500, Division 25 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all motors required for all mechanical equipment specified under this Division.

B. Furnish and install all individual motor controllers, starters and disconnect switches not provided under Divisions 26, 27 and 28 – Electrical Work.

C. All motors shall be premium efficiency suitable for the duty and voltage service available and as indicated on the contract drawings.

D. Provide all necessary control transformers so all motors, starters, disconnect switches, etc. are compatible with the control and operating sequences specified.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. AFBMA: Anti-Friction Bearing Manufacturers Association.

   a. 1-84 – Terminology for Anti Friction Ball and Roller Bearings and Parts.
   b. 9-84 – Load Ratings and Fatigue Life for Ball Bearings.
   c. 11-78 – Load Ratings and Fatigue Life for Roller Bearings.
   d. 20-77 – Metric Ball and Roller Bearings Conforming to Basic Boundary Plans

2. ANSI: American National Standards Institute.

   a. 50-84 – Mechanical Vibration of Rotating and Reciprocating Machinery.

3. ASTM: American Society for Testing and Materials.

   a. A48-83 – Gray Iron Castings.
   b. B117-85 – Method of Salt Spray (Fog) Testing.

4. IEEE: Institute of Electrical and Electronic Engineers.

   a. 1-86 – General Principals for Temperature Limits in the Rating of Electrical Equipment.
   b. 85-73 – Test Procedures for Airborne Sound Measurements on Rotating Electric Machinery.
   c. 112-84 – Standard Test Procedures for Polyphase Induction Motors and Generators.
   d. 114-82 – Test Procedures for Single-Phase Induction Motors.
   e. 117-74 – Test Procedures for Evaluation of Systems of Insulating Materials for Random-Wound AC Electric Machinery. Single-Phase Induction Motors.

5. NEMA: National Electrical Manufacturer's Association.

   a. MG 1-78 – Motors and Generators.

6. NFPA: National Fire Protection Association.
7. National Electrical Code.
8. SAE: Society of Automotive Engineers.
9. SAE Grade 5.

1.05 SYSTEM DESCRIPTION

A. Furnish and install all premium efficiency motors for all systems and equipment.

B. Motor Controllers: Provide individual motor controllers not provided under Division 26. Coordinate with the Division 26 Contractor to determine the location, size and number of individual motor controllers to be provided under this Division.

C. Mounting and installing of motors and drives.

D. Installation of motor controllers supplied under this Division.

E. Work shall be done in accordance with requirements of Division 26 "Electrical Work". Wiring shall be done under Divisions 26, 27 and 28.

F. Disconnect switches; Provide combination motor controller and disconnect switch where required under Division 23 as specified in Division 26. If not specified under individual product sections, then disconnect switches shall be furnished and installed under Division 26.

1.06 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: Provide product description and list of materials including all motor efficiency ratings.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.07 QUALITY ASSURANCE

A. Manufacturer regularly engaged in the design, testing and manufacturing of specified products and issuing complete catalog data on such products.

B. Manufacturers must prove expertise in the design, testing and production of specified or similar to specified products for at least ten (10) years prior to date of bid.

C. Manufacturer must provide written certification that the products provided meet or exceed the specification requirements. An executive officer of the company must sign the written certification.

1.08 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of materials shall be made to the project by the materials supplier in accordance with the instructions of the Contractor.

B. The Contractor shall provide adequate storage space for the materials, shall be responsible for all items of materials after receipt from the supplier, and shall replace all materials lost or damaged after delivery and receipt.

C. The Contractor shall furnish the materials supplier with receipts for all materials and accessory items received, and shall send copies of these receipts to the Architect.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURER CONTINGENT ON COMPLIANCE WITH SPECIFICATIONS

A. Motors:

1. Toshiba
2. General Electric Company
3. Reliance Electric Company
4. US motor
5. Baldor

B. Motor controllers:

1. General Electric
2. Square D.
3. Allen Bradley
4. Westinghouse/Cutler-Hammer
5. Cerus

2.02 GENERAL

A. All control wiring shall be installed in conduits and in accordance with the respective equipment manufacturer requirements. All connections shall be provided by the HVAC Contractor. All conduit and wiring provided by the Mechanical Contractor shall be installed in accordance with the requirements of Division 26 of these Specifications.

B. Motors shall be built in accordance with latest Standards of NEMA and as specified. Motors shall be specifically and expressly wound for voltage required.

C. Motors shall be tested in accordance with ANSI 50 and conform thereto for insulation resistance and dielectric strength.

D. Motors shall be provided with adequate starting and protective equipment as specified or required and with conduit terminal box of size adequate to accommodate conduits and wires.

E. Capacity shall be sufficient to operate motors under job conditions of operation and load, without overload and shall be at least the horsepower size indicated or specified.

F. All motors shall be suitable for continuous duty at rated horsepower, with temperature rise not to exceed 90°C above a 40º (with a 1.15 SF (before rise). All motors shall be capable of 15% overload without overheating. All motors shall be rated and certified for use with VFDs per NEMA MG1 Section 31.

G. All motors shall be properly grounded.

H. Motors Powered through Variable Frequency Drives

1. 3/4 to 75 MHP shall be provided with one of the following:

a. Shaft grounding rings (drive end)
b. Insulated sleeve bearings (Both ends)
c. Insulated bearings (Both ends).

2. 100 MHP and larger shall be provided with shaft grounding rings and one of the following:

a. Insulated sleeve bearings both ends.
b. Insulated bearings both ends.

I. All motors shall be rated and certified for inverter duty, and stamped as such.

1. All motors shall have Class F insulation or higher temperatures.
2. Manufactured to maximize Corona Inception Voltage (CIV) rating.

a. The minimum acceptable shall be 2500 Volts at 155°C.

3. Windings shall be in-slot wound type.

J. Direct connected motors shall be furnished with adjustable base. Motors connected to driven equipment by belt or shaft shall be furnished with adjustable sliding bases, except for fractional motors which shall be furnished with slotted mounting holes.

K. Motors shall have nameplates giving manufacturer's name, serial number, horsepower, speed and current characteristics.

L. Motors smaller than 1/2 HP shall be capacitor, starter or split-phase type. Motors 1/2 HP and larger shall be squirrel cage, induction type. Motors 1 HP and larger shall have grease lubricated ball bearings and approved grease fittings. Motors provided shall have voltage, phase and hertz characteristics, as scheduled on the drawings.

M. Except for electrical apparatus specifically called for to be provided under this Contract, all motor starters, disconnect switches, controllers and other electrical appurtenances required under the HVAC, Plumbing, Fire Protection, etc. work, shall be provided under Division 26. Study the Electrical drawings and coordinate requirements and quantities with the Electrical Contractor.

N. All electrical apparatus and controls furnished as a part of the HVAC, Plumbing, Fire Protection, etc. work shall conform to applicable requirements under Electrical Section.

O. Each Contractor shall provide the Electrical Contractor with all motor size and wiring requirements within (30) days from date of Contract to allow proper coordination of Trades by the General Contractor.

P. Each Contractor shall verify with the Electrical Contractor available electrical characteristics before ordering any equipment or motors.

Q. Equipment which includes a number of correlated electrical control devices mounted in a single enclosure or on a common base with equipment, shall be supplied for installation completely wired internally with terminal strip ready for external wiring. Unless specifically directed otherwise in the Contract Documents, if these control devices are separately mounted they shall be furnished by the HVAC Contractor and wired by ATC Contractor or Electrical Contractor in accordance with the manufacturer's wiring diagram, as shown on the drawings and as specified hereinafter.

R. All motors shall meet NEMA vibration requirements and shall be less than 0.15 in./sec.

2.03 SHAFT GROUNDING RINGS

A. Shall be maintenance-free, circumferential, conductive micro fiber shaft grounding ring

B. Shall be installed on the AC motor to discharge shaft currents to ground.

C. Similar to AEGIS shaft grounding rings (SGRs).

2.04 MOTORS

A. In accordance with NEMA, IEEE and ANSI 50 Standards.

B. Capacity: Minimum of indicated horsepower and to operate driven devices under all conditions without overload.

C. Provide all of the same manufacturer, except those provided integrally with equipment.

D. Motor type and application (1/2 hp and above):

1. Conditioned areas and heated ventilated areas protected from weather:

a. Squirrel-cage induction type, open drip-proof, NEMA B design, rated for 90 degree C rise over 40 degree C ambient, Class B insulation up to 1 hp and class f insulation above 1 hp, 1.15 service factor, continuous rating per NEMA MG1-1.40.
b. Unless otherwise noted on the mechanical contract drawings or specified.

2. Motors installed outdoors, on roofs and out of building airstreams:

   a. Squirrel-cage induction type, totally enclosed fan cooled, NEMA B design, class B insulation, up to 1 hp and Class F insulation above 1 hp 1.15 service factor, continuous duty unless otherwise noted on the contract drawings or specified.

E. Motor shall be 1800 rpm single speed motors unless otherwise noted on the contract drawings.

F. Motor type and application (less than ½ hp).

1. Built in overload protection.
2. Rewinding tap, permanent split capacitor type, unless otherwise noted on the contract drawings or specified.
3. Suitable for service and location.
4. Motor shall be 1800 rpm single speed motors, unless otherwise noted on the contract drawings.

G. Motor voltages:

1. Motors less than ½ hp: Single phase, 60 hertz, 120 volt, AC, unless otherwise indicated on the contract drawings.
2. Motors ½ hp and up. Suitable for 3 phase, 60 hertz, 480 volt, AC power source, unless otherwise indicated on the contract drawings.

H. Motor Efficiency Ratings And Construction

1. Motors 1.0 hp up to 250 hp: Suitable for 3 phase, 60 hertz, 480 volt, AC power source, premium-efficient type, unless otherwise noted on the contract drawings as specified.
2. Guaranteed minimum power factor at full load and rated voltage and guaranteed minimum efficiency at full load and rated voltage when tested in accordance with IEEE Test Procedure 112A, Method B.
3. Premium-efficient type motors shall conform to the following efficiencies:

Nominal Efficiencies For NEMA Premium Efficiency
Motors Rated at 600 Volts or Less

	Open Drip Proof			Totally Enclosed Fan-cooled		
HP	6 pole	4 pole	2 pole	6 pole	4 pole	2 pole
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	91.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93.0	94.1	94.5	93.0
60	94.5	95.0	93.6	94.5	95.0	93.6
75	94.5	95.0	93.6	94.5	95.4	93.6

Nominal Efficiencies For NEMA Premium Efficiency
Motors Rated at 600 Volts or Less

	Open Drip Proof			Totally Enclosed Fan-cooled		
HP	6 pole	4 pole	2 pole	6 pole	4 pole	2 pole
100	95.0	95.4	93.6	95.0	95.4	94.1
125	95.0	95.4	94.1	95.0	95.4	95.0
150	95.4	95.8	94.1	95.8	95.8	95.0

4. Motors less than 1 hp shall be manufacturer's standard premium efficiency design.
5. Motor nameplate shall be specially marked "energy efficient motor" or similar nomenclature.
6. Motors built in accordance with current NEMA Standard MG-1 except as noted.

    a. Motors NEMA Design B, NEMA T-frame sizes.
    b. Insulation tested by manufacturer, Class F or better. Test per NEMA MG1-12.03.
    c. Temperature rise limits in accordance with NEMA limits for insulation class, service factor and enclosure specified.

I. Materials and Construction:

1. Motors up to 5 hp

    a. Steel motor frames, cast aluminum end brackets, steel terminal box, copper windings.

2. Motors 5 hp and larger:

    a. Cast iron motor frames, cast iron end brackets, cast iron terminal box, copper windings.

3. TEFC Motors

    a. Cast iron motor frames, cast iron end brackets, cast iron terminal box, copper windings, corrosion resistant fan internals, epoxy varnish coated for corrosion protection, cadmium plated hardware.

    b. Severe duty motors:

        1) Cast iron construction (frame, end brackets and terminal box). External hardware, fan and fan cover coated or plated to prevent corrosion or corrosion-resistant material. Air gap surfaces coated with epoxy or zinc chromate. Shafts with rotating shaft mounted slingers or seals to prevent entry of contaminants at each end. Epoxy insulation system where used in high-moisture and corrosive atmospheres.

4. Explosion proof motors:

    a. UL listed for application or duty.
    b. Motors shall conform to requirements defined in Article 500, 501, 502, 503 of the National Electric Code.
    c. Motor nameplate shall be specifically marked "explosion proof" or similar such nomenclature.

5. Sound-power levels no greater than recommendations of NEMA (MG1-12-49).

J. Motors 1/2 hp and above, conform to following:

1. Bearings: Antifriction type with bearing housings equipped with easily accessible plugged provisions for relubrication. Minimum L-10 life of 100,000 hours based on direct drive equipment. Bearing housings shall be equipped with grease openings for simultaneously adding new grease and purging the old grease. Provide corrosion resistant plugs or caps on grease openings.
2. Belt-connected motors: NEMA foundation slide base and shaft as required for aligning pulleys. Minimum L-10 life based on belt drive shall be 40,000 hrs.
3. Motor enclosure: Suitable for service and location.

2.05 MOTOR DISCONNECT

A. Provide only devices of Specification Grade, UL listed and labeled, manufacturer's certification to meet applicable Federal Specifications, and to meet NEMA performance standards.

B. Disconnects shall be "Heavy Duty Type".

C. Single phase disconnect switches: Two pole toggle operated AC manual motor starting switch without overload protection for single phase motors.

D. Three phase disconnect switches: 3 pole fusible or unfusible as required; 250 or 600 volt as required in NEMA 4 enclosures.

E. The operating handle for three phase disconnect switches shall be of the box-mounted type that directly drives the switch mechanism.

F. Three phase disconnect switches shall have a defeatable, front accessible, interlock to prevent the opening of the cover when the switch is in the "ON" position and prevent turning the switch "ON" when the door is open.

G. Solid neutral: Provide as required.

H. Provide ground lug for ground wire termination.

I. All disconnects shall be lockable.

J. Operating handle: Lockable in either open or closed position.

K. All motor disconnects shall be horsepower rated.

L. Feed through or double lugged: UL approved for the purpose.

M. Installation:

1. All switches shall have a nameplate indicating the circuit number feeding the switch. Nameplate shall be laminated black with white letters engraved.
2. Install a motor disconnect switch with every motor unless noted otherwise on mechanical equipment schedules.

2.06 MOTOR CONTROLLERS

A. Manual motor controller:

1. For single phase motors, provide H-O-A switches with thermal overload.
2. 2-speed: Fast-slow-off selector switch with overload protection for each speed, with pilot lights for slow and fast speed.

B. Magnetic motor controller:

1. Provide magnetic contactors with three overload relays, for motor running overload protection, per NEC.
2. 120 Volt holding coil.
3. Provide status pilot light in cover, red for energized. Pilot light shall be operated by an extra interlock (not placed across holding coil). Pilot light shall be long life (130 volt) type 6S6 incandescent lamps.
4. Provide reset button, and Hand-Off-Automatic switch in cover, field convertible to Off-Auto or Start/Stop pushbutton.
5. Provide one set of convertible auxiliary contacts in addition to standard auxiliary holding contacts supplied with each contactor.
6. Provide control transformer 120 volt secondary of sufficient capacity to handle operating coil and associated controls plus 75 volt amps.
7. Provide surface mounted starters in NEMA Type 1 enclosure for indoor applications and NEMA Type 4 enclosure for outdoor applications.
8. Contacts shall be solid-silver cadmium oxide alloy which will not require any filing, dressing or cleaning throughout the life of the control equipment. Bare copper or silver flashed contacts shall not be permitted.
9. Operating coils shall be pressure molded. When a coil fails under over-voltage condition, the motor controller shall drop out.
10. Overload relays shall be of the hand-reset, trip-free variety so that blocking the reset mechanism in the reset position will not prevent the starter from dropping out if the motor is overloaded. This specifically excludes those overload relays which change to automatic reset from hand-reset when the reset mechanism is blocked unless the automatic reset feature can be removed or voided. Accidentally depressing the reset button or mechanism shall not shut off the motor. Overload relays shall not be field convertible from hand to automatic reset type.
11. Disconnect switch shall be provided under Division 26 unless otherwise noted.
12. Where specified, motor hp rated disconnect switches shall be provided in NEMA 1 enclosure for indoor applications and NEMA 4 enclosures for outdoor applications.
13. Provide full coordination between settings or ratings of protective devices in accordance with the NEC.

C. Combination motor controller (only where indicated on the contract drawings or specified).

1. Provide molded case circuit breakers with rotary operating handle and lock-off facility.
2. Restrict opening of switch enclosure by the use of a defeater screw unless switch is in the OFF position.
3. Provide contactors with three overlay relays.

    a. 120 Volt holding coil.

b. Provide status pilot light in cover, red for energized. Pilot light shall be operated by an extra interlock (not placed across holding coil) Pilot lights shall be long life (130 volt) type 6S6 incandescent lamps.

4. Provide reset button, and Hand-Off-Automatic switch in cover, field convertible to Off/Auto or Start/Stop pushbutton.
5. Provide one set of auxiliary contacts in addition to standard auxiliary hold contacts supplied with each contactor.
6. Provide control transformer 120 volt secondary of sufficient capacity to handle operating coil and associated controls plus additional 75 volt amps.
7. Time-delay relays shall be adjustable, pneumatic type, 2 to 60 seconds and operate on 120 volts, 60 hertz. They shall have at least one normally open and one normally closed timed contact. The type of operation is as indicated or required.

PART 3 INSTALLATION

3.01 MOTORS

A. Coordinate with appropriate trades.

1. Motor and base mounting requirements.
2. Motor electrical requirements.

B. Motors shall be installed in accordance with manufacturer's installation instructions.

C. Motors shall be installed in accordance with all applicable codes.

D. Mechanical Contractor shall assist the ATC Contractor in the calibration process of all motor current transformers as detailed in Division 25.

3.02 CONTROLLER

A. Provide all controllers not indicated on Electrical drawings.

END OF SECTION

SECTION 230514

VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install variable frequency drives (VFDs) for mechanical equipment as scheduled on the drawings and specified herein. The term VFD shall refer to the entire assembly including but not limited to the by-pass.

B. The VFD's shall comply with the latest applicable standards of ANSI, IEEE, NEMA, NEC, UL and City Test Lab. The controllers shall be rated as indicated. As a minimum, the full load output current of the drive shall be equal to the equivalent motor horsepower as listed by NEC Table 430-150.

C. Drive horsepowers shall be minimum size as indicated. Coordinate size with driven equipment manufacturer.

D. Provide UL listed, accessory reactors to be UL listed. Bypass panels shall be constructed of UL recognized components assembled in a UL listed enclosure in strict accordance with the NEC for electrical safety. In addition the assembly shall be UL listed.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. IEEE: Institute of Electrical and Electronic Engineers
2. NEMA: National electrical Manufacture's Association
3. MG 1-78: Motors and Generators
4. NEC: National Electrical Code
5. ANSI: American National Standards Institute
6. UL: Underwriter's Laboratories

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: Provide product description and list of materials, including the following:

1. Harmonic calculations

   a. List of all drives.
   b. Simplified one line diagram indicating linear as well as drives, transformers and PCC.
   c. Technical description of the program used for the calculations.
   d. Description of all inputs and outputs from the program.

2. Complete drawings furnished and approved before proceeding with manufacture. Drawings shall consist of a specific bill of materials, connection diagrams and suitable outline drawings showing details necessary to locate conduit stub-ups and field wiring.

   a. Details including all labeling.
   b. Assembled panel short circuit rating and how it will be labeled.
   c. Heat release of the drive.

3. Description of field testing.

   a. Proposed schedule of testing indications coordination with occupancy.

4. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.06 QUALITY ASSURANCE

A. Manufacturers must have more than ten (10) years of documents experience in the design, testing and manufacturing of specified or similar products.

B. Manufacturer must provide written certification that the products provided meet or exceed the specification requirements. An executive officer of the company must sign the written certification.

1.07 WARRANTY

A. Attention is directed to provisions of the General Conditions and Supplementary General Conditions regarding guarantees and warranties for work under this Contract.

B. Manufacturers shall provide guarantees for work under this Contract. However, such guarantees shall be in addition to and not in lieu of all other liabilities which the manufacturer and the Contractor may have by Law or by other provisions of the Contract Documents.

C. All materials, items of equipment and workmanship furnished under each Section shall carry the standard warranty against all defects in material and workmanship. Any fault due to defective or improper material, equipment, workmanship or design which may develop shall be made good, forthwith, by and at the expense of the Contractor including all other damage done to areas, materials and other systems resulting from this failure.

D. The Contractor shall guarantee that all elements of the systems provided under his Contract, are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.

E. Upon receipt of notice from the Owner's representative of failure of any part of the systems or equipment during the warranty period, the affected part or parts shall be replaced by the Contractor, within three (3) working days, at no cost to the Owner.

F. The Contractor shall furnish a written guarantee covering the above requirements before the final payment is made.

PART 2 PRODUCTS

2.01 VARIABLE FREQUENCY DRIVES

A. General

1. Provide a complete variable frequency drive (VFD) (in a single enclosure) of capacity, quantity and characteristics as described in this specification and as shown and scheduled on the drawings. Acceptable manufacturers contingent on compliance with specifications are:

a. 30 HP and Larger **(18-Pulse or Greater Units Only)**

1) ABB
2) Halmar Robocon Group
3) Schneider/Square D
4) General Electric
5) Cutler Hammer
6) Emerson
7) Danfoss
8) Yaskawa

<u>Note</u>: 6-pulse units will be rejected.

b. 25 HP and Less **(6 Pulse or Greater)**

1) ABB
2) Halmar Robocon Group
3) Schneider/Square D
4) General Electric
5) Cutler Hammer
6) Emerson
7) Danfoss
8) Yaskawa

2. All VFDs (6 & 18 pulse) shall be of the same manufacturer.
3. Each drive and assembly (with or without bypasses) shall be U.L. listed and labeled.

a. Label shall include the AIC rating for the assembly (SSCR) which shall not be less than 100,000 AIC.
b. Any unit shipped without such label shall be removed from the job with NO EXCEPTIONS. This also includes six pulse drives with or without bypasses.

4. Each drive shall be mounted with its accessories in a single cabinet.
5. Installation and start-up services for the equipment shall be covered by this specification.

6. Input control signal shall be compatible with automatic controls and/or building automation control system. Submit written, signed off coordination with submittal.
7. Complete drawings shall be furnished and approved before proceeding with manufacture. Drawings shall consist of a specific bill of materials, connection diagrams and suitable outline drawings showing details necessary to locate conduit stub-ups and field wiring.
8. The VFD shall comply with the latest applicable standards of ANSI, IEEE and NEMA. The controllers shall be rated as shown in the drawings. As a minimum, the full load output current of the drive shall be equal to the equivalent motor horsepower as listed by NEC Table 430-150.
9. Drive horsepowers shall be minimum size as indicated. Coordinate size with driven equipment manufacturer.
10. The VFD manufacturer shall supply with submittal information, harmonic calculations made in accordance with IEEE 519-1992 Standards showing the specified THVD, line notching and the specified THCD limits are met. Calculations shall assume worst case system conditions. System 1-line, 480V transformer data, standby generator data, and primary fault current data required to make these calculations are provided in the system short circuit study and can be obtained from the Electrical Contractor. The submittal shall include, as a minimum, the following information:

    a. All input data and assumptions.
    b. Explanation of method used to perform the analysis.
    c. All calculations and computer printouts used in the analysis, including input documentation.

        1) List all drives and accessories.
        2) Explanation of all inputs
        3) Explanation of all outputs.

    d. A system impedance diagram based on the Electrical one-line diagrams. It shall be the drive manufactures responsibility to obtain all information required.
    e. All calculations shall be in accordance with IEEE 519 with all drives at 100% speed. The point of common coupling shall be the secondary connection of the transformer supplying that group of devices. These calculations shall be done with the transformer loaded to no more than 70% of its nominal capacity (without fans). These calculations shall also be done with all 18-pulse or greater drives running as well as the smaller drives running.
    f. Each point of common coupling shall be defined as the secondary side of the transformer that feeds that group of drives. At the point of common coupling, the following numbers shall meet with the maximum load on the transformer no greater than 70% of its nominal capacity.

        1) **Total harmonic voltage distortion is less than 3%**
        2) **Total harmonic current distortion is less than 5% and harmonic table requirements I_{SC} / I_L <20**

        <u>Note</u>: 6-pulse drives will not be accepted on 30 HP drives or larger, even if this calculation is met.

    g. A detailed description of the tests, procedures and supporting calculations required to substantiate the installed systems compliance with the specified THD limits.

        1) The description shall include information on the proposed test equipment and test conditions.

2) Include the name and qualifications of the firm which will conduct the field tests.

h. **Submittals without calculations will not be reviewed**.

11. Drives shall be capable of the full rated motor horsepower at all carrier frequencies of that drive.

B. Construction

1. VFDs 30 HP and Larger

a. VFDs 30 HP and larger shall be 18-pulse (or greater) input. Provide data and calculations showing the drive harmonics do not exceed the following numbers at the power connection to the drive.

1) Total harmonic voltage distortion: Less than 3%
2) Total harmonic current distortion: Less than 5% and harmonic table requirements for $I_{SC}/I_L < 20$.

Note: These are the maximum harmonics that can be generated by each of these drives.

b. The use of the following devices is permitted:

1) A.C. Line reactors
2) DC chokes
3) KMP Transformers
4) KMP + XFMR Filter Transformers

c. The use of the following devices is not permitted:

1) Passive filters.
2) Broad band filters.

2. VFDs 25 HP and Less

a. VFDs 25 HP and less shall be 6-pulse (or greater) input. Provide data and calculations showing the drive harmonics.
b. 5% line reactors shall be provided on each drive as a minimum.
c. The use of the following devices is not permitted:

1) Passive filters.
2) Broad band filters.

d. The use of the following devices is permitted:

1) Changing additional drives to 18 pulse or greater.

3. Harmonic Table

I_{SC} / I_L	Harmonic Order (Odd Harmonics)					THD
	H<11	11<h17	17<h23	23<h35	35<h	
<20	4.0	2.0	1.5	0.6	0.3	5.0
20-50	7.0	3.5	2.5	1.0	0.5	8.0
50-100	10.0	4.5	4.0	1.5	0.7	12.0
100-1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

4. 18 Pulse Transformer

   a. Auto transformer

      1) Voltage 480.
      2) Input variation less than 3%.
      3) Insulation Class 220°C
      4) Temperature rise 150°C
      5) With 7.5% AC input line reactors for proper current balance.
      6) Output Voltage unbalance less than 2% for each bridge
      7) Output current shall be 1/3 of rated input

   b. Isolation Transformer.

      1) Voltage 480.
      2) Input variation less than 3%.
      3) Output Voltage unbalance less than 2% for each bridge
      4) Output current shall be 1/3 of rated input

5. All Drives

   a. The VFD shall be of the pulse width modulated (PWM) design converting the fixed utility voltage and frequency to a variable voltage and frequency output via a 2-step operation. VFDs utilizing a 3rd power section are not acceptable. Efficiency shall exceed 96% at 100% speed and load. Line side displacement power factor shall exceed (0.95) regardless of speed and load. The VFD shall be rated for 110% current for (1) minute for variable torque loads and 150% current for (1) minute for constant torque loads.
   b. VFDs located indoors shall be housed in a signal NEMA 1 metal enclosure (including 18-pulse transformer, filters, line reactor, and other required accessories.
   c. Drives located outside shall be provided with a single NEMA 3R enclosure and an independent heating and cooling system to maintain manufacturer's ambient operating conditions.
   d. Drives located other than outside (submit list of all drives individually indicating):

      1) Space drive is located.
      2) Space ventilation is adequate, space air conditioning is adequate or the size of the cooling provided in the drive.
      3) Space heating is adequate or the size of the heater provided in the drive.

e. Standard operating conditions shall be:

1) Incoming 3-phase 480 VAC power, +5% or -10%, 60 Hz.
2) Humidity 0 to 95% (non-condensing and non-corrosive).
3) Altitude 0'-0" to 3,300'-0" above sea level.
4) Ambient temperature 0° to 40°C.

f. VFDs shall include the following system interfaces:

1) Speed reference interface with a differential amplifier or isolated input 0-10 VDC or 4-20 mADC signal.
2) Run relay with an isolated set of Form C contacts.
3) Minimum of 2 programmable contacts.
4) Trip contacts (Form C).
5) VFD will accept an external trip contact and indicate so on the display.
6) Dedicated terminal blocks for interface with maintained remote start contacts.
7) Output signal proportional to output frequency (0-10 VDC or 4-20 mADC).
8) Output signal proportional to output current (0-10 VDC or 4-20 mADC).
9) Provided with communications chip to provide complete interface with the ATC control and automation system.

g. The VFD shall include the following protective features:

1) Lockable Fused disconnect (or breaker) rated for 100,000 AIC.
2) Electronic instantaneous overcurrent protection.
3) DC bus undervoltage protection.
4) DC bus overvoltage protection.
5) Ability to withstand output line-to-line short circuits without component failure.
6) Status indication via an LED display of the following protective functions:

a) DC Bus Undervoltage
b) Overcurrent
c) DC Bus Overvoltage
d) Controller Overtemperature
e) Overload
f) Overload Warning
g) Overfrequency and Phase Loss
h) A single light to indicate a VFD trip is not acceptable.

7) Overload capability shall be 110% of the inverter rating for (1) minute.
8) Selectable auto restart.
9) VFD will catch a motor spinning in the forward or reverse direction upon starting.
10) Upon loss of the input signal (4-20 mA), the drive will stop or go to preset speed.

h. Standard adjustments shall include:

1) Minimum frequency (4-60 Hz)
2) Maximum frequency (40-120 Hz)
3) Minimum of three (3) preset speeds (4-120 Hz) initiated by contact closures

4) Minimum of three (3) acceleration times (2-300 seconds)
5) Minimum of three (3) deceleration times (2-300 seconds)
6) Minimum speed dwell(stall speed) time (0-18 seconds)
7) Minimum stall speed (fraction of rpm)
8) Voltage boost (0-40V) for starting torque control
9) Adjustable Carrier frequency 700-8,000 Hz for motor noise reduction or flexible switching technology. This adjustment shall be without derating the drive or motor.
10) Current limit (70-120%)
11) Critical frequency avoidance ([2] bands with 10 Hz adjustable widths)

i. Door mounted operator controls and status indication from the LED display shall include:

1) Run/stop selection and LED indication (keypad or remote)
2) Speed control selection and LED indication
3) Forward/Reverse selection
4) Manual speed adjustment
5) Frequency meter
6) Motor RPM
7) Ammeter
8) Output voltage
9) Elapsed time meter

j. The keypad shall have an LED display. The reverse button and the programming functions may be locked out if desired.

6. The following features shall be included:

a. Input lockable disconnect rated 100,000 AIC.
b. Thermal motor overcurrent relay.
c. Bypass which includes an output contactor electrically and mechanically interlocked with a bypass contactor, run relay including control logic, status lights and a thermal motor overcurrent relay. The complete bypass system and Inverter/Off/Bypass selector switch shall be packaged in a single VFD enclosure. The bypass shall include a starter.
d. Drives may be provided without bypass only when

1) The drawing states that the specific drive shall not have bypass.
2) When the fan is part of a redundant configuration.
3) When the pump is part of a redundant configuration.
4) When an existing AHU fan/blower is retro-fit with new motor and VFD (to ensure existing duct distribution system does not become damaged).

e. Electronics shall allow VFD to follow discrete increase speed and discrete decrease speed contact closures from a photohelic or similar device.
f. 120V control transformer and circuitry.
g. Output line reactors or output filters when the drive location and the motor are more than 100 feet apart.
h. Interior heaters shall be provided to maintain the minimum drive temperature when the drive is off.

i. A Customer Interlock Terminal Strip – provide a separate terminal strip for connection of fire, smoke, freeze contacts and external start command. All external interlocks and start/stop contacts shall function with drive in hand, auto or bypass.

1) Damper control circuit shall be operable in the hand, auto and bypass.

7. Service

a. The VFD manufacturer shall provide a start-up service package for all VFDs provided. Service shall include inspector for final adjustment, operational checks, and a final report for record purposes. The service package shall include a (1) year parts and labor warranty and 2 year parts warranty each from date of written acceptance and be performed by local factory trained service engineers. The service center must be permanently located within (200) miles of the job site and able to provide 24-hour service.

8. Protection

a. The VFD shall be protected against damage at all times. The drive shall be stored in a clean, dry environment with temperature and humidity within the range as specified by the drive manufacturer. Space heaters shall be energized controlled storage as recommended by the manufacturer. Storage space shall be environmentally controlled.

9. Factory Tests and Checks

a. VFD power semiconductors and diodes shall be 100% inspected and tested, including load testing.
b. Small signal semiconductors, resistors, capacitors and diodes shall be lot sampled. Testing shall include parameter, as well as functional characteristics.
c. All printed circuit boards shall be tested under a temperature cycling (0°C to +65°C) 24-hour load test and then functionally tested via fault finder bench equipment prior to unit installation.
d. All final assemblies shall be tested at full load with application of line-to-line and line-to-ground bolted faults. The VFD shall trip electronically without device failure.
e. After all tests have been performed, each VFD shall undergo a 24-hour burn-in test. The drive shall be burned-in at 100% inductive or motor load for (24) hours without an unscheduled shutdown.

10. A (1) day training course for Owner's personnel shall be presented by representatives of the manufacturer at the jobsite.

PART 3 EXECUTION

3.01 VFD INSTALLATION

A. Install in accordance with manufacturer recommendations, Contract Drawings, and reviewed submittals.

B. Install to meet the Local and State Electrical Code and so as to ensure easy accessibility for service, removal, or replacement of all components.

C. Provide supplemental steel, support, rods and hangers necessary to hang or mount VFDs.

D. Receive and inspect VFDs to ensure they are without defect. Defective or damaged VFDs shall be returned to the manufacturer.

E. Protect equipment to prevent damage from water, dirt, or accident. Protection shall include, but not be limited to, temporary plastic wrap to maintain equipment in original factory condition.

F. Wiring installation and handling shall be in accordance with manufacturer's recommendations.

G. Provide field testing (as described in Paragraph F, of this above Section).

3.02 FIELD TESTS AND CHECKS

A. Testing, checkout and start-up of the VFD equipment shall be performed under the technical direction of the manufacturer's service engineer. Under no circumstances are any portions of the drive system to be energized without authorization from the manufacturer's representative.

B. The Contractor shall provide independent harmonic testing by an independent testing company. Provide readings with printouts of the harmonic current at each harmonic as well as the total voltage distortion. The following readings shall be provided:

1. At each point of common coupling:

   a. With all drives running with load
   b. With all drives off

2. At the power connection to each drive:

   a. With the drive running loaded
   b. With drive off

3. All the above data shall be submitted to the Architect for review. If these tests shown that the drives are not in compliance with the Specifications, the drive manufacturer shall make all changes required to comply with the Specifications at no cost to the Owner. If required, this could mean replacing the drives that are not in compliance.
4. A copy of all tests and checks performed in the field, complete with meter readings and recordings, where applicable, shall be submitted to the Owner for this record.

END OF SECTION

SECTION 230516

PIPE EXPANSION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all necessary offsets, joints, expansion loops, compensators, anchors and guides so that no stress is placed on the piping systems or equipment due to thermal expansion.

B. Make proper provision for expansion and contraction in all parts of piping systems wherever possible by means of pipe bends, pipe offsets, swing connections or changes in direction of piping. Where piping network cannot be employed to absorb expansion and contraction in the piping systems, provide expansion joint compensators.

C. Expansion compensator elements shall be as specified herein and shall be selected by the manufacturer to withstand system pressure and temperature conditions and to absorb thermal expansion of the piping. Use of expansion compensators in non-accessible locations shall not be permitted.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

B. Refer to Section 230548 – Mechanical Vibration Controls and Seismic Restraints for specific information related to and affecting this Section.

C. Refer to Section 230529 – Hangers and Supports.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ASME B31.1 – Power Piping.
2. ASME B16.5 – Pipe Flanges and Flanged Fittings.
3. ASTM A 269 – Standard specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
4. EJMA (STDS) – Standards; Expansion Joint Manufacturers Association; 1993.
5. MIL-E-17814 – Expansion Joints, Pipe, Slip-Type, Packed

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional information.

B. Product Data:

1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure and total number of wires in braid.
2. Expansion Joints: Indicate maximum temperature and pressure rating and maximum expansion compensation.

C. Design Data: Indicate selection calculations.

D. Constant force hangers shall include the installed load, actual travel and total travel as a minimum.

E. Complete expansion, stress, and seismic calculations.

F. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures and external controls.

G. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors and guides.

H. Maintenance Data: Include adjustment instructions.

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

1.06 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products of the type specified in Part 2 – Products.

B. Installer: Company specializing in performing work of the type specified in this section, with documented experience.

C. Welders: Certify in accordance with ASME.

D. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by Victaulic. Grooving tools shall be supplied by the same manufacturer as the grooved components

1.07 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 code for installation of piping system and ASTM F708 for design and installation of pipe supports.

B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

1. Provide certificate of compliance from authority having jurisdiction, Indicating approval of welders.

1.08 DELIVERY, STORAGE AND HANDLING

A. All expansion compensators shall be delivered in containers and shall be kept in a dry and protected area.

B. All anchors and guides, where exposed, shall be given 2 coats of rust resistant paint of a color selected by the Architect prior to installation.

1.09 ENVIRONMENTAL

A. Do not paint or install expansion compensators, anchors or guides when:

1. Environmental conditions are outside the specific limitations of the referenced codes and/or manufacturer's recommendations.

PART 2 PRODUCTS

2.01 ENGINEERING SERVICES

A. The Contractor shall retain a registered Professional Engineer licensed to practice in the State of Connecticut to review all loads imposed on the building structure and piping system to assure that no points are overstressed.

B. The maximum allowable stress shall be 15,000 psi for cold water, hot water, condensate, and steam piping if pipe material is low carbon steel A53 B or A106 B (Marks' Standard Handbook for Mechanical Engineers, Tenth Edition).

C. The Contractor shall submit shop drawings with calculations (with P.E. stamp) detailing the proposed anchor locations for review.

D. All anchor details and forces shall be submitted to the project structural engineer for review prior to any installation.

E. For Victaulic grooved systems, the manufacturer shall evaluate contractors piping layout to determine if proposed placement of anchors, guides, flexible couplings and expansion compensators is in conformance with the manufacturers' installation guidelines.

2.02 GENERAL

A. Make proper provision for expansion and contraction in all parts of piping systems:

1. Steam and condensate (all pressures)
2. Hot water
3. Relief vents
4. Other piping

B. Wherever possible, provide expansion and contraction by means of pipe bends, pipe offsets, swing connections or changes in direction of piping.

C. Where piping network cannot be employed to absorb expansion and contraction in the piping systems, provide expansion joint compensators. Securely anchor all piping utilizing expansion loops and joints to the building structure with steel angles, properly braced and welded to the pipe.

D. Furnish and install expansion compensators for hot water piping, for all steam and condensate piping, and steam vents.

1. At the Contractor's option, for 2" and smaller horizontal hot water piping, pipe guides and anchors may be deleted provided adequate expansion capability is provided by the pipe bends, pipe offsets and/or changes in direction of piping.

E. Acceptable manufacturers subject to compliance with the specifications shall be as follows:

1. Expansion compensators larger than 4".

a. American Boa, Inc.
b. Metraflex
c. Adsco Manufacturing
d. Senior Flexonics Pathway

2. Expansion compensators 4" and smaller.

a. American Boa, Inc.
b. Metraflex
c. Keflex Quadra-Side high pressure
d. Senior Flexonics Pathway
e. Robertshaw-Fulton
f. PHD Manufacturing, Co.

3. Grooved-End Expansion Joints for Steel Piping 2-1/2” and Larger

a. Victaulic

4. Guides

a. Keflex, Inc.
b. Metraflex
c. Robertshaw-Fulton
d. Senior Flexonics Pathway
e. PHD Manufacturing, Co.

F. Use of expansion compensators in non-accessible locations shall not be permitted.

G. Temperature and pressure suitable for the service.

2.03 ANCHORS, GUIDES AND EXPANSION COMPENSATION

A. Expansion compensators: water and steam larger than 4"

1. Water: Expansion joints shall be of the corrugated multi-ply bellows type formed hydraulically from metallic tubes with longitudinal welded seams. The middle plies shall be spiral wound and act as a labyrinth seal, and shall be of packless, leakproof, all-welded construction and maintenance free. Bellows shall be minimum 20 gauge up to 6" and 18 gauge for pipes larger than 6". If joint will be exposed to salt (e.g., in manhole, direct buried, marine), material shall be Inconel 625, otherwise material shall be 321 stainless steel. End fittings shall match pipe schedule as specified. Compensators shall be equipped with setscrew and drain holes and shall have steel casing.
2. Steam: Expansion joints shall be of the corrugated multi-ply bellows type formed hydraulically from metallic tubes with longitudinal welded seams, and shall have telescopic shrouds to snugly fit around the bellows. The middle plies shall be spiral wound and act as a labyrinth seal, and shall be of packless, leakproof, all-welded construction and maintenance free. Bellows shall be minimum 20 gauge up to 6" and 18 gauge for pipes larger than 6". If joint will be exposed to salt (e.g., in manhole, direct buried, marine), material shall be Inconel 625, otherwise material shall be 321 stainless steel. End fittings shall match pipe schedule as specified. Compensators shall be equipped with setscrew and drain holes and shall have steel casing.
3. Compensators shall be fitted with lightweight reinforcing rings to reinforce bellows. Compensators shall be suitable for pressures and temperatures indicated under pipe specifications.

B. Expansion compensators: water and steam 4" and smaller.

1. Water: Expansion joints shall be of the corrugated multi-ply bellows type formed hydraulically from metallic tubes with longitudinal welded seams. The middle plies shall be spiral wound and act as a labyrinth seal, and shall be of packless, leakproof, all-welded construction and maintenance free. Bellows shall be minimum 20 gauge up to 6" and 18 gauge for pipes larger than 6". If joint will be exposed to salt (e.g., in manhole, direct buried, marine), material shall be Inconel 625, otherwise material shall be 321 stainless steel. End fittings shall match pipe schedule as specified. Compensators shall be equipped with setscrew and drain holes and shall have steel casing.
2. Steam: Expansion joints shall be of the corrugated multi-ply bellows type formed hydraulically from metallic tubes with longitudinal welded seams, and shall have telescopic shrouds to snugly fit around the bellows. The middle plies shall be spiral wound and act as a labyrinth seal, and shall be of packless, leakproof, all-welded construction and maintenance free. Bellows shall be minimum 20 gauge up to 6" and 18 gauge for pipes larger than 6". If joint will be exposed to salt (e.g., in manhole, direct buried, marine), material shall be Inconel 625, otherwise material shall be 321 stainless steel. End fittings shall match pipe schedule as specified. Compensators shall be equipped with setscrew and drain holes and shall have steel casing.

C. Expansion Compensators for Grooved Piping Systems: water (no steam) 2-1/2” and larger:

1. 2-1/2” through 6”: Packless, gasketed, slip-type expansion joint with grooved end telescoping body for installation with Victaulic Style 107H or 07 rigid couplings. Provides axial end movement to 3”, designed for water services up to 230°F and working pressure to 350 psi. Victaulic Style 150 Mover®.

2. 2-1/2” through 24: Combination of short nipples and Victaulic Style 177, 77 or W7flexible couplings joined in tandem for increased expansion. Joint movement and expansion capabilities dependent on number of couplings/nipples used in the joint. Pressure rating dependent on size and style of flexible couplings used. Victaulic Style 155.

D. For Building Expansion Joints

1. Water and steam piping compensators shall comprise a loop assembly consisting of two flexible legs connected by a return piping bend. Compensators shall include Series 300 stainless steel hose and braid, and Schedule 40 pipe/fittings. Compensators shall be similar to Matraloop flexible expansion loops as manufactured by Metraflex Co.

E. Guides

1. Pipe guides shall be of spider and sleeve type to insure multiplanar guiding and to allow complete insulation of the piping and shall be covered inside and outside with protective coating. Top half shall be removable.
2. Guides shall be installed in accordance with "Standards of the Expansion Compensators Mfrs. Assn.", latest edition.

PART 3 EXECUTION

3.01 INSTALLATION

A. All mains and risers having expansion offsets or compensators shall be securely anchored to the building construction in such a manner as to throw all expansion towards the offsets or joints.

B. All anchors shall be constructed from heavy steel and connected to the building construction. Anchors shall be furnished with turnbuckles or other suitable means for adjustment.

C. Contractor shall be responsible for any additional structural members that may be required for proper installation of hangers, anchors, guides and supports.

D. The method of securing the anchors to the building construction must be approved by the Architect prior to installation.

E. Grooved end expansion compensators shall be installed in accordance with the manufacturer's (Victaulic) guidelines and recommendations. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by the grooved coupling manufacturer. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. A Victaulic factory trained field representative shall provide on-site training to contractor's field personnel in the installation of grooved piping products. Representative shall be a direct employee of Victaulic; a third party distributor representative shall not be considered qualified. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any installed products deemed improperly installed by Victaulic; without additional charges.

F. On Victaulic expansion loop installations, use (8) Victaulic Style 177, 77 or W77 flexible couplings, (4)-90° elbows, and (3) grooved end pipe spools to provide expansion loops in water systems to 250°F or 230F (as dictated by gasket published ratings) and in accordance with the latest Victaulic recommendations for expansion compensation. Rigid couplings shall not be installed on expansion loops.

G. Anchors and guides shall not compromise the piping vibration isolation requirements specified in Section 23 05 48, MECHANICAL VIBRATION CONTROLS AND SEISMIC RESTRAINTS.

END OF SECTION

SECTION 230519.20

HYDRONIC PIPING SPECIALTIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Secure all permits and local/state approvals for the installation of all components included under this Section.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. ASME: American Society of Mechanical Engineers

C. ANSI: American National Standards Institute

1. B16.1: Cast Iron Pipe Flanges and Flanged Fittings
2. B16.3: Malleable Iron Threaded Fittings
3. B16.4: Cast Iron Threaded Fittings
4. B16.5: Pipe Flanges and Flanged Fittings
5. B16.22: Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
6. B31.1: Power Piping

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: Include steam/condensate specialties, pipe fittings and accessories. Provide manufacturers catalogue information.

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

D. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.06 QUALITY ASSURANCE

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

1.07 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 code for installation of steam and condensate piping systems including specialties.

B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

1.08 DELIVERY, STORAGE AND HANDLING

A. Provide temporary end caps and closures piping and fittings. Maintain in place until installation.

B. Protect piping systems and specialties from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.09 ENVIRONMENTAL

A. Do not install equipment when environmental conditions are outside the specific limitations of the referenced codes and manufacturer's recommendations.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide thermometers and gauges:

1. At each inlet and outlet of each air handling unit coil
2. At each pump
3. At each heat exchanger
4. As shown on the drawings
5. As required

B. Thermometers and pressure gauges shall be provided for the above described equipment regardless of pipe size. If pipe size is such that the installation of wells or taps is not feasible, then oversized pipe to accommodate the above installation requirements.

C. No products containing mercury will be acceptable.

2.02 THERMOMETERS

A. Acceptable manufacturers subject to compliance with the specifications.

1. Weksler
2. Moeller
3. Taylor
4. Dresser
5. WIKA Instrument Corp.

6. Miljoco

B. All thermometers in liquids shall have separable sockets.

C. Thermometers shall be with glass fronts, aluminum or phenol cases, and adjustable as required for ready reading from the floor.

D. All thermometers shall use non-toxic liquid filled magnifying lens front tubes.

E. All thermometers shall have 9" scales and 12" cases.

F. All thermometers shall be accurate to ±1% of scale range.

G. Thermometer ranges shall be selected so that the normal operating range of each will occur in the middle half of the total range and so that under minimum and maximum conditions thermometers will not be harmed.

2.03 THERMOMETER WELL

A. 304 or 316 stainless steel tapered shank.

B. Where installed in insulated systems provide extended neck.

C. 3/4 inch NPT process connection; 1/2 inch NPT instrument connection and nominal 1/4 inch bore.

2.04 GAUGES

A. Acceptable manufacturers subject to compliance with the specifications.

1. Weksler
2. Dresser
3. Fisher & Porter
4. WIKA Instrument Corp.
5. Miljoco

B. Except for the automatic temperature control system, gauges shall be constructed with bourdon type bronze tubes, stainless steel movements, white dials, black micrometer adjustable points, aluminum or phenol surface mounted beaded cases, matching aluminum or phenol screwed rings and bottom connections. All gauges shall have 4 1/2" diameter cases. All gauges shall be accurate to 1% of scale range.

C. Gauge ranges shall be selected such that the normal operating range of each will occur in the center of the total range and under minimum and maximum conditions no gauge will be harmed.

D. All gauges shall be provided with needle valves

1. Barstock needle Valves shall be equal to:

a. Crane
b. Edward
c. Dresser.
d. WIKA Instrument Corp.

E. Gauges installed in pump discharge piping shall be provided with snubbers and steam with siphons equal to Ray.

2.05 PRESSURE/TEMPERATURE TAPS

A. Acceptable manufacturers subject to compliance with the specifications.

1. Sisco P/T Plugs.
2. Peterson Equipment Company.
3. Fairfax Company
4. WIKA Instrument Corp.

B. All pressure/temperature taps shall have a solid brass 1/4" or 1/2" NPT fitting (test plug).

C. Test plug shall be capable of receiving either a pressure or temperature probe 1/8" o.d. Valve core shall be neoprene for temperatures 60°F to 200°F, nordel to 350°F, and shall be rated zero leakage from vacuum to 1000 psig.

D. The Contractor shall also furnish the following:

1. Pressure gauge adapters with 1/16" and 1/8" o.d. probe
2. 5" stem pocket testing thermometers for 25° to 125°F (chilled water)
3. 5" stem pocket testing thermometers 0° to 220°F (hot water)
4. 5" stem pocket testing thermometers 50° to 500°F (temperatures above 220°F).
5. A Master test kit which shall contain

a. A 2 1/2" test gauge of suitable range
b. A gauge adapter with 1/16" and 1/8" o.d. probe
c. A 5" stem pocket testing thermometers 0° to 220°F
d. A 5" stem pocket testing thermometers 50° to 550°F).

2.06 PRESSURE DIFFERENTIAL GAUGE

A. Acceptable manufacturers subject to compliance with the specifications.

1. Similar to ITT Barton Instruments Company.

B. Dual rupture proof liquid filled bellows having integral temperature compensation.

C. Designed to withstand repeated overranges equal to the working pressure of the instrument housing without causing a calibration change. Gauge and components shall be suitable for a working pressure of 200 psig and a water temperature of 200 degrees F.

D. Motion transmission is by a hermetically sealed torque tube, no lubrication required.

E. Dial shall be a minimum of 6 inches round. Indicator case shall be fabricated from die-cast aluminum and finished in black epoxy paint. The indicating scale shall be graduated uniformly for measurement of differential pressure.

F. Scale shall be calibrated in 1 psig increments. Full scale range shall be from 0 to 25 psig.

G. The indicating mechanism shall consist of a precision-made, jeweled, rotary movement. It multiplies rotation of the torque tube through a gear and pinion to the indicating pointer. The indicating pointer shall traverse a 270 degree arc. The movement shall have micrometer screws for convenient zero and range adjustments. Zero and range adjustments shall be made without removing the scale plate or the pointer. The rotary movement and the pointer should be fully protected from overrange in either direction.

H. Accuracy shall be within 2 percent of the full scale differential pressure range when operating at or below 200 psig.

I. A three-valve manifold shall be used. The manifold shall provide two block valves and a bypass valve for installation and zero check. Valves shall also be provided on the instrument housings for bleeding or venting.

J. Two 10 foot neoprene hoses shall be included with the differential pressure gauge. Hoses shall be equipped with 1/4 inch NPT male fittings for connecting to the manifold. The other end of the hoses shall have an adaptor to mate with the pressure temperature tap.

K. The differential pressure gauge, valve manifold, bleed valves, hoses and instruction booklet shall all be placed in a plastic carrying case. The gauge indicator and manifold shall be permanently mounted on the base of the case. The case cover shall be equipped with a handle fastened to the base with toggle type latches.

L. Differential pressure gauge shall be similar to ITT Barton Model 247A.

2.07 RELIEF VALVES

A. Acceptable manufacturers subject to compliance with the specifications.

1. Bell and Gossett, ITT
2. Amtrol
3. Watts Regulator Company
4. Kunkle Valve Company

B. Relief valve body shall be of iron or bronze construction.

C. ASME rated direct spring loaded type, level operated, non-adjustable factory set discharge pressure.

D. For expansion tank application, select system relief valve pressure setting and equipment relief valve pressure setting as indicated on mechanical contract drawings.

E. Pressure relief valve shall be suitable for maximum system operating pressure and temperature.

2.08 PRESSURE REDUCING VALVE

A. Acceptable manufacturers subject to compliance with the specifications.

1. Bell and Gossett, ITT
2. Amtrol
3. Watts Regulator Company

4. Kunkle Valve Company

B. Pressure reducing valve shall be bronze or iron body construction, with renewable stainless steel seat, and high temperature resisting diaphragm, direct acting, spring-loaded, suitable for inlet pressure of 150 psi.

C. Built in stops shall protect diaphragm against sudden shock waves that could stretch or tear the diaphragm.

D. Provide a cartridge seat assembly with a seat washer and monel strainer for quick cleaning and replacement.

2.09 AIR VENTING AND DRAINAGE

A. Manual air vent.

1. Provide hose end ball valves, (minimum size 1/2" with chains and caps), or larger where shown or required by the service.
2. See HVAC Valve specification

B. Automatic air vent.

1. Acceptable manufactures subject to compliance with the specifications:

   a. Armstrong
   b. Bell and Gossett

2. Float type with isolating valve, cast iron body, stainless steel float, stainless steel valve, and valve seat. Suitable for 300 psig operating pressure and 300 degrees F system temperature.
3. Vents shall be designed to eliminate air from the system automatically without permitting the passage of water.
4. Minimum size shall be 3/4” or as indicated or required.
5. Similar to Armstrong Model 1-AV.

C. Drains

1. Provide ball valves with caped hose connections, (minimum size 3/4"), or larger where shown or required by the service.
2. See HVAC Valve specification.

2.10 FLOW ELEMENTS (Flow Indicating Assemblies)

A. Provide flow elements as indicated and or specified.

B. Acceptable manufacturers subject to compliance with the specifications.

1. Preso
2. Ellison Instrument Div.
3. Dieterich Standard Corp.
4. Barco
5. Onicon
6. Foxboro

C. Sensing system components

1. Provide self-averaging annular sensor flow metering stations

a. At each pump
b. At each chiller
c. At each cooling tower
d. At each air handling unit coil
e. At mains
f. All major piping distribution branches.
g. Where shown on drawings

h. Exceptions:

1) Hydronic Locations with flow control balancing valves with meter taps.

2. Flow metering systems shall include annular sensors with self-averaging interpolating tube design at each flow station and a portable meter set supplied by one manufacturer.
3. Each annular measuring station shall be complete with safety shutoff valves, quick coupling connections, and a tag showing designed flow rates, meter readings for designed flow rates, metered fluid, line size and tag, and station or location number.
4. Annular measuring sensor shall be made of 304 stainless steel.
5. Stations shall be either nipple suction or weld insert type, rated to 300 psi at 400°F. Annular measuring stations shall be rotable sensing elements so that all pressure sensing ports can be pointed downstream when station is not in use.
6. Permanent pressure loss to the system shall not exceed 5" of water column (0.42 foot) of head on sizes over 1 1/2". Accuracy of the flow measuring elements shall be ±2.3%, as verified by independent laboratory reports.

D. Furnish portable differential pressure meter sets compatible with the primary elements capable of measuring direct differential pressure which shall then be converted to flow rate from a master chart.

1. Differential pressure meter sets shall be as follows:

a. Meter sets shall be of the single diaphragm type not requiring a fill fluid, shall have a 6" dial pointer indicator, and shall have wetted metal parts of only 304 stainless steel.
b. Meter set shall include a variable pulsation dampening control, an integral equalizing valve, and (2) bleed valves.

1) Each meter set shall be supplied complete with a master chart for direct conversion of meter readings to GPM, rustproof carrying case, and (2) 10'-0" rubber test hoses with brass valves for quick connections to annular sensors.
2) Meter shall become property of the Owner immediately after balancing and completion of work under this Contract is completed.
3) Submit a signed receipt of delivery of meter to the Architect for his records.

PART 3 EXECUTION

3.01 THERMOMETER INSTALLATION

A. Shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

B. Shall be turned as such to be readily visible from the operating floor.

C. Thermometers subject to vibration or physical damage shall be adequately supported and protected.

3.02 THERMOMETER WELL

A. Shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

3.03 PRESSURE RELIEF VALVE

A. Shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

3.04 PRESSURE REDUCING VALVE

A. Shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

3.05 PRESSURE DIFFERENTIAL GAUGE

A. Shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

B. Provide differential pressure gauge package to user after system balancing.

3.06 GAUGE INSTALLATION

A. Shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

B. Shall be turned as such to be readily visible from the operating floor.

C. If the gauge is more than 8'-0" above the floor or cannot otherwise be made readily readable, extended pipe connections gauge to a readable location.

D. Gauges subject to vibration or physical damage shall be adequately supported and protected.

3.07 PRESSURE/TEMPERATURE TAPS INSTALLATION

A. Shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

B. Provide pressure taps wells for all in-duct or in-box water coils.

3.08 AIR VENTING INSTALLATION

A. Manual air vent

1. Provide all high points in closed water piping systems shall be relieved of air through accessible manual vents on the high points of the pipe lines and at the equipment. Vent valves on piping and equipment shall be 1/2" ball valves with chains and caps and with discharge pipes to convenient points for catching discharge.
2. Provide access doors to all vents.

B. Automatic air vent

1. Provide as indicates and at expansion tank connection to main pipe.
2. Pipe to spill over floor drain or sink.

3.09 DRAINAGE

A. Grade all piping for drainage through equipment or through accessible drain valves so that system can be conveniently freed of water by gravity flow.

B. Provide drains from air handling units and from air intake and other intake and exhaust plenums with traps. Traps shall be a minimum of 4", unless the static pressure requires additional trap depth. Discharge drains to nearest floor drain.

3.10 FLOW ELEMENTS INSTALLATION

A. Shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

B. Shall be provided with a chained cap.

C. Each location shall be labeled.

D. Gauges and thermometers subject to vibration or physical damage shall be adequately supported and protected.

END OF SECTION

SECTION 230523

HVAC VALVES AND STRAINERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Divisions Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all shut-off, gate, globe, check, ball, strainers, balancing and other type valves as shown and as required to make a complete and operational system.

B. Provide isolation valves at all drains, piping mains and branches at all piping systems, equipment, risers and before and after all control valves.

C. Secure all permits and local/state approval for the installation of all components included under this Section.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. All valves to be designed, manufactured and tested to the following standards and/or reference societies. Material standards shall be as specified or detailed hereinafter and as follows:

1. MSS SP-67 – Butterfly Valves (Lug and Wafer); Manufacturers Standardization Society of the Valve and Fittings Industry.
2. MSS SP-68 – Butterfly Valves: High Performance (High Pressure Butterfly Valves with Offset Disc design); Manufacturers Standardization Society of the Valve and Fittings Industry.
3. MSS SP-69 – Pipe Hangers and Supports – Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry.
4. MSS SP –70 - Iron Gate Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry.
5. MSS SP-71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry.
6. MSS SP-72 Ball Valves with Flanged or Butt Weld Ends; Manufacturers Standardization Society of the Valve and Fittings Industry.
7. MSS SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry.

8. MSS SP-80 – Bronze Gate, Globe, Angle and Check Valves; Manufacturers Standardization Society of the Valve and Fittings Industry.
9. MSS SP-85 – Iron Globe & Angles Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry.
10. MSS SP-89 – Pipe Hangers and Supports – Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry.
11. MSS SP-110- Ball Valves Threaded, Socket-Weld, Solder Joint, Grooved and Flared Ends; Manufacturers Standardization Society of the Valve and Fittings Industry.
12. MSS SP-25-Standard Marking system for Valves, Fittings, Flanges and Unions; Manufacturers Standardization Society of the Valve and Fittings Industry.
13. MSS SP-45 Bypasses and Drain connections; Manufacturers Standardization Society of the Valve and Fittings Industry.
14. MSS SP-45 Table II Series A, to be utilized for Steam Service Valves requiring By-Passes with built up bypasses to be performed only at plant of manufacture by Valve manufacturer; By-Pass valves shall be same manufacturer as in line valve; Manufacturers Standardization Society of the Valve and Fittings Industry.
15. Threads, Flanges, Fittings shall conform to ANSI Standards: B1.1; B1.20.1; B2.4; B16.1; B16.10; B16.34; B16.5; B16.34A.
16. NFPA 54 – National Fuel Gas Code; National Fire Protection Association.
17. NFPA 58 – Standard for the Storage and Handling of Liquefied Petroleum Gases; National Fire Protection Association.
18. NFPA 99 and CGA G-4-1; Medical Gas Services cleaning procedures and standards for Valves.
19. UL 1479 – Standard for Fire Tests of Through-Penetration Firestops; Underwriters Laboratories Inc.

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: Include data on valve materials, pressure class, construction, dimensions and ratings. Provide manufacturers catalogue information. All valves of one type shall be by same manufacturer.

C. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable designation.

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

E. Project Record Documents: Record actual locations of all valves and valve tag numbers.

F. Maintenance Data: Include spare parts list and exploded valve assembly views.

1.06 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing valve and strainer products specified in this section, with documented experience.

B. Installer: Company specializing in performing work of the type specified in this section, with documented experience.

C. All grooved joint couplings, fittings, valves and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

D. All valves and strainers shall contain manufacturer's name and pressure class marked on the valve body.

E. In order to prevent dezincification, all bronze body gate, globe, angle, check and ball valves shall contain body, end pieces, and stems with no more than 15% zinc content. Manufacturers other than those specified by part number shall provide material list containing ASTM number containing percentage of zinc content for all valve materials and wetted part components.

1.07 REGULATORY REQUIREMENTS

A. Perform Work in accordance with all State and Local codes.

B. Conform to all State and Local code for installation of boiler safety valves and backflow prevention devices.

C. Provide certificate of compliance from the authority having jurisdiction indicating approval of installation of all boilers, gas piping, vents and backflow prevention devices.

1.08 DELIVERY, STORAGE AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Weld end preparations shall be coated with 2 mil minimum thickness of "Deoxaluminate", "Bloxide" or equal to preserve the surface during storage.

PART 2 PRODUCTS

2.01 GENERAL

A. Manufacturer's figure numbers are listed; based on the following catalog data and catalog year: (Please also note that if a valve changes in a later catalog the specified figure number may not be acceptable. The submitted valve shall be compared to the figure number based in the specified catalog.)

1. NIBCO INC:

   a. Gate, Globe, Angle and Check Valves: (C-BIV-0207)
   b. Ball Valves: (C-BV-0607)
   c. Butterfly Valves: (C-BFV-1007).

2. Vogt: Catalog VVACT0000-01, 2004
3. Neles-Jamesbury: 2007
4. Apollo: 2006 Combraco Ind. Inc.
5. Jenkins: 2007
6. Bray: 2003 Bray international
7. Victaulic: 2007 Victaulic company
8. Crane: 2007
9. Nordstrom: Flowserve 2007

10. Edwards: 2003
11. Mueller Steam Specialty 2007
12. William E. Williams: 2007
13. Milwaukee

B. The following is a listing of representative figure numbers desired by service, valve design, style and materials of construction indicative of the product quality required. Substitutions to be accompanied by manufacturer catalog cuts, submittal drawings and material certifications containing properties of all valve materials. Valves from other manufacturers listed in the list of acceptable manufacturers will be accepted provided they meet the specifications, materials of construction, and provide manufacturer catalog cut, certificate of compliance with specifications. If the specified manufactures figure number changes or the design of the valve no longer meets the specified figure number based on the year listed above it is not an acceptable valve.

C. Provide all shutoff, gate, globe, check, ball, strainers, balancing and other types of valves as shown on the drawings and required for proper operation, maintenance, isolation and safety of all piping systems.

D. Provide isolation valves at all drains and piping mains and branches for all water, steam and condensate piping, at all equipment connections and before and after automatic control valves.

E. Provide 1" diameter integral bypass with globe valve at all globe and gate valves 10” and larger; and ¾” diameter integral bypass with globe valve at all globe and gate valves 6” and 8”; for high pressure steam, medium pressure steam and condensate feedwater. All bypasses shall conform to MSS-SP-45 Table II, Series A and be performed at plant of manufacture. If high performance butterfly valves are used 1" bypass with globe valve shall be field-piped for valves 6” or larger.

F. All gate and globe valves 2 1/2" and above shall have a bolted gland follower.

G. The pressure-temperature rating of valves shall not be less than 120% of the design criteria applicable to all components of the system.

H. All 2 ½” and larger gate and globe valves shall be OS&Y type unless specifically noted otherwise.

I. Face-to-face and end-to-end dimensions of flanged iron body valve shall conform to ANSI B16.10. Design workmanship, materials and testing shall conform to MSS-SP-70 (gates), MSS-SP-71 (swing checks) and MSS-SP-85 (globe and angle).

J. Face-to-face and end-to-end dimensions of flanged steel body valves shall conform to ANSI B16.34.

K. End-to-end dimensions of grooved ductile iron body valves shall conform to the latest published dimensions.

L. All steel valves shall be tested in accordance with ANSI B16.34 standards at 1.5 times design pressure (hydrostatic test). Provide a certified test reports.

M. All valves and/or strainers of the same type shall be of the same manufacturer. Before purchasing any valve, the Contractor shall submit for approval the name of the manufacturer, the figure number which he proposes to furnish and engineering data on each figure number. For acceptable manufacturers, see schedules herein.

N. Valves/Strainers in grooved piping systems may be grooved or installed between grooved flange adapters. All valves used for isolation of equipment shall be threaded, flanged.

O. All valves used for balancing purposes, shall have memory stops; lever lock handle operators that may be locked via locking hole designed into the handle and lever; or gear operated with position indicators.

P. All Butterfly valves shall have stainless steel discs and bodies shall be constructed of Ductile Iron, Stainless Steel or Carbon Steel.

Q. All Butterfly valves shall, at minimum, be suitable for bi-directional dead end service at full pressure rating of the valve with no downstream flanges required.

R. Provide handwheels for all manually operated gate and globe valves and for all valves equipped with gear operators. Handwheels shall accept bolt-on chain operators.

S. Provide chain operators for all valves located 7'-0" above floor or higher.

T. Size valve handwheels for not more than 80 lbs. pull on one side of the handwheel to effect tight closure. Where the manufacturer's standard handwheel size is not large enough to accomplish this, provide a gear operator.

U. All handwheels on bronze body gate, globe and angle valves shall be constructed of malleable iron ASTM A 47.

V. Weld end preparations shall be coated with 2 mil minimum thickness of "Deoxaluminate", "Bloxide" or equal to preserve the surface during storage.

W. Valve bonnets and gear operators shall be designed to withstand all forces which may be applied to the handwheels, including those from chain operators.

X. Valves and strainers shall be rated in accordance with or greater then the "Spec. Class No." Specified for that system.

2.02 ACCEPTABLE MANUFACTURERS CONTINGENT ON COMPLIANCE WITH THE SPECIFICATIONS. Note that unless a manufacturer is listed here the manufacturer is not acceptable even if the manufacturer is the specified manufacturer with the figure number for comparison called out elsewhere in the specification:

A. Gate, Globe, Angle and Drain

1. Bronze, Cast Iron, and Ductile Iron Valves

a. NIBCO INC.
b. Crane
c. Jenkins
d. Stockham
e. Milwaukee
f. Vogt

2. Cast Steel and Forged Steel Valves

a. Pacific

b. Powell
c. Vogt
d. Milwaukee
e. Kitz
f. Crane
g. Velan
h. Flowserve (Edwards)

3. Butterfly Valves

a. High Performance

1) Jamesbury (Metso automation)
2) Dezurik
3) Bray

b. Soft Seated

1) Bray
2) NIBCO INC.
3) Jamesbury
4) Victaulic (Masterseal 300 or AGS Vic-300 only)
5) Milwaukee

4. Lubricated Plug Valves

a. Flowserve (Nordstrom)
b. Walworth
c. Milliken
d. Resun

5. Flow Control Balancing Valves

a. Tour & Anderson / TA Hydronics
b. Armstrong
c. Macon Balancing

6. Constant Flow Valve

a. Griswold
b. Hays
c. Auto-Flow / Flow Design, Inc.

7. Check Valves

a. Swing

1) Walworth
2) William E. Williams
3) Vogt
4) Powell
5) NIBCO INC.
6) Flowserve (Edwards)

7) Victaulic (for grooved systems only)
8) Milwaukee

b. Silent

1) NIBCO INC.
2) Mueller Steam Specialty
3) Williams Hager
4) Victaulic
5) Milwaukee

8. Vacuum Breakers

a. Hoffman specialties
b. Johnson
c. Bell & Gossett

9. Ball Valves

a. Apollo
b. NIBCO INC.
c. Milwaukee

10. Strainers

a. Y Type

1) Elliot
2) Armstrong
3) Mueller Steam Specialty
4) Sarco
5) Victaulic
6) Keckley

b. T Type

1) Victaulic

c. Basket

1) Mueller Steam Specialty
2) Keckley

d. Duplex

1) Water

a) Mueller Steam Specialty
b) Zurn
c) Elliot
d) Kraissl
e) Keckley

2.03 VALVE CHART

Service	Minimum Class and Material			Joints	
	2" and Less	**2½" to 12"**	**14" & Up**	**2" and Less**	**2½" & Up**
Chilled water supply and return	MSS Class 150 Bronze	MSS Class 150 Ductile iron or steel	ANSI Class 150 Cast Steel	Threaded	Flanged or Grooved*
AHU preheat hot water supply and return	MSS Class 150 Bronze	MSS Class 150 Ductile iron or steel	ANSI Class 150 Cast Steel	Threaded	Flanged or Grooved*
Reheat and façade/radiation/induction unit hot water system	MSS Class 150 Bronze	MSS Class 150 Ductile iron or steel	ANSI Class 150 Cast Steel	Threaded	Flanged or Grooved*
Low pressure steam (0 to 15 psig)	MSS Class 150 Bronze	MSS Class 150 Ductile iron or steel	ANSI Class 150 Cast Steel	Threaded	Flanged
Low pressure condensate return	MSS Class 150 Bronze	MSS Class 150 Ductile iron or steel	ANSI Class 150 Cast Steel	Threaded	Flanged
Pumped condensate	MSS Class 150 Bronze	MSS Class 150 Ductile iron or steel	ANSI Class 150 Cast Steel	Threaded	Flanged
Makeup and fill	MSS Class 150 Bronze	MSS Class 150 Ductile iron or steel	ANSI Class 150 Cast Steel	Threaded	Flanged or Grooved*
Miscellaneous drains 2½" and up		Match system			Flanged or Grooved*
Miscellaneous drains to 2"	Match system			Threaded	
Refrigerant system	MSS Class 150 Bronze			Silver Brazed	Flanged
Other piping	MSS Class 150 Bronze	MSS Class 150 Ductile iron or steel	ANSI Class 150 Cast Steel	Threaded	Flanged or Grooved*

* Grooved piping systems of standard wall shall be **roll** grooved or cut grooved according to Victaulic groove specification standards. On piping heavier than standard wall, cut grooving required per Victaulic **cut** groove specification standards. All grooved valves shall be a minimum class of 300.

2.04 GATE VALVES

A. Up to 2"

1. Valves shall be:

a. Threaded
b. Rising stem
c. Union bonnet
d. Solid wedge and manufactured in accordance with MSS-SP 80.

e. Body, bonnet and wedge are to be of cast bronze ASTM B-62 (Class 150) or ASTM B-61 (Class 200 & 300).
f. Stems shall be of dezincification-resistant silicon bronze ASTM B-371 or low-zinc alloy ASTM B-99.
g. Non-asbestos packing
h. Malleable or ductile iron handwheel

1) Class 150: Similar to NIBCO Fig. T-134
2) Class 200: Similar to NIBCO Fig. T-154-A
3) Class 300: Similar to NIBCO Fig. T-174-A

2. Bronze Body and bonnet, socket weld ends, solid wedge, inside screw, non-rising steam, screw-in bonnet, for copper pipe

a. Class 150: Similar to Kitz Fig. C150E (Code64)

B. 2 1/2" & Up

1. For chilled water, hot water services

a. Manufactured in accordance with MSS-SP 70
b. Raised face flanged ends
c. Bolted bonnet
d. OS&Y
e. Rising stem
f. Solid wedge
g. Bronze trim
h. Body and bonnets conforming to ASTM A395 Ductile Iron.

i. Packing and gaskets to be non-asbestos.

1) Class 150: Similar to NIBCO Fig. F-637-31

2. For steam and water treatment services

a. Same as 1 above except:

1) Stainless Steel trim
2) Body and bonnet conforming to ASTM A395 Ductile Iron Or cast steel

a) Class 150: Flanged Ends: Similar to NIBCO Fig F-637-33
b) Class 300: Cast Steel

(1) Weld Ends: Similar to Crane Fig. 33½
(2) Flange Ends: Similar to Crane Fig. 33.

c) Class 600: Cast Steel

(1) Weld Ends: Similar to Crane Fig.76½.
(2) Flange Ends: Similar to Crane Fig. 76

2.05 GLOBE AND ANGLE VALVES

A. Up to 2"

1. Class 150: Valves shall be ASTM B-62

a. Bronze body and trim
b. Rising stem
c. Union bonnet
d. Integral seat with renewable seat and Teflon disc with screwed ends, conforming to MSS SP-80.

1) Class 150

a) Angle: Similar to NIBCO Fig. T-335-Y
b) Globe: Similar to NIBCO Fig. T-235-Y

2. Class 200 and Class 300:

a. Valves shall be ASTM B-61
b. Bronze body
c. Regrinding/renewable stainless steel plug disc and seat ring
d. Threaded ends
e. Union bonnet.

1) Class 200

a) Angle: Similar to NIBCO T-376-AP
b) Globe: Similar to NIBCO Fig. T-256-AP

2) Class 300

a) Angle: Similar to NIBCO Fig. T-376-AP
b) Globe: Similar to NIBCO Fig. T-276-AP

B. 2 1/2" & Up

1. For chilled water, hot water services.

a. Raised face flanged ends
b. Bolted bonnet
c. OS&Y, rising stem
d. B-584 seat and seat ring, with body and bonnet conforming to ASTM A395 Ductile Iron.
e. Packing and gaskets to be non-asbestos

1) Class 150 in accordance with MSS-SP 85

a) Angle: Similar to NIBCO Fig. F-838-31
b) Globe: Similar to NIBCO Fig. F-738-31

2. For steam and water treatment services:

a. Cast steel
b. Stainless steel trim and plug
c. OS&Y, rising steam
d. Flanged or butt weld ends.

1) Class 150

a) Welded Ends: Similar to Crane Fig. 143½
b) Flanged Ends: Similar to Crane Fig. 143

2) Class 300

a) Welded Ends: Similar to Crane Fig. 151½
b) Flanged Ends: Similar to Crane Fig. 151

2.06 BALL VALVES

A. Up to 2 1/2" (for water below 200°F and below)

1. Full port
2. All stainless steel ball and stem
3. Extended stem for insulation
4. Two piece bronze body
5. 600 PSIG WOG
6. 250 PSIG steam trim
7. Threaded

a. Similar to Apollo Fig. 77-140-64

8. Soldered

a. Similar to Apollo Fig. 77-240-64

B. Up to 2-1/2" (for steam and water 200ºF and above)

1. Full port
2. All stainless steel ball and stem
3. Two piece steel body
4. 600 PSIG WOG 250 PSIG steam
5. Extended stem for insulation
6. 250 PSIG steam trim
7. Threaded

a. Similar to Apollo Fig. Apollo 92-140-64

8. Socket Welded:

a. Three piece steel body
b. Similar to Apollo Fig. Apollo 83R-240-64

C. 3” and Larger (All Services)

1. Flanged body
2. Stainless Steel body, Ball and Stem.

   a. 316 Stainless Steel trim.

3. Fire Safe, conforming to ANSI 16.34, 16.35, MSS-SP-72, American Petroleum Institute 607 4th Edition and MSS SP 25.
4. Class 300

   a. 720 PSI CWP
   b. Gear operated
   c. Similar to Apollo Fig No. 87A-900-MG

D. Drain Valves

1. Ball valves or gate valve.

   a. All drains shall be provided with a brass hose connection with a pressure rated brass cap with a chain.

      1) 3/4 hose thread on valve
      2) 1” and 2” use brass pipe thread by straight thread hose connection adapter.
      3) Each shall be provided with brass pressure rated cap and chain.

2.07 SWING CHECK VALVES

A. Access to Elements

1. Up to 2" except as noted: Screw-in caps
2. 2" to 2-1/2": Bolted or coupled covers

B. Water (Except at Pump Discharge and as Noted)

1. Up to 2":

   a. Bronze body check valves shall be, swing type, Y-Pattern with renewable seat and disc, regrinding type with Bronze ASTM B-62 body for Class 150 valves and ASTM B-62 body for Class 200 and Class 300

      1) Class 150: Similar to NIBCO Fig. T-433
      2) Class 200: Similar to NIBCO Fig. T-453-B
      3) Class 300: Similar to NIBCO Fig. T-473

   b. Forged steel, screwed ends lift type, bolted cover.

      1) Class 800:

         a) Threaded: Similar to Vogt Fig. 701
         b) Socket welded: Similar to Vogt Fig. SW701

2. 2 1/2" and Up

a. For chilled water, condenser water, hot water services.
b. Valves to be Class 150, swing check valves, MSS-SP 71

1) Raised face flanged ends
2) Bolted bonnet
3) Bronze ASTM B-584 disc and seat rings
4) Body and bonnet conforming to ASTM A395 Ductile Iron.

a) Class 150: Similar to NIBCO Fig. F-938-31 (cat. 2007)

5) Iron body, stainless steel disc, grooved.

a) 300 PSIG CWP: Victaulic Series 712

c. For steam and water treatment services.

1) Valves to be Class 150, manufactured in accordance with MSS-SP 71
2) Raised face flanged ends
3) Bolted bonnet
4) Stainless Steel disc and seat rings
5) Body and bonnet conforming to ASTM A395 Ductile Iron.

a) Class 150: Similar to NIBCO Fig. F-938-33 (cat. 2007)

6) Body and bonnet Cast steel.

a) Class 150: Similar to William E. Williams Fig# 151F2

d. Class 300, 600 and 900 Same as above except:

1) Valves to be cast steel bodies
2) Stainless steel trim
3) Raised Face Flanged ends
4) Swing type, bolted bonnet.

a) Class 300: Similar to William E. Williams Fig# 301F2
b) Class 600: Similar to William E. Williams Fig# 601F2
c) Class 900: Similar to William E. Williams Fig# 901F2

C. Steam and Condensate Return

1. Up to 2"

a. Bronze body check valves shall be, swing type, Y-Pattern with renewable seat and disc, regrinding type with Bronze ASTM B-62 bodies; Class 200 and Class 300.

1) Class 200: Similar to NIBCO Fig. T-453-B
2) Class 300: Similar to NIBCO Fig. T-473

2. 2 1/2" and Up

a. As specified for water service (low pressure steam only).

1) Class 150: Similar to NIBCO Fig. F-938-31 (cat. 2007)

b. Cast Steel, globe style, Flanged, Stellite seat and disk.

1) ANSI Class 300: Similar to Edwards 394 (cat 2003)

2.08 SILENT CHECK VALVES

A. Spring Loaded, Globe

1. Valves up to 300 psi.

a. Ductile iron body
b. Stainless steel trim

2. Valves class 300 psi. or greater.

a. Cast steel body
b. Stainless steel trim
c. Stainless steel trim for valves.

3. Body Flanged

a. Class 150: Similar to Crane Fig. C15DDMF3
b. Class 300: Similar to Crane Fig. C30STF3
c. Class 600: Similar to Crane Fig. C60STF3

4. Grooved Body: Where approved

a. Conforming to ANSI/AWWA C-606
b. Through 12”.

1) Victaulic Series 716 or 779

c. 14” Through 24”

1) Victaulic Series W715

2.09 VACUUM BREAKERS

A. Adjustable from 1⁄4" - 20" (8-508mm) Hg vacuum

1. Factory set at 2” (51mm) Hg vacuum

B. For use on closed vessels and piping systems to control induced vacuum within safe limits

C. 3⁄4" NPT straight shank

D. Maximum operating temperature 366°F (186°C)

E. Maximum operating pressure 150 psig (10.3 bar)

F. Similar to Hoffman specialties Model 62 (catalog 2007)

2.10 LUBRICATED PLUG VALVES

A. Screwed ends up to 2", flanged ends for 2 1/2" and up.

B. Maximum port opening tapered plug suitable for lubrication under service pressure with plug in any position.

C. Lubricating Guns

1. One (1) for every (10) valves.
2. Extra heavy, lever type, hydraulic hand gun.
3. 15,000 psi gauge and 12" long connection hose.
4. Similar to Rockwell-Nordstrom Model #400-C.

D. Lubricant

1. Similar to Rockwell Sealant #421.
2. One (1) year supply for each valve.

E. Operators

1. Up to 6" (Wrench, Except as Noted)

a. Wrench set for each size valve.

2. 8" & Up (Gear Operated)

a. Permanently installed handwheel.

3. Where noted or required for inaccessible overhead valves:

a. Chain operated handwheel with rustproof chain and chain guide.

F. Motor operated as noted in other Sections of this Specification.

G. Piping systems with maximum temperature under 100 °F

1. Piping less than 100 psi, minimum 200 lbs. WOG Class, cast iron body.

a. Up to 2": Screwed
b. 2 1/2" & Up: Flanged, 125 lbs. ANSI

2. Piping 100 psi to 250 PSI, minimum 500 lbs. WOG Class, cast iron body.

a. Up to 2": Screwed
b. 2 1/2" & Up: Flanged, 250 lbs. ANSI

3. Piping over 250 PSI use ANSI CLASS carbon steel class 300

H. Piping systems with maximum temperature over 100 °F

1. ANSI CLASS 150, carbon steel body

a. Up to 2": Screwed
b. 2 1/2" & Up: Flanged, 150 lbs. ANSI

2. ANSI class 300.carbon steel body.

a. Up to 2": Screwed
b. 2 1/2" & Up: Flanged, 300 lbs. ANSI

I. Similar to the following Rockwell-Nordstrom numbers:

1. 200 lbs. WOG Class

a. Up to 2": Fig. 142 (cat. 2007)
b. 2 1/2" thru 5": Fig. 143 (cat. 2007)
c. 6" thru 12": Fig. 149 (cat. 2007)
d. 14 thru 36 Fig 1169 (cat. 2007) (150 CWP)

2. 500 lbs. WOG Class

a. Up to 2": Fig. 524 (cat. 2007)
b. 2 1/2" to 4": Fig. 525 (cat. 2007)
c. 6" thru 24": Fig. 1589 (cat. 2007) (400 CWP)

3. 150 lbs. ANSI

a. Up to 2": Fig. 1924 (cat. 2007)
b. 2 1/2" to 4": Fig. 1925 (cat. 2007)
c. 6"thru 12” Fig. 2449 (cat. 2007)
d. 14 thru 30” Fig. 4149 (cat. 2007)

4. 300 lbs. ANSI

a. Up to 2": Fig. 2024 (cat. 2007)
b. 2 1/2" to 4": Fig. 2025 (cat. 2007)
c. 6"thru 24: Fig. 4249 (cat. 2007)

2.11 FLOW CONTROL BALANCING VALVES

A. General

1. Balancing valves shall be installed, as shown on the drawings and as required, to ensure the accurate balancing of all flows in the hydronic heating and cooling systems.
2. The balancing shall meet the specified water flows with a maximum tolerance of ±5%.
3. Valves shall be of the "Y" pattern globe style design and must offer a minimum of (4) full rotations of the handwheel for accurate adjustment and for precise flow control.
4. Valves shall exhibit an accuracy of ±5% within the normal operating range.

5. Valves shall have integral self-sealing metering ports for measuring differential pressure, flow rates and temperature. Ports shall be protected with individual threaded caps.
6. Valves must offer 100% positive, leakproof shutoff against the same fluid pressure as the valve body rating to a nominal value of 300°F (230°F if grooved) at 250 psi.

B. All balancing valves must offer a hidden memory feature to prevent unauthorized adjustment and to ensure a return to the original setting after shutoff.

C. All balancing valves shall comply with international quality standard ISO 9001.

D. Valves sizes 1/2" to 16"

1. This is the only type of valve that can be 1/2”.
2. This valve may be 1/2” with a reducer and increaser to 3/4” pipe as required for balancing.
3. All balancing valves 1/2” to 2” shall be manufactured from pressure diecast dezincification resistant AMETAL copper alloy which does not require dielectric fittings.
4. Valve bodies 2-1/2” to 16” shall be manufactured from a ductile iron equivalent to ASTM A536 with all wetted, moving parts of dezincification resistant AMETAL copper alloy.
5. Shall have a digital handwheel for positioning accuracy.

    a. Provide a transparent dust/paint cover to prevent destruction of the digits during construction.

6. Valves sizes 1/2" to 2"

    a. Similar to TA (STAD/S)

7. Sizes 2 1/2" through 16"

    a. Shall have a digital handwheel or numerical vernier sleeve for position readout.
    b. Similar to TA (STAF/G)

E. Valves larger than 16": use lubricated plug valve with separate flow elements.

2.12 PRESSURE INDEPENDENT COMBINED CONTROL AND BALANCING VALVES (FOR HVAC HOT WATER REHEAT DISTRIBUTION SYSTEM)

A. General

1. The valve should be a control valve with adjustable kvs, i.e a stepless, pre-settable balancing and a built-in dp-controller. It shall be supplied and installed as shown on the drawings to ensure proper balancing and performs the control function for water flows in the hydronic heating and cooling system. (Specific application for valve use is associated with the hvac hot water reheat system connection to the existing reverse return distribution system.)
2. The valve should be pressure independent with integral spring and diaphragm arrangement for integral differential pressure control over built in control section.
3. The flow for fully open control part should be adjustable down to 20% of maximum flow. In this way, the flow shall be easily adjusted on each valve on site
4. The valve should have retained EQM characteristic for all recommended pre-settings.

5. Test points shall be provided for measuring differential pressure, temperature and available differential pressure and be integral with the body and incorporate means for positive leak tight shut-off when not in use.
6. True flow measurement verification must be possible with a balancing instrument. Flow deviation max ±10% at fully open (accordingly to BS 7350).
7. The valve should have a rangeability of minimum 50 for all recommended pre-settings.
8. The valve should have the capacity for manual, leak-tight shut off without the actuator attached for maintenance purposes and to allow measurement of available differential pressure for diagnostics.
9. It should be possible to perform a high speed flush with the valve installed in the system without causing damage to the product and without removing/replacing any parts.
10. The valve should have a pressure balanced cone to provide low force actuating and easy maneuvering.
11. The valve should be able to work in a temperature range of minimum -20 – +120 °C.
12. All valves shall be manufactured in accordance ISO 9001 and ISO 14001.
13. Certificate of Origin and Certificate of Quality from factory shall be submitted for inspection when the valves are delivered to site before installation.

B. Valves to be utilized for the new Hot Water reheat system floor take-offs when connecting to existing distribution system supporting existing hot water reheat coils.

1. Similar to Victaulic / TA-FUS1ON – P 1¼" to 6"
2. Designed for simple and accurate measurement for balancing, differential pressure control, trouble shooting, and power measurement in heating and cooling systems. Valve shall allow for adjustable flow settings, with valve and actuators supplied together ensuring optimum control performance. 1 ¼ - 2" valves shall be suitable for working pressures to 235 psi and water temperature range of -4°F through 250°F. 2 ½ - 6" valves shall be suitable for working pressures to 365 psi and water temperature range of -4°F through 250°F.

   a. 1¼" to 2":Valve shall consist of an Ametal® (dezincification resistant alloy) body and valve plug, EPDM spindle seal and O-rings, with seat seal of EPDM/stainless steel. The valve shall include stainless steel springs and spindles, with an Ametal® / PPS / PTFE valve insert, HNBR membrane, and Δp insert of stainless steel / PPS.
   b. 2½" to 6" : Valve shall consist of a ductile iron body and stainless steel valve plug, EPDM O-rings, with seat seal of EPDM/stainless steel. The valve shall include stainless steel Δp spring (painted steel for 6" [DN150] size), with stainless steel and brass plug mechanisms, EPDM membrane, and stainless steel screws and nuts.

C. Valve to be utilized for Hot Water reheat system connecting to existing (basement reverse return) distribution system supporting the lower floors (such as level G and north side of Level Main.)

1. Similar to Victaulic / TA-PILOT-R 8"
2. Designed for simple and accurate measurement for balancing, differential pressure control, trouble shooting, and power measurement in heating and cooling systems. Valve shall allow for adjustable flow settings, with valve and actuators supplied together ensuring optimum control performance. 8" valves shall be suitable for working pressures to 235 psi and water temperature range of -4°F through 250°F.

D. Differential Pressure Control Valves

1. Valves 1/2" through 2": Maximum differential pressure is 51 psi with full body rating of 232-psi, maximum temperature is 248°F for use in heating and cooling systems only. NPT threaded valve body and bonnet shall be manufactured of Ametal® copper alloy, O-rings, seat seal, and membrane manufactured of HBNR. Shall have adjustable differential control, single pressure temperature port, dead end service shut off capabilities, stainless steel spring, polymide handle, and drain.

   a. Shall be capable of stabilizing ΔpV ranges of 1.5 - 8.7 psi in sizes ¾ - 1" or 2.9 - 11.6 psi in sizes 1 ¼ - 2" as determined by project engineer or certified TA representative. Supply side valve shall be Tour and Andersson style STAD, STAS, STAG, or STAF dependent on system size and connection requirements.
   b. Capillary tube, hose kit, and all connection fittings shall be manufactured by Tour and Andersson to ensure proper operation of installed STAP valves. Mechanical contractor and balancing contractor shall be trained on installation, connection, and balancing procedures by certified TA representative.

2. Valves 2 1/2" through 4": Maximum differential pressure 51 psi with full body rating of 232-psi, maximum temperature is 176°F for use in heating and cooling systems only. ANSI Class 150 flange body to be cast of ductile iron and bonnet shall be manufactured of Ametal® copper alloy, O-rings, seat seal, and membrane manufactured of EPDM. Shall have adjustable differential control, single pressure temperature port, dead end service shut off capabilities, stainless steel spring, polymide handle, and drain if required by project engineer.

   a. Shall be capable of stabilizing ΔpV ranges of 2.9-11.6 psi for spring option 1 and 5.8-23.3 psi for spring option 2, as determined by project engineer or certified TA representative. Supply side valve shall be Tour and Andersson style STAD, STAS, STAG, or STAF dependent on system size and connection requirements.
   b. Capillary tube, hose kit, and all connection fittings shall be manufactured by Tour and Andersson to ensure proper operation of installed STAP valves. Mechanical contractor and balancing contractor shall be trained on installation, connection, and balancing procedures by certified TA representative.

2.13 CONSTANT FLOW VALVES

A. General

1. Automatic flow control valves shall automatically control flow rates with Accuracy ±5% over an operating pressure differential range of at least 95% of the control range.
2. Valve internal control mechanism shall consist of:

   a. An accessible passivated stainless steel one-piece cartridge with segmented port design and full travel linear coil spring.
   b. Pressure/temperature test valves for verifying the pressure differential across the cartridge and system temperature shall be provided on each valve
   c. Flow control cartridge assembly shall be precision ground; all AISI type 300 series passivated stainless steel.
   d. Cartridge shall be available in four PSID control ranges with, minimum range capable of being activated by less than 2 PSID and capable of controlling flow within ±5% of rated flow.

e. Flow control cartridge shall be removable from body of valve for service and/or replacement.

3. Manufacturer shall supply certified independent laboratory tests verifying accuracy of performance of all products.
4. Shall have single or multiple, parallel-installed stainless steel cartridge assemblies to provide rated flow rate; shall include all plated steel studs required for installation shall be available in 3", 4", 6", 8", 10", 12", 14", 20" and 30" sizes, with flow rates from 14.0 GPM to 12,750.0 GPM.
5. Valves shall be permanently marked to indicate:

   a. Show flow rate.
   b. PSID control range.
   c. Direction of flow.

6. Valve

   a. Sizes 1 1/2" and less:

      1) Shall have female NPT end connections
      2) Shall be supplied with pressure/temperature test valves,
      3) Shall be permanently marked to show direction of flow,
      4) Shall have body tag to indicate flow rate, model number and PSID.
      5) For steel pipe

         a) Threaded iron valves shall consist of ductile iron body and accessible stainless steel flow control cartridge assembly, shall be rated at 450 psi/200°F
         b) Similar to Griswold Model 35

      6) For copper pipe

         a) Threaded valves
         b) Removable flow cartridge from the y-pattern
         c) Ametal brass copper alloy body
         d) Rated at 400 psi/250°F.
         e) For brazed pipe.

            (1) Shall accept direct soldering to copper tubing.

      7) Similar to Griswold Series 35

   b. For pipe sizes 1 1/2" and 2 1/2" valves shall consist of

      1) Grey iron (ASTM A126-61T, Class 30) body
      2) Accessible stainless steel flow control cartridge assembly.
      3) Valves shall be rated at 300 psi/275°F
      4) Shall have female NPT threaded flange end connections and shall be supplied with plated steel studs and nuts.
      5) Valves shall be permanently marked to show direction of flow; shall have body tag to indicate model number, flow rate and PSID control range
      6) Similar to Griswold Model 354

c. For steel pipe sizes larger than 2 1/2", valves shall be:

1) Wafer type and shall consist of a grey iron (ASTM A-126-61T, Class 30) body and accessible stainless steel flow control cartridge assemblies
2) Shall be rated at 200 psi,/250°F; shall be mechanically compatible with ANSI B/16.1-1967 125 lb.
3) MSS-SP-44 150 lb. steel flanges.
4) Wafer type consisting of a ductile iron ASTM A536 body, compatible with Class 150 or 300 lb. flanges, extended pressure/temperature ports, stainless steel flow cartridge, rated at 600 psi/250°F.
5) Similar to Griswold Model 3

7. Accessories

a. Meter kit with:

1) Portable
2) Double-hose kit,
3) Pressure gauge with 4 1/2" dial shall have range of -14.7 to 150 psi.
4) End connections for pressure/temperature test valves.
5) Carrying cases, all kits shall include
6) Laminated flow rate chart for determining flow rate.

b. Identification tags (all valves)

1) Tags shall be indelibly marked with flow rate, model number, zone identification, and tags shall be 3" x 3" aluminum.

c. P/T adaptor shall include pressure/temperature test valve for measuring the temperature and/or pressure differential across the terminal unit.

2.14 BUTTERFLY VALVES

A. High Performance (For services above 190°F)

1. Sizes 2 1/2" and larger shall be an **ANSI class valve** equal to or greater than the class specified for the service but in no case be less than ANSI Class 150.
2. Body:

a. Carbon steel
b. Fully lugged body .suitable for bi-directional tight shut off to full rated pressure without a downstream flange.

3. Valve shall have no disk contact with the seat when in the open position or any intermediate position.
4. Seal suitable for the operating service and operating temperature plus 50°F.
5. Bearings shall be constructed of SS/Graphite.
6. Seats shall be Xtreme (X).
7. Valve shall be of the double off-set design.
8. The disk shall be 316 stainless steel.
9. The shaft shall be 17-4 PH stainless steel.
10. The disk pin shall be 316 or 17-4 stainless steel.
11. Seat retainer ring fasteners shall not in contact with system fluid.

12. The disk shall be stainless steel.

    a. Operator

        1) Less than 6" except

            a) Lever Operator except for steam service.

                (1) Infinite Positioner:
                (2) Ductile iron ASTM A536.
                (3) With position indicator which shall also indicate "open" and "closed" position.
                (4) Provide memory stop.

        2) Valve Sizes 6" and Greater and all sizes for steam service.

            a) Gear Operator

                (1) Cast iron ASTM A126
                (2) Housing Class B.
                (3) Shaft bearings: Bronze.
                (4) Worm gear: Steel ASTM A216.
                (5) Segment gear: Ductile iron ASTM A536.
                (6) Handwheel: Ductile iron ASTM A536.

                    (a) Minimum diameter

                        ((1)) 6” for valve sizes through 6”
                        ((2)) 12" for valve sizes 8” through 20".
                        ((3)) 18" for valves larger than 20".

                (7) Position indicator and shall also indicate "open" and "closed" position.
                (8) Provide memory stop.
                (9) All gearing shall be enclosed in a housing.

    b. Class 150

        1) Similar to Jamesbury series 815 High performance wafer sphere butterfly valve.

    c. Class 300

        1) Similar to Jamesbury series 830 High performance wafer sphere butterfly valve.

B. Soft Seated (For services below 190°F):

    1. Sizes 2 1/2" and Larger: Suitable for bi-directional dead end service (full pressure rating of valve) with downstream flange removed.
    2. Minimum 250 psig bubble tight shut-off with flow in either direction.
    3. Valve shall comply with MSS-SP67, or MSS SP-68, unless more stringent requirements are specified.

4. Each valve shall be hydrostatically tested at the factory to 110% of pressure rating and proven bubble tight for a minimum of (1) minute.

    a. Body:

        1) Cast iron ASTM A126 minimum Class B, ductile iron ASTM A536, carbon steel ASTM A515 or A516 minimum grade 70, or cast carbon steel ASTM A216 WCB.
        2) Fully lugged body drilled and tapped for ANSI B16.5 Class 150 flanges.
        3) Ductile iron ASTM A536. Grooved end body. (Sizes 14” through 24” supplied with AGS grooved ends.)

5. Disc:

    a. Streamline design for low pressure drop and resistance to cavitation.
    b. Electroless nickel coated ductile iron ASTM A536, aluminum bronze ASTM B1011/1011M, or 316 stainless steel ASTM A351 CF8M.
    c. Machined and polished to minimize seating torque and extend seat life.
    d. Attached to shaft by stainless steel screws, pins or integral key.

6. Disc flutter is not acceptable.
7. Shaft:

    a. One-piece through shaft or 2-piece shaft design
    b. Blowout proof:

        1) Shall not rely on operator for retention.

    c. Shall be 316 stainless steel ASTM A276 type 316 or 17-4 PH stainless steel ASTM A564 Type 630.

        1) Seal by valve seat with secondary seal "O" ring or adjustable packing gland with Teflon packing.

8. Shaft Bushings:

    a. Shaft bushings at each end of seat.

        1) Bushings shall be reinforced Teflon, fiberglass with TFE lining, 316 stainless steel backed TFE, low friction bronze ASTM B438 or stainless steel.

9. Seat:

    a. Bonded encapsulating the valve interior or seat with a mechanically attached retaining ring.
    b. Ethylene propylene diener monomer (EPDM).

10. Operator

    a. Sizes Less Than 6

        1) Lever Operator.

            a) Infinite positioner:
            b) Ductile iron ASTM A536.
            c) Position indicator which shall also indicate "open" and "closed" position.
            d) Provide memory stop.

    b. Sizes 6" and Greater

        1) Gear Operator

            a) Housing: Cast iron ASTM A126 Class B.
            b) Shaft bearings: Bronze.
            c) Worm gear: Steel ASTM A216.
            d) Segment gear: Ductile iron ASTM A536.
            e) Handwheel: Ductile iron ASTM A536.

                (1) Minimum diameter

                    (a) 12" for valve sizes through 20"
                    (b) 18" for valves larger than 20".

            f) Provide operator with position indicator and shall also indicate "open" and "closed" position.
            g) Memory stop
            h) All gearing shall be enclosed in a housing

    c. Valves through 20"

        1) Similar to Bray Series 31H.

    d. Valves 24” and larger

        1) Use high performance Full ANSI rated valve.

C. Grooved End Soft Seated: Butterfly Valves: (When approved for services below 190°F.)

    1. Ductile iron grooved end body.
    2. Bubble-tight shutoff, bi-directional.
    3. Dead-end service at full rated pressure without downstream flange.
    4. Disc

        a. Electroless nickel-plated ductile iron
        b. Offset from the stem centerline to provide continuous 360 degree seating.

    5. Stem: Blowout-proof 416 stainless steel
    6. Bearings: TFE lined fiberglass.

7. EPDM seat and seal material,
8. lever handle or gear operator with handwheel
9. memory stop,
10. Sizes 2” through 12

    a. Rated at 300 psi, 250°F.
    b. Similar to Victaulic Vic-300 MasterSeal,

11. Sizes 14” through 24”

    a. Rated at 300 psi, 230°F.
    b. Similar to Victaulic Vic-AGS-300.

12. Sizes above 24”

    a. Use High performance valve.

2.15 STRAINERS

A. General

1. Screwed ends to 2", flanged or grooved ends 2 1/2" and up.
2. Body

    a. Class 150 lbs.

        1) Ductile iron or carbon steel Note cast brass may be used for copper piping systems.

    b. Class 300

        1) Ductile iron or carbon steel.

    c. Over Class 300

        1) Forged steel or cast steel.

3. Screen

    a. 316 Stainless steel or Monel.
    b. Free area not less than 2.5 times inlet area.
    c. Perforations (unless noted otherwise)

        1) Water

            a) Up to 4": 1/16"
            b) 6" & 8": 1/8"
            c) 10" & Up: 5/32"

        2) Steam and Condensate

            a) Up to 2": 1/64"
            b) 2 1/2 to 4": 1/32"

c) 5" & Up: 3/64"

d. Construction

1) Screen wire gauge to suit size and service.
2) Reinforced.

e. Magnets (Except for Handwheel Operated Type)

1) Water Strainers

a) All 8" and larger.
b) Each pump suction.

2) Provide continuous magnetic field around entire circumference of screen.
3) Removable cast Alnico #5 channel magnets or approved baskets constructed of magnetic alloy.
4) Secure magnets with stainless steel retaining lugs and threaded rods.

B. Y Type

1. Up to 2 1/2”

a. Threaded and gasket.
b. Class 300

1) Similar to Mueller Steam Specialty Fig. #251DI.

c. Socket welded

1) Class 600 Similar to Mueller Steam Specialty 582.

d. Grooved

1) Carbon steel or Ductile Iron
2) Class 150

a) Similar to Victaulic 732.

3) Class 300

a) Similar to Mueller Steam Specialty Fig. #782.

2. 2 1/2” and larger

a. Flanged or Grooved
b. Carbon steel or Ductile Iron
c. Bolted or coupled cover
d. Class 150

1) Similar to Mueller Steam Specialty 781M for flanged.
2) Similar to Victaulic Style 732/W732 for grooved.

e. Class 300

1) Similar to Mueller Steam Specialty 782.

C. T Type

1. 2-1/2” and larger

a. Grooved

1) Ductile Iron
2) Bolted or coupled cover
3) Class 150

a) Similar to Victaulic Style 730/W730.

D. Basket Type

1. Carbon steel body.
2. Suitable for service
3. Screen size: See Y type strainers
4. Bolted cover, bottom drain connection.
5. Class 150

a. Similar to Mueller Steam Specialty Fig. #185

6. Class 300

a. Similar to Mueller Steam Specialty Fig. #186

PART 3 INSTALLATION OF VALVES AND STRAINERS

3.01 VALVES

A. Provide valves, check valves, balancing valves and cocks, and lubricated plug as noted and as indicated on drawings.

B. Shutoff Valves

1. Inlets and outlets of equipment.
2. All branch connections to mains.
3. As noted.

C. Check Valves

1. Pump Discharges: Silent check valves
2. Other Locations: Types as noted

D. Valves

1. Accessible, but no valve handles pointing down below horizontal position. Removable without separating or lifting piping in which valves are installed. Provide cap screws on threaded bodies. Where abutting flanged strainers or similar devices, position valve with respect to device so as to permit removal of bolts.

E. Drain valves at low points in water piping and where noted.

1. In Equipment Rooms

a. Up to 3" Pipe: 3/4"gate or ball valve
b. 3" to 4" Pipe: 1 " gate or ball valve
c. 5” Up Pipe: 2 " gate or ball valve

2. 3/4" drain valve gate or ball valve.
3. All drains shall be provided with a brass hose connection with a pressure rated brass cap with a chain.

a. 3/4 hose thread
b. 1” and 2” use brass pipe thread by straight thread hose connection.
c. Each shall be provided with brass pressure rated cap and chain.
d. No dust covers shall be allowed or caps with holes covered by gaskets.

F. Manual air vents at high points and where required to expel air.

1. Up to 3" Pipe

a. Line size air chamber, 12" long, 1/2" gate valve.

2. 4" to 8" Pipe

a. Line size air chamber, 6" long, 1/2" gate valve.

3. 10" & Up

a. Line size pipe cap, 1/2" gate valve.

G. Where possible install gate, globe and ball valves with stems upright and not more than 15° off of vertical, not inverted.

H. Where possible install butterfly valves with stems in horizontal position and with the low point of disc opening with the direction of flow.

I. Provide stem extensions for insulated lines on all valves such that hand wheel or lever extends beyond insulation and is operable.

J. Ball valves (line sizes through 2") and butterfly valves (line sizes 2 1/2 " and larger) may be used interchangeably with gate valves for shut-off and isolating service in all water systems. Note soft seated butterfly valves can only be used in water services below 190°F. All butterfly valves in water services above 190°F shall be of the high performance type.

K. Use Globe valves (line sizes through 2") and flow control-balancing valve (through 12") lubricated plug valves (line sizes 14" and larger) in water systems for throttling service. Use lubricated plug valves for line sizes smaller than 12" where shown on drawings.

L. Provide spring loaded silent type check valves on discharge of pumps.

M. Install swing check valves in horizontal position only.

N. Provide drain valves at low points between valves, low points of piping system and at equipment.

O. No butterfly valves shall be used in steam systems except high performance type where indicated.

P. All steam service high performance butterfly valves shall be provided with gear operators.

Q. Threaded valves shall be provided with a union adjacent to and downstream of valve.

R. Grooved end valves shall be provided with grooved joint couplings of the same manufacturer.

S. Butterfly valves shall not be used for balancing.

T. Remove internal cartridges from constant flow valves during flushing and cleaning.

U. Butterfly valves shall be installed between weld neck flanges, grooved joint couplings or grooved flange adapters.

V. Provide chain operated sheaves for valves in exposed areas located more than 7'-0" from floor. Provide chain lever kits for all ball valves in exposed areas located more than 7'-0" from floor. Extend chains to about 5'-0" from above floor and hook to clips arranged to clear walking aisles.

W. Pressure Relief Valves

1. Provide at:

a. Cooling coil side of isolation valve.
b. Sectionalized chilled water mains and submains.
c. Sectionalized chilled water and secondary chilled water mains and submains.
d. Equipment side of isolation valve.

1) Water chillers
2) Heat exchangers
3) Convertors in water piping.

e. Other locations as noted.

2. Pipe to spill over floor drain or slop sink unless otherwise indicated.

3.02 STRAINERS

A. Valved and provided with hose connection chain and pressure rated cap. (See strainer assembly detail.)

B. Line size, except as noted.

C. Locate upstream of:

1. Pumps
2. Automatic control valves, except water valves smaller than 1 1/2”, if a central strainer system is used on each floor up stream of the control valve.
3. Steam condensate drip traps
4. Pressure reducing valves
5. Other equipment as noted
6. At steam pressure reducing valves:
7. As indicated

END OF SECTION

SECTION 230529

HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all hangers, supports and assemblies for all parts of the mechanical systems. This shall include all piping, ducts and equipment specified in this Division and as shown on the drawings

B. All materials shall be new and manufactured for the specific purpose of supporting systems, equipment, pipes, ducts, conduits and accessories.

C. All system components shall be installed in accordance with local codes including seismic isolation as required and specified under Section 230548.

D. Refer to Section 230516 Pipe Expansion and closely coordinate with this work.

E. Secure all permits and local/state approval for the components as specified and included under this Section.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

B. Refer to Section 230548 – Mechanical Vibration Controls and Seismic Restraints for specified information related to and affecting this section.

C. Refer to Section 230516 – Pipe Expansion.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

1. Material standards shall be as specified or detailed hereinafter and as following:

   a. ASME B31.9 – Building Services Piping, The American Society of Mechanical Engineers.
   b. ASME B31.1 – power piping.
   c. ASHRAE Systems and Equipment Handbook.
   d. ASTM F 708 – Standard Practice for Design and Installation of Rigid Pipe Hangers.

e. MSS SP-58 – Pipe Hangers and Supports – Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry.
f. MSS SP-69 – Pipe Hangers and Supports – Selection and Application; Manufacturers Standardization Society of the Valve Fittings Industry.
g. MSS SP-89 – Pipe Hangers and Supports – Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry.
h. NFPA-13 – Installation of Sprinkler Systems
i. MSS-SP-127-2001 – Bracing for Piping Systems.

1.05 SYSTEM DESCRIPTION

A. In addition to special hangers and supports specified elsewhere in this Section and shown on the drawings for ducts, piping and equipment, furnish and install safe and substantial means of support for all parts of the mechanical systems. Shop drawings shall be submitted for review and approval for all supports. All piping, ductwork, hangers and supports in all mechanical rooms, and penthouses shall be installed with vibration isolators and Seismic restraints. This requirement is mandatory and shall be strictly enforced.

B. All piping shall be hung to true alignment, using appropriate and substantial hanger arrangements. Wire and strap hangers will not be permitted. Hangers shall be located so that piping and hangers will be clear of other piping, hangers, conduits, lighting and other obstructions.

C. The hanging and supporting of piping and equipment shall conform to recommendations of the manufacturers of same and American National Standard, ANSI/MSS SP-58 and SP-69 latest edition, except where requirements of this specification exceed the above referenced Standards.

1.06 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. All brackets and hangers shall be submitted for review. Include the method of hanging and supporting all piping, ductwork and equipment.

C. The Architect is to be notified when the first bracket is assembled so that the installation can be reviewed in the field.

D. Provide location of all inserts to be used for hanging ductwork, piping and equipment and the weight of all components (including water weight).

1.07 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products of the type specified in Part 2 – Products.

B. Installer: Company specializing in performing work of the type specified in this section, with documented experience.

C. Welders: Certify in accordance with ASME.

1.08 REGULATORY REQUIREMENTS

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

B. Conform to ASME B31.1 code for power piping.

C. All applicable seismic codes.

D. ASTM F708 for design and installation of pipe hangers.

E. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations

1. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.09 DELIVERY, STORAGE AND HANDLING

A. All hangers and supports shall be delivered in containers and shall be kept in a dry and protected area.

B. All exposed hangers, supports, etc. shall be given 2 coats of rust resistant paint of a color selected by the Architect prior to installation.

1.10 ENVIRONMENTAL

A. Do not paint or install inserts, hangers and/or supports when environmental conditions are outside the specific limitations of the referenced codes and manufacturer's recommendations.

PART 2 PRODUCTS

2.01 GENERAL

A. Pipe supports shall be of type and figure number as specified.

B. Acceptable manufacturers subject to compliance with the specifications shall be as follows:

1. Pipe Hangers

a. Carpenter & Patterson
b. B-Line
c. Grinnell
d. National Pipe Hanger Corp.
e. Piping Technology & Products Inc.
f. PHD Manufacturing, Inc.

2. Channel Support Systems

a. B-Line Systems, Inc.
b. Grinnell Corp. Power-Strut Unit
c. GS Metals Corp.
d. Michigan Hanger Co., Inc. O-Strut Div.

e. National Pipe Hanger Corp.
f. Thomas & Betts Corp.
g. Unistrut Corp.
h. Wesanco, Inc.

3. Thermal-Hanger Shield Inserts

a. Carpenter & Patterson, Inc.
b. Michigan Hanger Co., Inc.
c. PHS Industries, Inc.
d. Pipe Shields, Inc.
e. Rilco Manufacturing Co., Inc.
f. Value Engineered Products, Inc.

2.02 PIPE HANGERS

A. Bracket assemblies for supporting piping are to be fabricated by welding and all irregular surfaces are to be smoothed up by grinding. Shop drawings shall be submitted for review for each type bracket. The Architect is to be notified when the first bracket is assembled so that installation can be reviewed in the field. Exposed hangers, supports and brackets are to be given (2) coats of rust resistant paint of the color as selected by the Architect. Additionally, provide for Architect's review, the following:

1. Location of all inserts to be used for hanging ductwork and piping where applicable and the weight of such pipe or equipment to be hung, including the weight of water, valves and insulation.
2. Method of hanging and support of all piping, ducts and other equipment.

B. All pipe supports shall be of type and arrangement as hereinafter specified. They shall be so arranged as to prevent excessive bending stresses between supports.

C. All bracket clamp and rod sizes indicated in this specification are minimum sizes only. This Section shall be responsible for structural integrity of all supports. All structural hanging materials shall have a safety factor of (5) built in. Beam clamps shall be 2-sided steel clamps designed to firmly attach to the flange of the beam with the load directed downward on the centerline of the beam web. Beam clamps shall be similar to B-Line #B3055, or approved equal.

D. Other forms of hangers and supports shall be used to accommodate special or unusual job conditions or conditions not covered herein, subject to the approval of the Architect. When special conditions require the use of concrete inserts which are not "built in", such inserts may be used in locations approved by the Architect and shall be Phillips "Red Head" or approved equal. Explosive powder studs or detonator assisted studs or anchors will not be permitted.

E. All pipes shall be hung free of dependence on pipe sleeves for support.

F. All auxiliary steel required for pipe, duct and equipment supports shall be furnished and installed by the Mechanical Contractor.

G. Threaded pipe, chains, wire and perforated straps will not be accepted. No piping shall be supported from ductwork, conduit or other piping. All system components and equipment shall be independently supported. Distribute hangers on parallel piping to avoid overloading of structure.

H. Roller type supports shall be used for pipes subject to axial movement (all hot water steam, condensate and any emergency generator exhaust). They shall be braced so that movement occurs in roller rather than support rods. This requirement shall apply to piping 2 1/2" and up.

I. Hangers and supports used for systems exposed to weather shall be hot dipped galvanized in accordance with ASTM A153-73 or A123. Rods and nuts shall be electro-galvanized.

J. All horizontal water, drain, waste, vent and rainwater piping shall be hung with clevis steel hangers similar to B-Line #B3100. Groups of pipes in the same horizontal plane and with the same pitch may be supported on B-Line #3160 gang hangers. Wall brackets similar to shall be B-Line #B3066 and #B3077.

K. All pipes which are hung so that the centerline of the pipe is less than 10" below the point of suspension of the hanger rod and all hydronic hot water piping shall be supported on roller hangers similar to B-Line #B3110.

L. Unless otherwise noted, maximum hydronic pipe hanger spacing shall not exceed the recommendations of the pipe manufacturer and the following:

1. For 1/2" copper and steel pipe: 5'-0" o.c.
2. For pipe 3/4" to 1 1/2": 8'-0" o.c.
3. For pipe 2" to 8": 10'-0" o.c.
4. For pipes 10" and up: 15'-0" o.c.
5. In addition, hangers shall be installed within 2'-0" of each change in direction and on each side of valves 3" in size and up.

M. Hanger rods shall be of steel and not less in diameter than:

1. For pipe 2" and under: 3/8"
2. For pipe 2 1/2" and 3": 1/2"
3. For pipe 4" and 5": 5/8"
4. For pipe 6": 3/4"
5. For pipe 8", 10" and 12": 7/8"
6. For pipe 14" and 16": 1"
7. For pipe 18" and up: 1 1/4"

N. Insulated steel piping 2 1/2" and up, except chilled water, shall be fitted with steel pipe covering protection saddles similar to B-Line #B3163 and of the same depth as the specified insulation. Saddles shall be tack welded to the pipe and filled with loose insulation. Standard length saddles may be cut in (2) equal sections for attachment to pipes 6” diameter and under.

O. Insulated piping 2" and under, except chilled water, shall be fitted with 16 gauge steel covering protectors at each hanger location similar to B-Line #B3151.

P. Chilled water piping shall be insulated with high density hydrous calcium silicate shields where hangers occur similar to #B3380CW. Special care shall be exercised to assure a continuous vapor barrier installation to protect the system and prevent sweating.

Q. All vertical piping shall be supported with steel riser clamps similar to B-Line #B3773. Such clamps on copper tubing shall be applied over couplings only.

R. All pipes suspended at an elbow shall be hung using plate lugs similar to Grinnell #HS.53 with forged steel clevis similar to B-Line #B3201.

S. Spring hanger locations shall be provided as specified herein, under vibration isolation, and shall be Grinnell, pre-engineered to meet loads and movements in accordance with ANSI B.31.1.10, where applicable.

T. Drop rods for hangers may be used wherever possible and shall be installed prior to slabs being poured. Drop rod details shall be submitted to the Architect and Engineer for review.

2.03 DUCT HANGERS

A. See Specification 233100 Sheet Metal.

2.04 MISCELLANEOUS MATERIALS

A. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

B. Structural Steel: ASTM A 36M, steel plates, shapes, and bars, black and galvanized.

C. Grout: ASTM C 1107, Grade B, factory-mixed and packaged, non-shrink and nonmetallic, dry, hydraulic-cement grout.

1. Characteristics: Post hardening and volume adjusting recommended for both interior and exterior applications.
2. Properties: Non-staining, non-corrosive and nongaseous
3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.01 PREPARATION

A. All hangers, rod and supports shall receive two (2) coats of rust inhibitive paint.

B. Provide inserts for placement in concrete formwork.

C. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

D. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

E. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.02 INSTALLATION

A. Pipe Hangers and Supports.

1. Install in accordance with ASME B31.9, ASTM F 708, or MSS SP-89 or NFPA-13.
2. Support piping, ductwork and equipment as specified under Part 2.
3. Install hangers to provide minimum ½ inch space between finished covering and adjacent work.
4. Place hangers with 24 inches of each horizontal elbow and on each side of valves 3” in size and up.
5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

6. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
8. Provide copper plated hangers and supports for copper piping or between hanger support and piping.
9. Prime coat (2 coats rust inhibitive paint) exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
10. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

B. Where pipe support members are welded to structural building framing, scrape, brush clean and apply two coats of zinc rich primer to welds.

3.03 INSERTS

A. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

B. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 4 inch or ducts over 60 inches wide.

C. Finish inserts, flush with slab surface.

D. Inserts: Steel, slotted type, factory-painted.

1. Single rod: Similar to Grinnell Figure 281.
2. Multi-rod: Similar to Carpenter and Paterson 1480 Type 1.
3. Clip form nails flush with inserts.
4. Maximum load 75 percent of rating.

3.04 SUPPORTS FROM BUILDING CONSTRUCTION

A. Inserts, Beam Clamps, Steel Fishplates (in concrete fill only), Cantilever Brackets or Other Means.

B. Submit for Review.

C. Grouped Lines and Services

1. Trapeze Hangers fabricated of Bolted Angles or Channels.

D. Where Building Construction is Inadequate

1. Provide Additional Framing.
2. Submit for Review.

3.05 EXPANSION DEVICES

A. Expansion anchors: Similar to Hilti "Drop-In Anchor HDI" flush type.

B. Drill concrete to receive required expansion cases on concrete fasteners.

C. Install in shear only, not in tension.

3.06 EQUIPMENT BASES AND SUPPORTS

A. Provide rigid anchors for ducts and pipes immediately after vibration connections to equipment.

B. Refer to Specification Sections 230500 and 230548 for additional information.

C. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.

D. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.07 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.

B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base-metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.08 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.09 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

B. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 230548

MECHANICAL VIBRATION CONTROLS AND SEISMIC RESTRAINTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all necessary vibration isolation materials to eliminate excessive noise and vibration from all building mechanical systems.

B. Seismic restraints for all systems shall be installed in accordance with:

1.	Code	IBC 2003
2.	Use group	III
3.	Seismic design category	C
4.	Site classification	D
5.	Building I_p (Importance Factor)	1.5
6.	All Life safety systems	Importance Factor = 1.5
7.	Emergency electrical	Importance Factor = 1.5
8.	Hazardous systems	Importance Factor = 1.5
9.	HVAC	
	a. All smoke exhaust systems	Importance Factor = 1.5
	b. Hospital ductwork	Importance Factor = 1.5
10.	Plumbing systems	
	a. Medical gas	Importance Factor = 1.5
	b. Laboratory gases	Importance Factor = 1.5
	c. Compressed air system	Importance Factor = 1.5
	d. High Purity water system	Importance Factor = 1.5
	e. Pneumatic gases	Importance Factor = 1.5
	f. Domestic water system	Importance Factor = 1.5
	g. Non Potable water system	Importance Factor = 1.0
	h. Waste and vent system	Importance Factor = 1.0
	i. Laboratory waste and vent	Importance Factor = 1.5
	j. Acid waste and vent	Importance Factor = 1.5
	k. Storm Drain system	Importance Factor = 1.0
11.	Other systems	
	a. All other ductwork systems	Importance Factor = 1.5
	b. All other piping systems	Importance Factor = 1.5
	c. All other electrical systems	Importance Factor = 1.5
	d. All other plumbing systems	Importance Factor = 1.5
	e. Control conduits	Importance Factor = 1.5

C. Piping Types

1. High deformability piping:

a. Welded steel
b. Welded stainless steel
c. Socket welded steel
d. Grooved steel that is ASME B31.1
e. Braised copper
f. Grooved copper

2. Limited-deformability

a. Threaded Steel
b. Grooved steel that is not ASME B31.1
c. Soldered copper

3. Low-deformability

a. PVC
b. Cast iron
c. Glass
d. Non-ductile plastic

D. All trapeze supported Items weighing 10 Lbs per foot or greater shall be braced. This weight shall include all pipes and conduits filled with water.

E. Secure all permits and local/state approval for the installation of all components included under this Section.

F. The work in this Section shall include the following:

1. Vibration isolation elements for equipment.
2. Equipment isolation bases.
3. Piping flexible connectors.
4. Seismic restraints for isolated equipment.
5. Seismic restraints for non-isolated equipment.
6. Seismic restraints for ductwork
7. Seismic restraints for piping
8. Certification of seismic restraint designs and installation supervision.
9. Certification of seismic attachment of housekeeping pads.

G. Coordinate closely with Hangers and Supports, Pipe Expansion and Structural documents.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

B. Refer to Section 230516 – Pipe Expansion.

C. Refer to Section 230529 – Hangers and Supports.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. NEBB– Procedural Standards for Measuring Sound and Vibration; National Environmental Balancing Bureau.
2. NEBB– Sound and Vibration in Environmental Systems; National Environmental Balancing Bureau.
3. SMACNA – Guidelines for Seismic Restraint of Mechanical Systems.
4. ASHRAE Guidelines – HVAC Applications; Chapter– Sound and Vibration Control, Chapter – Seismic Restraint Design, Latest Edition.
5. ASCE Standard 7 Minimum Design Loads for Buildings and Other Structures

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. The Vibration Isolation Submittal shall include descriptive data for all products and materials including the following:

1. Product Descriptions

a. A complete description of products to be supplied, including product data, dimensions, specifications and installation instructions.
b. An itemized list of isolated and non-isolated equipment. Detailed schedule and selection data for each vibration isolator and seismic restraint supporting equipment, including:

1) Equipment identification mark
2) Isolator type
3) Actual load
4) Static deflection expected under actual load
5) Specified minimum static deflection
6) Additional deflection-to-solid under load
7) Ratio of spring height under load to spring diameter
8) Base type
9) Seismic restraint type

c. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.

2. Show equipment base construction for all equipment, including dimensions, structural member sizes and support point locations.
3. Indicate isolation devices selected with complete dimensional and deflection data.
4. Show all methods of suspension and support for ceiling hung equipment.
5. Detail methods of isolation for ducts and pipes piercing walls and slabs.
6. Provide specific details of seismic restraints and anchors, including number, size and locations for each piece of equipment.

7. Provide special details necessary to convey complete understanding of the work to be performed.

C. Seismic Analysis and Certification submittals shall include the following:

1. Seismic restraint calculations must be provided for all connections of equipment to the structure.
2. Calculations to support seismic restraint designs shall be stamped by a registered Professional Engineer.
3. Analysis must indicate calculated dead loads, derived loads, and materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and weld length.
4. A seismic design liability insurance certificate must accompany all submittals.
5. Coordinate all hangers and supports.
6. Provide Approved Agencies Certificate of Compliance meeting Seismic Category D for all components. Tests shall include anchorage, structural and on line capability from analytical or shaker test method.

    a. Where the requirements of this specification cannot be met by any vendor, the contractor will submit a written summary indicating the lack of resources.

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

E. Provide seismic certifications for all equipment including, but not limited to:

1. Air handling equipment
2. Fans
3. VFDs
4. Motor control centers
5. Pumps
6. Heat exchangers
7. Seismic joints

1.06 QUALITY ASSURANCE

A. All vibration isolators shall have calibration markings or some method to determine the actual deflection under the imposed load after installation and adjustment.

B. All isolators shall operate within the linear portion of their load versus deflection curves. Load versus deflection curves shall be furnished by the manufacturer and must be linear over a deflection range of at least 50% above the design deflection.

C. The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than ±10%, and shall be non-resonant with equipment forcing frequencies or support structure natural frequencies.

D. All neoprene components shall have a shore hardness of 30 to 50 ±5%, after minimum aging of (20) days or equal oven aging.

E. Substitution of internally isolated and restrained equipment in lieu of the isolation and restraints specified in this Section is acceptable provided all conditions of this Section are met. The equipment manufacturer shall provide a letter of guarantee stating that the specified noise and vibration levels will be obtained and that the seismic restraints shall be in compliance with these specifications. All costs for converting to the specified external vibration isolation and/or restraints shall be borne by the equipment manufacturer/installing contractor should submissions or installations be found to be unacceptable pursuant to the intent of this specifications.

F. Should any rotating equipment cause excessive noise or vibration, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

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

H. Manufacturer Responsibility

1. Manufacturer of vibration and seismic control equipment shall have the following responsibilities:

a. Determine vibration isolation and seismic restraint sizes and locations.
b. Provide equipment vibration isolation and seismic restraints as scheduled or specified.
c. Guarantee specified isolation system deflections.
d. Provide installation instructions, drawings and field supervision to ensure proper installation and performance of systems.
e. Provide certification by a licensed engineer that all mounts and restraints meet the project requirements for seismic loading.

2. Substitution of internally isolated mechanical equipment in lieu of the specified isolation of this Section must be approved for individual equipment units and is acceptable only if above acceleration loads are certified in writing by the equipment manufacturer and stamped and sealed by a licensed Civil or Structural Engineer.
3. Licensed Engineers shall be licensed in the project state.

I. Contractor Responsibilities

1. The Contractor performing the work on equipment in the section shall have the following responsibilities.

a. Identify the components that are part of the Quality Assurance Plan.

1) All flammable, combustible and highly toxic piping and their associated mechanical systems.
2) All ductwork containing hazardous materials.
3) All equipment using combustible or toxic energy sources.

b. Identify all Special inspection and Testing.

c. List control procedures within the contractor's organization including methods and frequency of reporting and their distribution.
d. List personnel and their qualifications exercising control over the seismic aspects of the project.

2. Purchased and/or fabricated equipment must be designed to safely accept external forces of 1.8 g load in any direction for all rigidly supported equipment, piping and ductwork without failure and permanent displacement of the equipment. Resiliently supported equipment, piping and ductwork and Life safety equipment such as fire pumps, smoke exhaust fans, emergency generators and other life safety designated equipment must be capable of accepting external forces of up to 3.6 g in any direction without permanent displacement or failure of the equipment.

1.07 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 code for installation of piping system and ASTM F708 for design and installation of pipe hangers.

B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

C. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.08 DELIVERY, STORAGE AND HANDLING

A. All vibration control and SEISMIC restraint equipment shall be delivered in containers and shall be kept in a dry and protected area.

B. All exposed hangers, supports, etc. shall be given 2 coats of rust resistant paint of a color selected by the Architect prior to installation.

PART 2 PRODUCTS

2.01 ISOLATORS AND RESTRAINTS – GENERAL

A. Acceptable Manufacturers subject to compliance to specifications.

1. Mason Industries (MI)
2. Amber/Booth (AB)
3. Kinetics Noise Control (KNC)
4. Vibration Eliminator Co. (VEC)
5. Vibration Mountings & Controls (VMC)

B. The Mechanical Contractor shall provide necessary vibration isolation materials to eliminate excessive noise and vibration from being transmitted from HVAC equipment to the occupied areas of the structure, and to serve as the basis for seismic restraint design for the entire HVAC system within the building. This includes all non-structural components such as, but not limited to, air handlers, fans, pumps, tanks, ductwork, piping, etc. (hereinafter called equipment).

C. Seismic restraints and vibration isolation types shall be capable of accepting, without failure, seismic forces determined in accordance with:

1. International Building Code
2. State/Country Codes
3. Local codes enforced at the specified project location.

D. Isolators and supports shall maintain the equipment in a captive position and not short circuit isolation during normal operating conditions. Isolators shall have provisions for bolting and/or welding to the structure.

E. All metal parts of vibration isolation units installed out-of-doors shall be cold dip galvanized, cadmium plated, or neoprene or PVC coated after fabrication. Galvanizing shall meet ASTM Salt Spray Test Standards and Federal Test Standard #14.

F. All base supported isolators shall have base plates with bolt holes for fastening the isolators to the support members.

G. Isolator types are scheduled to establish minimum standards. At the Contractor's option, laborsaving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories must not degrade the vibration isolation system.

H. Static deflection of isolators shall be as scheduled in this Section and as shown on the drawings. All static deflections stated are the minimum acceptable deflection under actual load. Isolators shall be selected for no less than 50% reserve deflection beyond actual operating conditions.

I. Attachment plates to be cast into housekeeping pads, concrete inserts, beam clamps, etc. that may be required for seismic compliance shall be provided by this Section.

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

2.02 SEISMIC RESTRAINT TYPES

A. Type I

1. Type I shall comply with general characteristics of spring isolator Type A with snubbing restraint in all directions capable of supporting equipment at fixed elevations during installation. Cast or aluminum housings, except ductile iron are not acceptable.
2. Type I seismic restraint shall be similar to Mason Industries Type SLRS.

B. Type II

1. Each corner or side of equipment base shall incorporate a seismic restraint snubber having a minimum of 5/8" thick resilient pad limit stop. Seismic snubbers shall be in accordance with manufacturer's recommendations.
2. Type II seismic restraints shall be similar to Mason Industries Type Z-1011 or Z-1225.

C. Type III

1. Type III shall be multiple metal cable or strut type with approved fastening devices to equipment and structure. System to be field bolted to deck or to overhead structural members using 2-sided beam clamps or appropriately designed inserts for concrete. All parts of the system including cables, excluding fasteners, are to be of a single supplier to ensure seismic compliance.

D. Type IV

1. Type IV shall have double deflection neoprene isolator (minimum 0.3") encased in ductile iron or steel casing.
2. Type IV seismic restraints shall be similar to Mason Industries Type BR, RBA or RCA.

E. Type V

1. Non-isolated equipment shall be field bolted or welded (powder shots not acceptable) to the structure as required to meet seismic forces. Bolt diameter, imbedment data and/or weld length must be shown in certified calculations.

2.03 VIBRATION ISOLATOR TYPES

A. Type A (Floor Spring and Neoprene)

1. The Type A spring isolator shall:

a. Have a minimum outside diameter to overall height of 0.8:1.
b. Have corrosion resistance where exposed to corrosive environment with:

1) Springs cadmium plated or electro-galvanized.
2) Hardware cadmium plated.
3) All other metal parts hot dip galvanized.

c. Have reserve deflection (from loaded to solid height) of 50% of rated deflection.
d. Have minimum 1/4" thick neoprene acoustical base pad on underside, unless designed otherwise.
e. Be designed and installed so that ends of springs remain parallel.

2. Type A isolator shall be similar to Mason Industries Type SLF.

Note: Must be used with Seismic Restraint II.

3. Fans in the AHUs should be resiliently supported with isolators that are selected to achieve at least 1.5” deflection under load.

B. Type B (Floor Spring and Neoprene Travel Limited)

1. The Type B spring isolator shall be the same as Type A with the following additional features.

a. Built-in vertical limit stops with minimum 1/4" clearance under normal operation.
b. Tapped holes in top plate for bolting to equipment.

c. Capable of supporting equipment at fixed elevation during equipment installation. Installed and operating heights shall be identical.
d. Adjustable and removable spring pack with separate neoprene isolation pad.

2. Type B isolator shall be similar to Mason Industries Type SLR.

Note: This isolator must be bolted or welded to the structure.

C. Type C (Spring Hanger Rod Isolator)

1. Spring isolator (Type A) seated on a steel washer within a neoprene cup incorporating a rod isolation bushing.
2. Spring diameters and hanger box shall allow 30° of hanger rod movement.
3. When used on ductwork, provide eyebolts for attachment to duct straps.
4. Type C isolator shall be similar to Mason Industries Type 30 or W30.

Note: Must be used with Seismic Restraint III.

D. Type D

1. Same as Seismic Restraint Type IV.

E. Type E (Elastomer Hanger Rod Isolator)

1. Molded (minimum 1 3/4" thick) neoprene element with projecting bushing lining the rod clearance hole. Static deflection at rated load shall be minimum 0.035".
2. Steel retainer box encasing neoprene mounting capable of supporting equipment up to (4) times the rated capacity of the element.
3. Type E isolator shall be similar to Mason Industries Type HD.

Note: Must be used with Seismic Restraint III.

F. Type F (Combination Spring/Elastomer Hanger Rod Isolator)

1. Spring and neoprene elements in a steel retainer box with the features as described for Type C and Type E isolators.
2. Type F isolator shall be similar to Mason Industries Type 30N.
3. Suspended fans to be resiliently supported with isolators selected to achieve at least 1.5” deflection under load.

Note: Must be used with Seismic Restraint III.

G. Type G (Pad Type Elastomer Isolator)

1. 0.75" minimum thickness, 50 psi maximum loading, ribbed or waffled design.
2. Minimum 0.1" deflection.
3. 1/16" galvanized steel plate between multiple pad layers.
4. Provide load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.
5. Type G isolators shall be similar to Mason Industries Type Super W.

Note: Bolting required for seismic compliance. Neoprene and duck washers and bushings shall be provided to prevent short circuiting.

H. Type H (Pad Type Elastomer Isolator)

1. Laminated cotton duck and neoprene, maximum loading 1000 psi, minimum 1/2" thick.
2. Provide load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.
3. Type H isolator shall be similar to Mason Industries Type HL.

Note: Bolting required for seismic compliance. Neoprene and duck washers and bushings shall be provided to prevent short circuiting.

I. Type I (Thrust Restraints)

1. A spring element similar to Type A isolator shall be combined with steel angles, back-up plates, threaded rod, washers and nuts to produce a pair of devices capable of limiting movement of air handling equipment to 1/4".
2. Restraint shall be easily converted in the field from a compression type to tension type.
3. Unit shall be factory pre-compressed.
4. Thrust restraints shall be installed on all cabinet fan heads, axial or centrifugal fans and other equipment as scheduled.
5. Type I restraint shall be similar to Mason Industries Type WB.

J. Type J (Steel Rails)

1. Steel members of sufficient strength to prevent equipment flexure during operation.
2. Height saving brackets as required to reduce operating height.
3. Type J isolator shall be similar to Mason Industries Type ICS.

K. Type K (Pipe Anchors and Guides)

1. Acoustical pipe anchor or guide, consisting of a telescopic arrangement of (2) sizes of steel tubing separated by a minimum 1/2" thickness of Type H pad.
2. Vertical restraints shall be provided by a similar material arranged to prevent vertical travel in either direction (anchors only).
3. Allowable loads on isolation materials shall not exceed 500 psi, and the design shall be balanced for equal resistance in any direction.
4. Anchors and guides must be bolted or welded to meet seismic criteria.
5. Type K anchor shall be similar to Mason Industries Type ADA.

L. Type L (Isolated Clevis Hanger)

1. Combination clevis or rod roller hanger and a Type C, E, or F, isolation hanger.
2. System shall be pre-compressed to allow for rod insertion and standard leveling.
3. Type L hanger shall include Mason Industries Type CCB clevis brace.

2.04 EQUIPMENT BASES

A. All curbs and roof rails are to be bolted or welded to the building steel or concrete deck to attain acceleration criteria and shall be wind restrained for 110 mph wind loads.

B. Type B-1 (Integral Structural Steel Base)

1. The integral structural steel base shall be reinforced as required to prevent base flexure at equipment start-up and misalignment of driver and driven units. Centrifugal fan bases shall be complete with motor slide rails and shall be drilled for driver and driven units.
2. Height saving brackets shall be provided, as required, to reduce operating height and maintain 1" operating clearance under base.
3. Member depth shall be a minimum of 1/10 of the longest unsupported span.
4. Type B-1 equipment base shall be similar to Mason Industries Type M or WF.

Note: Must be used with Restraint I, II or IV.

C. Type B-2 (Concrete Inertia Base)

1. Concrete inertia base shall have rectangular structural concrete forms for floating foundations. Base for split-case pumps shall be large enough to support elbows. The base depth shall be a minimum of 1/12 the longest span, but not less than 6" or greater than 14". Forms shall include concrete reinforcement consisting of 1/2" bars or angles welded in place on 6" centers both ways in a layer 1 1/2" above the bottom. Provide an additional top layer of reinforcing for all bases exceeding 10'-0" in one direction.
2. Isolators shall be set into pocket housings which are an integral part of the base construction and set at the proper height to maintain 1" clearance below the base. Base shall be furnished with templates for equipment attachment and anchor bolt sleeves.
3. Type B-2 equipment base shall be similar to Mason Industries Type K or KIPWF.

Note: Must be used with Restraint I, II or IV.

D. Type B-3 (Spring Roof Curb)

1. Curb mounted rooftop equipment shall be mounted on structural spring isolation curbs that bear directly on the roof support structure, and are flashed and waterproofed into the roof's membrane waterproofing system. Equipment manufacturer's curb shall not be used.
2. All spring locations shall have removable waterproof covers to allow for spring adjustment and/or removal. Springs shall be Type A.
3. Curbs shall be thermal and sound attenuating type utilizing standard 2" roof insulation supplied and installed by the Roofing Contractor.
4. Unit shall be provided with wood nailer and flashing.
5. Curbs shall meet all NRCA Standards.
6. Curbs shall include a means of incorporating a sound barrier package, Type SBC-3 consisting of (2) layers of waterproof sheetrock furnished and installed by others.
7. Curbs installed on pitched roofs shall be factory built to compensate for elevation changes.
8. Curbs shall be similar to Mason Industries Type RSC having a minimum 3" rated static deflection.

E. Type B-4 (Flashable Roof Rail System)

1. Rooftop fans, condensing units, air handlers, etc. shall be mounted on continuous support piers that combines equipment support and isolation into (1) assembly.
2. Rails shall incorporate Type A isolators which are adjustable, removable and interchangeable after equipment has been installed.

3. The system shall maintain the same installed and operating height with or without the equipment load.
4. The system shall have full plywood nailers on all (4) sides, designed to accept membrane waterproofing and shall be dry galvanized or plastic coated.
5. Unit to be supplied with flashing.
6. Roof rail shall be similar to Mason Industries Type R-7000 having a minimum 3" rated static deflection.

F. Type B-5 (Roof Rail Base)

1. Rails shall be constructed from structural steel angles sized as required to prevent flexure and misalignment under load.
2. Each rail shall be the full length of the supported equipment and be welded to a series of Type B isolators. Bolt-on angle cross ties at the ends and center shall form (1) rigid platform.
3. Roof rail shall be similar to Mason Industries Type TRSLR.

G. Type B-6 (Non-Isolated Roof Curb)

1. Non-isolated, curb mounted rooftop equipment shall be mounted on structural curbs that meet the acceleration criteria hereinbefore defined.
2. Curbs shall accept standard 2" roof insulation furnished and installed by the Roofing Contractor.
3. Non-isolated curbs shall be similar to Mason Industries Type RRC.

2.05 FLEXIBLE PIPE CONNECTOR

A. All flexible connectors shall be:

1. Installed on the equipment side of the shutoff valves, horizontal and parallel to equipment shafts whenever possible. All piping between the flexible connector and the equipment shall be independently supported off the equipment base.
2. Provided wherever rigidity supported piping is connected to equipment.

B. Type FC-1 (Elastomer Connector)

1. Manufactured of nylon tire cord and EPDM, both molded and cured in hydraulic presses. Neoprene used in lieu of EPDM is not acceptable.
2. Straight connectors to have (2) spheres reinforced with a molded in external ductile iron ring between the spheres.
3. Rated at 250 psig/170°F, dropping in a straight line to 170 psig/250°F for sizes 1 1/2" to 12".
4. All sizes shall employ control cables with neoprene end fittings isolated from anchor plates by means of 1/2" bridge bearing neoprene bushings.
5. Connectors shall be installed pre-extended per manufacturer's recommendations to prevent elongation under pressure.
6. Minimum safety factory of 3.6:1 at maximum pressure ratings shall be certified by test reports. Submittals shall also include (2) test reports by independent consultants showing minimum reduction of 20 dB in vibration accelerations and 10 dB in sound pressure levels at typical blade passage frequencies.
7. Connectors bolted to Victaulic type coupling or gage, butterfly or check valves to have a minimum 5/8" flange spacer installed between the connector and the coupling flange.

8. Connectors for pipe size 2" and smaller shall have threaded female union couplings on each end. Larger pipe sizes shall be fitted with flange couplings.
9. Type FC-1 flexible connector shall be similar to Mason Industries Super-Flex Type MFTNC or MFTFU.

C. Type FC-2 (Flexible Stainless Steel Hose)

1. Stainless steel hose and braid rated with 3:1 safety factor.
2. 2" and smaller with male nipples, 2 1/2" and larger with fixed steel flanges.
3. Lengths as follows:

Size		Length	Size		Length	Size		Length
1/2	x	9	2	x	14	8	x	22
3/4	x	10	2 1/2	x	13	10	x	26
1	x	11	3	x	14	12	x	28
1 1/4	x	12	4	x	15	14	x	30
1 1/2	x	13	5	x	19	16	x	32
			6	x	20			

4. Type FC-2 flexible connector shall be similar to Mason Industries Type BSS.
5. 250 PSIG working pressure.

D. Type FC-3 (Unbraided Exhaust Hose)

1. Low pressure stainless steel annularly corrugated with flanged ends.
2. Maximum temperature of 1500°F.
3. Lengths (in inches) as follows:

Size		Length	Size		Length
2 1/2	x	15	8	x	22
3	x	16	10	x	26
4	x	17	12	x	28
5	x	18	14	x	30
6	x	19	16	x	32

4. Type FC-3 flexible connector shall be Mason Industries Type SDL-RF or equal by approved manufacturer.

E. Type FC-4 (Bronze Braided Flexible Hose)

1. Bronze hose and braid rated with a minimum 3:1 safety factor (minimum 150 psi).
2. Copper tube ends.
3. Minimum lengths (in inches) as follows:

Size		Length	Size		Length	Size		Length
1/8	x	7 1/2	3/4	x	11 1/2	3	x	27
1/4	x	8 1/4	1	x	13	3 1/2	x	32
3/8	x	9	1 1/4	x	14 3/4	4	x	33
1/2	x	9 3/4	1 1/2	x	17	5	x	41
5/8	x	10	2	x	20	6	x	48
			2 1/2	x	24			

4. Type FC-4 flexible connector shall be similar to Mason Industries Type BFF.
5. 250 PSIG working pressure.

F. Seismic Expansion Joints

1. Provide seismic expansion joints on all ducts, piping, conduits or other systems crossing building expansion seismic joints. Provide these joints to allow for the movement in the XY&Z direction as indicated on the structural documents.
2. Pressure rated for 250 PSIG at maximum service temperature.

2.06 VIBRATION ISOLATION SCHEDULE

Equipment	HP	Mtng	On Grade ****				Above Grade			
			Isol	Defl	Base	Restr	Isol	Defl	Base	Restr
Air Conditioning Condensers		Roof	---	---	---	---	A	2.50	B-1	I
Air Conditioning Units (DX)		Flr Clg	A ---	1.0 ---	--- ---	II ---	A F	1.0 1.0	B-1 ---	I,II III
Base Mounted Pumps	to 15 >15	Flr Flr	A A	1.0 1.5	B-2 B-2	II II	A A	1.5 2.0	B-2 B-2	I,II I,II
In Line Pump		Clg	---	---	---	---	F	.35	---	III
Cabinet Type Fans & Packaged AHUs	To 1	Flr Clg	D ---	.50 ---	--- ---	IV ---	D	See Guide	--- ---	IV
Cabinet Type Fans & Packaged AHUs	>1	Flr Clg	A ---	1.0 ---	--- ---	II ---	A ** F	See Guide	--- ---	I,II III
Centrifugal Fans		Flr Clg	A ---	1.0 ---	B-1 ***	II ---	A** F	See Guide	B-2 ***	I,II III
Plenum Fan		Flr Clg	A ---	1.0 ---	B-1 ***	II ---	A** F	See Guide	B-2 ***	I,II III
Centrifugal Fans Arrangement 9 and 10		Flr Clg	A ---	1.0 ---	B-1 ---	II ---	A** F	See Guide	B-2	I,II III
Curb Mounted Equipment Other than AHU*****		Roof	---	---	---	---	---	---	B-6	V
Rooftop AHU >10 Ton		Roof	---	---	---	---	A	2.50	B-3	V
Unit/Cab. Heaters		Clg	---	---	--	--	E	.30	---	III
Air Compressor		Flr	A	1.0	B-2	II	A ** F	See Guide	B-2 ---	I,II III
Refrigerated Dryer			---	---	---	---	D	.5	---	IV
Interior portion of split system		Clg	---	---	---	---	E	0.35	---	III
Piping Connection to Isolated Equipment (******)		Clg	---	---	---	---	E	0.30	---	III
Miscellaneous equipment, heat exchangers, receivers, tanks PRV stations, etc., that are interconnected with isolated pipes		Flr	E	0.30	---	II	E	0.30	---	III

* Used on vertically arranged units. Rails shall be 1.5 times the unit height.
** Substitute Type B isolator for Outdoor installations.
*** Substitute Type B-2 base for floor mounted Class 2 and 3 fans.

**** "On Grade" shall mean slab on grade only.
***** Fans in all units shall be isolated in accordance with chart.
****** This isolation should extend throughout the mechanical spaces and for not less than 50 ft pipe length if the pipe in question leaves the mechanical room.

Notes:

1. "Isol", "Base" and "Restr" columns indicate letter type as appears in the specs.
2. "Mtng" refers to method of support of equipment from the structure.
3. "See Guide" indicates isolator deflection selection to be taken from Deflection Guide below.

Deflection Guide	
RPM	MW Deflection
<400	3.5"
<600	2.5"
>600	1.5"

PART 3 EXECUTION

3.01 GENERAL

A. Isolation and seismic restraint systems must be installed in strict accordance with the manufacturer's written instructions and submittal data. Vibration isolators shall not cause any change of position of equipment resulting in stress on equipment connections.

B. Design Criteria

1. All mechanical equipment such as pumps, heat pumps, fans, air handling units, etc. shall be isolated from the building structure by means of noise and vibration isolators.
2. All piping ductwork in mechanical equipment rooms and penthouses shall be isolated from the building structure by means of noise and vibration isolation hangers and provided with seismic restraints.
3. Piping and/or ductwork penetrations through floors and walls shall not be rigidly connected to the building structure. Provide sleeves with clearances around the outside, as recommended by the vibration materials manufacturer. All such penetrations shall be smokeproofed and firestopped in an approved manner as hereinbefore specified.
4. Generally, isolation facilities shall be designed to limit equipment room floor or roof loading to a maximum of 50 lbs./sq.ft. and vibration isolators shall be carefully and specifically selected for each piece of equipment.
5. Flexible duct connections at fans and air handling units shall have a minimum clear gap of 3" between metal collars. Flexible connectors exposed to the weather shall be weatherproofed by the Mechanical Contractor. Refer to the Sheet Metal Section of this specification for requirements of flexible duct connections.
6. Piping found to have water hammer or other objectionable vibration or noise which cannot be eliminated by proper grading or other natural means shall be braced, trapped, hung with vibration isolation hangers, equipped with air chambers or mechanical shock absorbers, flexible pipe connectors, or otherwise silenced using means as approved by the Architect.
7. Motor driven equipment which is to be isolated shall have motor mounted on the isolated equipment or shall have motor, equipment and drive mounted on a common base.

8. The Contractor shall not install any equipment, piping or conduit which makes rigid contact with the "building" unless permitted in this Specification. Building includes, but is not limited to, slabs, beams, columns, studs and walls.
9. Isolation mounting deflection shall be (minimum) as specified or scheduled on drawings.
10. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering or electrical, to avoid any contact which would reduce the vibration isolation.
11. Bring to the Architect's attention, prior to installation, any conflicts with other trades that will result in unavoidable rigid contact with equipment or piping as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
12. Bring to the Architect's attention any discrepancies between the specifications and field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the contractor's expense.
13. Obtain inspection and approval of any installation to be covered or enclosed, prior to such closure.
14. Correct, at no additional cost, all installations which are deemed defective in workmanship or materials.

3.02 SPRING RISER SUPPORT SYSTEM

A. All vertical riser subjected to thermal expansion and/or construction as noted herein or on the documents, shall be supported by spring isolators and central anchors designed to insure loading within design limits at structural support points. The riser design must include the initial load, initial deflection, change in deflection, final load and change in load at all spring support locations. In order to minimize load changes, the initial spring deflection must be at least 4 times the thermal movement. The submittal must also include anchor loads when installed, cold filled, and at operating temperature. Include calculated pipe stress at end conditions and branch off locations as well as installation instruction. The submittals must be stamped and signed by a licensed Professional Engineer in the employ of the vibration vendor for at least five years.

B. Neutral resilient anchors close to the center of the run shall direct movement up and down. The anchors shall be capable of holding an upward force equal to the water weight when the system is drained. If one level cannot accommodate this force, anchors can be located on 2 or 3 adjacent floors. Resilient guides shall be spaced and sized properly depending on the pipe diameter.

C. Proper provision shall be made for seismic protection in seismic zones, as required.

D. The support spring mounts shall be specification Type A, anchors Type ADA, telescoping guides Type VSG, all similar to as manufactured by Mason Industries, Inc.

E. The isolation vendor shall provide and design all brackets at riser spring and anchor locations where standard clamps lack capacity or do not fit. The contractor must install and adjust all isolators under the supervision of the designing isolation vendor or his representative.

3.03 EQUIPMENT ISOLATION INSTALLATION

A. Equipment shall be isolated and restrained as per the vibration isolation schedule at the end of this Section.

B. Place floor mounted equipment on 4" high concrete housekeeping pads (unless detailed otherwise) properly doweled or expansion shielded to the deck to meet acceleration criteria. Anchor isolators and/or bases to housekeeping pads. Housekeeping pad concrete work shall be by Division 3. Housekeeping pads shall be sized to have a minimum of 6” of clearance all around the equipment or 12 bolt diameters, whichever is greater.

C. Additional Requirements

1. The minimum operating clearance under inertia bases shall be 2".
2. The minimum operating clearance under other bases shall be 1".
3. All bases shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the equipment, isolators and restraints.
4. The isolators shall be installed without raising the equipment.
5. After the entire installation is complete, and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. The blocks shall be barely free and shall be removed. Remove all debris from beneath the equipment and verify that there are not short circuits of the isolation. The equipment shall be free in all directions.
6. Install equipment with flexibility in wiring.

3.04 PIPING AND DUCTWORK ISOLATION INSTALLATION

A. Isolate piping and ductwork outside shafts connected to rotating or reciprocating equipment and pressure reducing stations as follows:

1. All water piping in mechanical rooms.
2. Water piping within 50'-0" or 100 pipe diameters (whichever is greater) from connected isolated equipment.

B. The isolators shall be installed with the hanger box hung as closely as possible (without direct contact) to the structure.

C. The isolators shall be suspended from substantial structural members sized for a maximum deflection of L/360 at mid span, not from slab diaphragm, unless specifically permitted by the structural engineer.

D. Hanger rods shall not short circuit the hanger box.

E. Horizontal suspended water piping 1 1/4" to 2" shall be suspended by Type E isolators with a minimum 3/8" deflection. Water pipe larger than 2" shall be supported by Type F isolators with a minimum 0.75" deflection or same deflection as equipment for the first (3) locations nearest equipment, whichever is greater.

1. Type L isolators may be substituted for the above.

2. Horizontal floor and roof supported pipe shall be the same as above except use isolators Type D and Type A, respectively.

F. Ductwork shall be supported by Type C isolators with a minimum 0.75" deflection.

G. Vertical riser pipe supports, where required, under 2" diameter shall utilize Type H isolation.

H. Vertical riser guides, where required, shall avoid direct contact of piping with the building.

I. Pipe anchors or guides, where required, shall utilize Type K isolators.

J. Riser sway supports, where required, shall utilize (2) neoprene elements (Type G or H) to accommodate tension and compression forces.

K. Install Type FC-1 (FC-4 for refrigerant piping) flexible connectors at all connections of pipe to isolated equipment such as pumps, as shown on the drawings.

L. Install FC-2, FC-3 or FC-4 type connectors only at locations which exceed temperature or service (such as gas, fuel oil, or refrigerant) limitations of FC-1.

M. Emergency generator exhaust shall be provided with Type R isolators with a minimum deflection of 1" (larger deflections may be required). These isolators shall be closely coordinated with expansion and stress calculations and seismic restraints and movements.

3.05 SEISMIC RESTRAINTS INSTALLATION

A. All floor mounted equipment, whether isolated or not, shall be bolted or welded to the structure to allow for required acceleration. Bolt points, diameter of inserts, imbedment depth and weld length as shown on approved submittal drawings shall be followed in all respects.

B. All suspended equipment shall be 2-point or 4-point independently braced with Type III restraints, installed taut for non-isolated equipment, such as piping or ductwork and slack with 1/2" cable deflection for isolated equipment. Note: Stiffeners for support rods may be required, certifications shall clearly delineate when such stiffening is required or not.

1. Piping Bracing: Schedule 10 thru 40 welded, screwed, flanged or grooved; 40'-0" maximum transversely, 80'-0" maximum longitudinally, and within 4'-0" each change of direction. No- hub piping shall be at 10’-0” intervals or 40’-0” if 1.0 g couplings are used.
2. Ductwork Bracing: 30'-0" maximum, transversely, 60'-0" maximum longitudinally, and within 4'-0" of each change of direction.

C. Seismic restraints are not required:

1. Only when explicitly permitted by the code. These permitted exceptions shall be detailed clearly on the first page of the seismic submittal.

D. Seismic restraints are not required on the following (there are no exceptions for piping containing flammable or hazardous material or connected to life/safety equipment):

1. Piping in mechanical equipment rooms less than 1 1/4".
2. Other piping less than 2 1/2".
3. All rectangular ducts less than 6 sq.ft. in cross sectional areas.
4. All round ducts less than 28" diameter.
5. All pipe suspended by individual hangers 12" in length or less from the top of the pipe support to the bottom of the support for the hanger.
6. All top supported ducts suspended by hangers 12" or less in length from the top of the duct to the bottom of the support for the hanger.

E. Where base anchoring of equipment is insufficient to resist seismic forces, restraints such as Type III shall be located above the unit's center of gravity to resist "G" forces.

Note: Vertically mounted tanks and upblast tubular centrifugal fans may require this additional restraint.

F. For overhead supported equipment, overstress of the building structure must not occur. Bracing may occur from:

1. Upper flanges of structural beams.
2. Upper truss chords in bar joists.
3. Cast-in-place inserts or drilled and shielded inserts in concrete structures.

G. Chimneys and stacks passing through floors are to be bolted at each floor level or secured above and below each floor with riser clamps or approved vibration isolation systems with seismic restraints.

H. Chimneys and stacks running horizontally to be braced every 30 ft (9 m) with Type III restraining system.

I. Inspection

1. On completion of installation of all vibration isolation and seismic restraint devices herein specified, the local representative of the isolation materials manufacturer shall inspect the completed system and report in writing any installation errors, improperly selected isolation or restraint devices, or other faults that could affect the performance of the system. Contractor shall submit a report to the Architect, including the manufacturer's representative's final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.
2. Provide all special inspections in accordance with IBC and as specified herein.

   a. Continuous inspection: The full-time observation of work by an approved special inspector pursuant to IBC. The following pieces of equipment require these inspections:

      1) All equipment using combustible or toxic energy sources.
      2) All electric motors and motor control centers.
      3) Reciprocating and rotating type machinery.
      4) Pipe.
      5) Tanks, heat exchangers & pressure vessels.
      6) Ductwork.

   b. Periodic inspection: Provide intermittent observation of work by an approved special inspector of the following pieces of equipment in compliance with IBC.

      1) All smoke control systems during construction & prior to concealment for leakage testing.
      2) Isolator units for seismic isolation system.
      3) All flammable, combustible and highly toxic piping and their associated mechanical systems.
      4) All ductwork containing hazardous materials.

c. After all inspections a written report shall be provided.

3.06 INSTALLATION INSTRUCTIONS

A. Adjust all base and piping isolators as required to prevent stress transfer to equipment.

B. Set steel bases for 1" clearance between housekeeping pad and base. Set concrete inertia bases for 2" clearance. Adjust equipment level.

C. Position equipment, structural base and concrete base on blocks or wedges at proper operating height.

D. Provide all equipment and provide operating load conditions before transferring base isolation loads to springs and removing wedges.

E. Install inertia bases of type and thickness, with isolators of type and static deflection indicated.

F. Provide isolators as specified and install in accordance with the manufacturers recommendations. Seismic restraints shall not be installed until isolators are adjusted and equipment height is finalized.

G. Provide forms for 4" high housekeeping pads under all floor mounted equipment, including those with inertia blocks. Provide necessary reinforcing.

H. Install equipment with flexibility in wiring connection.

I. Verify all installed isolators and mounting system permit equipment motion in all directions.

J. Adjust or provide additional resilient restraints to flexibly limit lateral motion to 1/4" during start-up of equipment.

K. Before start-up, clean out all foreign matter between bases and equipment to prevent short circuit.

L. Install flexible pipe connectors on pipe connected to equipment supported by vibration isolation. Hook up piping to equipment and mains with spool pieces. After completion of pressure testing but prior to start-up, remove spool pieces and install flexible pipe connectors. Identify spool pieces as to equipment served and either entering or leaving.

M. Provide seismic displacement joints for all piping, ductwork and conduits crossing building expansion joints or building seismic joints.

3.07 CERTIFICATION

A. Upon completion of installation of all vibration isolation devices and seismic restraints, the Mechanical Contractor shall hire an independent Seismic Professional Engineer to visit the site, inspect the completed project and certify in writing to the Architect that all systems are installed properly, or require correction.

END OF SECTION

SECTION 230553

MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install nameplates, valve tags, valve charts, stencils and pipe markers on all Mechanical equipment, piping and ductwork.

B. Provide nameplates with the unit number and service designation on all mechanical equipment.

C. Indicate all valve tag numbers on Record Drawings and submit framed under glass valve tag charts including valve service and location.

D. Install color coded ceiling tacks in acoustical tile ceilings or color coded tape on ceiling grid to identify location of equipment, valves and dampers that require regular maintenance or are part of a life safety system (fire dampers, smoke dampers, sprinkler valves or main isolation valves).

E. Provide manufactured pipe and ductwork identification stencils with flow arrows and service indicated. All backgrounds of the stencils shall be color coded with specific service designation

F. Prepare valve charts and frame under glass. All valves and the tag numbers shall be shown on the Record As-Built Drawings.

G. Provide valve computer data base to match chart.

H. Prepare and install exterior protected brass plaques indicating underground service entrances.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ASME A 13.1 – Scheme for Identification of Piping Systems; The American Society of Mechanical Engineers.

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: Submit product description including materials, attachment methods, color coding and lettering sizes.

1.06 QUALITY ASSURANCE

A. All materials, lettering and individual system color coding schemes shall be uniform and of one single manufacturer.

B. No identification shall be installed until all systems are complete and insulated.

C. All surfaces shall be cleaned.

D. No nametag or identification shall break or penetrate a surface used as a vapor barrier.

1.07 REGULATORY REQUIREMENTS

A. Conform to all local/state and NFPA requirements for color-coding or painting of systems, piping or equipment related to Life Safety or Fire Protection.

1.08 DELIVERY, STORAGE AND HANDLING

A. All identification systems shall be stored in sealed containers in suitable locations to keep the containers and contents dry and clean.

1.09 ENVIRONMENTAL REQUIREMENTS

A. All surfaces shall be cleaned and dry before applying any form of identification or tagging.

B. Consult with the manufacturer prior to installation for the proper tagging and identification procedure and materials to be used on exterior outdoor equipment.

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable manufactures contingent on compliance with the specification.

1. Seton
2. Brady Corporation
3. Marning Services Incorporated

2.02 PIPE IDENTIFICATION AND VALVE TAGS

A. All piping, except that piping which is within inaccessible chases, shall be identified with semi-rigid plastic identification markers equal to Seton Setmark pipe markers.

1. Direction of flow arrows is to be included on each marker.
2. Each marker background shall be appropriately color coded with a clearly printed legend to identify the contents of the pipe in conformance with the “Scheme for the Identification of Piping Systems” (ASME A13.1-1981).
3. Setmark snap-around markers shall be used for overall diameters up to 6” and strap-around markers shall be used above 6” overall diameters.
4. Markers shall be located:

   a. Adjacent to each valve
   b. At each branch
   c. At each cap for future
   d. At each riser takeoff,
   e. At each pipe passage through wall (each side)
   f. At each pipe passage at 20’ – 0” intervals maximum.

B. Valve tags

1. All valves shall be designated by distinguishing numbers and letters carefully coordinated with a valve chart.
2. Valve tags shall be color coded 0.032” anodized aluminum tags, with engraved letters similar to Seton S Type 250-BL or approved equal.

   a. HVAC tags shall be round 2” diameter, similar to Seton 15426.
   b. Plumbing tags shall be square 2” x 2” similar to Seton 42769.
   c. Fire Protection tags shall be square 2” x 2” similar to Seton 42769 RED.
   d. Lettering shall be ¼” high for type service and ½” for valve number. Tag shall indicate service and valve number.
   e. Each service shall be a different color.

3. Tag shall be attached to valves with chain similar to Seton No. 16 stainless steel jack chain.
4. Whenever a valve is above a hung ceiling, the valve tag shall be located immediately above the hung ceiling.
5. Provide a tag for every valve except:

   a. Perimeter radiation shut-off valves that are located at the finned tube radiation element within the accessible (from the space) heating enclosure

C. Furnish a minimum of two (2) typed valve lists

1. Each framed under glass or Plexiglas. Each chart shall be enclosed in an approved 0.015” thick plastic closure for permanent protection.

2. Valve numbers shall correspond to those indicated on the Record Drawings and on the printed valve lists.
3. The printed list shall include the valve number, location and purpose of each valve.

4. It shall state other necessary information such as the required opening or closing of another valve when one valve is to be opened or closed.
5. Printed framed valve lists shall be displayed in each Mechanical Room or in a location designated by the Owner.

D. Valve data base.

1. Provide a valve data base for all valves to operate on the building computer.
2. Every valve shall include:

   a. Tag Number
   b. Service (Hot water, Chilled water, Sprinkler, etc.)
   c. Size
   d. Operation
   e. Location
   f. Manufacture
   g. Model number
   h. Submittal reference

2.03 DUCTWORK IDENTIFICATION

A. All ductwork (supply, return, exhaust, etc.) serving multiple spaces or floors shall be identified with directional flow arrows and unit identification numbers (AHU-1, EX-1, etc.) on the side of each duct (or bottom if abutting other systems or obstructions).

B. All flow arrows and labels shall be similar to Seton Name Plate Company vinyl labels or stencil painted.

C. All duct access doors.

2.04 EQUIPMENT NAMEPLATES

A. Equipment nameplates shall be 3” x 6” long, 0.02” aluminum with a black enamel background with engraved natural aluminum letters similar to Seton Style 2065-20. Nameplate shall have pressure sensitive taped backing.

B. The nameplate shall contain the unit or equipment designation (“AHU” for air handling unit, “HP” for heat pump, “P” for circulating pump, etc.), unit number and area or system served.

C. Nameplates for exterior equipment shall be applied with waterproof adhesive.

2.05 CEILING TACKS OR TAPE

A. Provide steel color coded ¾ inch diameter ceiling tacks in acoustical tile ceilings or color coded tape applied to ceiling grid to locate equipment, valves or dampers that require regular maintenance or are part of a Life Safety System.

B. The tacks or tapes shall be color codes as follows (coordinate with Owner):

1. Yellow – HVAC
2. Red – Life Safety (fire dampers, sprinkler valves, etc.)
3. Green - Plumbing Valves.
4. Blue – Heating/Cooling Valves.

PART 3 EXECUTION

3.01 PREPARATION

A. All surfaces shall be cleaned and insulated (if applicable) prior to installing any identification.

B. Exterior surfaces of outdoor equipment shall be dry and prepared to accept the specified identification.

3.02 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion. Seal with clear lacquer.

B. Install valve tags with chain.

C. Install duct markers in accordance with manufacturer's instructions.

D. Install plastic pipe markers in accordance with manufacturer's Instructions.

E. Install plastic tape markers complete around pipe in accordance with manufacturer's instructions.

F. Identify air handling units, pumps, domestic hot water heaters, heat transfer equipment tanks, water treatment devices, etc. with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

G. Identify control panels and major control components outside panels with plastic nameplates.

H. Identify thermostats relating to air handling equipment serving multiple spaces.

I. Identify valves in main and branch piping with valve tags.

J. Tag automatic controls, instruments and relays. Key to control schematic.

K. Identify piping, concealed or exposed, with pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

L. Identify ductwork with plastic nameplates and flow arrows. Identify with air handling unit or fan identification number and area served. Locate identification at air handling unit or fan, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION

SECTION 230584

THROUGH-PENETRATION FIRESTOP SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Through-penetration firestop systems for penetrations through the following fire-resistance-rated assemblies, including both empty openings and openings containing penetrating items:

1. Floors
2. Roofs
3. Walls and partitions
4. Smoke barriers
5. Construction enclosing compartmentalized areas.
6. Other rated assemblies.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. American Society for Testing and Materials Standards (ASTM):

1. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials
2. ASTM E814: Standard Test Methods for Fire Tests of Through-Penetration Firestops
3. ASTM E119: Standard Test Methods for Fire Tests of Building Construction Materials
4. ASTM E1399: Standard Test Methods for Cyclic Movement and Measuring of Joint Systems
5. ASTM E1725: Standard Test Methods for Fire Tests of Fire-Resistive Barrier Systems of Electrical Systems Components
6. ASTM E1966: Standard Test Methods for Fire Tests of Joints

B. Underwriters Laboratories, Inc. (UL):

1. UL 723 Surface Burning Characteristics of Building Materials
2. UL 1479 Fire Tests of Through-Penetration Firestops, including optional air leak test
3. UL 2079 Fire Test of Building Joint Firestop systems
4. UL Fire Resistance Directory (Component Listing Test Criterion)

C. National Fire Protection Agency (NFPA)

1. NFPA 80 Standard Fire Door and Window Assembly Tolerances

2. NFPA 252 Standard Fire Test for Fire Rated Doors (not specified for positive or negative furnace test pressure)
3. NFPA 257 Standard Fire Test for Fire Rated Windows (not specified for positive or negative furnace test pressure)
4. NFPA 101 Life Safety Code
5. NEC 70 National Electrical Code

1.05 PERFORMANCE REQUIREMENTS

A. General: For the following constructions, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly penetrated.

1. Fire-resistance-rated load-bearing walls, including partitions, with fire-protection-rated openings.
2. Fire-resistance-rated non-load-bearing walls, including partitions, with fire-protection-rated openings.
3. Fire-resistance-rated floor assemblies.
4. Fire-resistance-rated roof assemblies.

B. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.

C. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, as determined per ASTM E 814, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas.

1. Penetrations located outside wall cavities.
2. Penetrations located outside fire-resistive shaft enclosures.
3. Penetrations located in construction containing fire-protection rated openings.
4. Penetrating items larger than 4-inch diameter normal pipe or 16 sq. in. in overall cross-sectional area.

D. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide product that after curing do not deteriorate when exposed to these conditions both during and after construction.

1. For piping penetrations for plumbing and wet pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
2. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved either by installing floor plates or by other means.
3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

E. For through-penetration firestop systems exposed to view, provide products with flame-spread ratings of less than 25 and smoke-development ratings of less than 50, as determined per ASTM E 84.

1.06 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: For each type through-penetration firestop system product indicated.

C. Shop Drawings: For each through-penetration firestop system show each kind of construction condition penetrated, relationships to adjoining construction, and kind of penetrating items. Include firestop design designation of testing and inspecting agency acceptable to authorities having, jurisdiction that evidences compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
2. Where Project conditions require modification of qualified testing and inspecting agency's illustration to suit a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer.

D. Submit complete plans indicating clearly where all seals are located and the type of seal to be used at that location

E. Qualification Data: For firms and persons specified to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

F. Product Certificates: Signed by manufacturers of through-penetration firestop system products certifying that products furnished comply with requirements.

G. Product Test Reports: From a qualified testing agency indicating through-penetration firestop system complies with requirements, based on comprehensive testing of current products.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed through-penetration firestop systems similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.

C. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in "Performance Requirements" Article:

1. Through-Penetration Firestop Systems tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, ITS, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.

2. Through-penetration firestop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements:

   a. Through-penetration firestop system products hear classification marking of qualified testing and inspecting agency.
   b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:

      1) UL in “Fire Resistance Directory.”
      2) ITS in “Directory of Listed Products.”

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers’ labels identifying product and manufacturer, date of manufacture; lot number; shelf life, if applicable, qualified testing and inspecting agency’s classification marking applicable to Project; curing time; and mixing instructions for multi-component materials.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.09 PROJECT CONDITIONS

A. Environmental Limitations: Do not install through-penetration fires top systems when ambient or substrate temperatures are outside limits permitted by through penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturer’s written instructions by natural means or, where this is inadequate, forced-air circulation.

1.10 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

C. Notify Owner’s inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.

D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until Owner’s inspecting agency and building inspector, if required by authorities having jurisdiction, have examined each installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable manufacturers subject to compliance with the specifications shall be one of following:

1. A/D Fire Protection Systems, Inc.
2. Hilti Construction Chemicals, Inc.
3. Nelson Firestop Products
4. RectorSeal Corporation (The)
5. Specified Technologies Inc.
6. 3M Fire Protection Products
7. Tremco
8. United Stated Gypsum Company

2.02 FIRESTOPPING GENERAL

A. Compatibility: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and fired experience.

B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with “Performance Requirements” Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:

1. Permanent forming/damming/backing materials, including the following:

   a. Slag-/rock-wool-fire insulation.
   b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
   c. Fire-rated form board

2. Temporary forming materials
3. Substrate primers
4. Collars
5. Steel sleeves

2.03 MIXING

A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer’s written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.

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

3.02 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop systems manufacturer and the following requirements:

1. Remove from surfaces of openings substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contactor by cleaning methods used to remove smears from firestop systems materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.03 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Install fill materials for firestop systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.

3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 FIELD-QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified independent inspecting agency to inspect through-penetration firestop systems and to prepare test reports.

1. Inspecting agency will state in each report whether inspected through-penetration firestop systems comply with or deviate from requirements.

B. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued.

C. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

3.05 IDENTIFICATION

A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels.

1. The words: “Warning-Through-Penetration Firestop System-Do Not Disturb. Notify Building Management of Any Damage.”
2. Contractor’s name, address, and phone number.
3. Through-penetration firestop systems designation of applicable testing and inspecting agency.
4. Date of installation.
5. Through-penetration firestop systems manufacturer’s name.
6. Installer’s name.

3.06 CLEANING AND PROTECTION

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

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

END OF SECTION

SECTION 230593

TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Provide all labor, instruments and materials necessary to completely test, adjust and balance all HVAC systems and equipment installed under this contract.

B. All instruments shall be newly calibrated for this specific project.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. AABC MN-1 – National Standard for Testing and Balancing Heating, Ventilating and Air Conditioning Systems.
2. ASHRAE 111 – Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

1.05 SYSTEM DESCRIPTION

A. Provide under this contract the services of an independent test and balance firm that specializes in testing and balancing of HVAC systems. The following services shall be provided:

1. Balance Plan Check and Review: Review the design documents prior to commencing balancing. Submit any noted questions or discrepancies in writing to the Architect.
2. On-going job site inspections of equipment, controls and metering devices during construction to verify conformance with design specifications, manufacturer's installation instructions.
3. Air System Balance
4. Hydronic System Balance
5. Control Systems Verification
6. Special System Testing and Verification

    a. Duct leakage testing

b. Sound and vibration testing

7. System Performance Verification
8. Opposite Season Test

1.06 SUBMITTALS

A. See Section 230500 – Submittals, for submittal procedures.

B. Submit name of testing, adjusting and balancing contractor for approval within 30 days after award of Contract.

C. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting and balancing of systems and equipment to achieve specified performance.

1. Submit under provisions of Section 014000 – Quality Control.
2. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing and equipment data required.
3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for inclusion in operating and maintenance manuals.
4. Provide reports in letter size, 3 ring binder manual, complete with index page and indexing tabs with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets and indicating thermostat locations.
5. Include detailed procedures, agenda, sample reports forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.
6. Test Reports: Indicate data on AABC MN-1 forms, forms prepared following ASHRAE 111, NEBB forms, or forms containing information indicated in Schedules.
7. Include the following on the title page of each report.

a. Name of Testing, Adjusting and Balancing Agency.
b. Address of Testing, Adjusting and Balancing Agency.
c. Telephone number of Testing, Adjusting and Balancing Agency.
d. Project name.
e. Project location.
f. Project Architect.
g. Project Engineer.
h. Project Contractor.
i. Report date.

D. Project Record Documents: Record actual locations of all water systems balancing valves and rough setting.

1.07 DEFINITIONS

A. AABC: The Associated Air Balance Council is a non-profit association of independent, certified agencies specializing in testing and balancing HVAC systems.

B. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers.

C. HVAC: Heating, Ventilating and Air Conditioning.

D. TAB: Testing, Adjusting and Balancing of HVAC Systems to meet design objectives and obtain optimum system performance.

E. NEBB: National Environmental Balancing Bureau

F. TBE: Test and Balance Engineer is an individual certified by AABC as having a degree in Engineering and (3) years of test and balance experience, or (5) years of background in the air conditioning field and (5) years continuous field experience in testing and balancing work. The TBE must also pass the AABC Test and Balance Engineer Certification Examination.

1.08 AGENCY QUALIFICATIONS

A. Testing and balancing agency shall be a member of AABC or NEBB with a minimum of five (5) years of documented experience.

B. An AABC certified NEBB certified testing and balancing person shall be responsible for certification of the total work of this section.

C. All work shall be performed in accordance with AABC National Standards. If these specifications set forth more stringent requirements than the AABC National Standards, the more stringent specifications shall prevail.

1.09 QUALIFICATION SUBMITTALS

A. Testing and Balancing Agency shall submit a company resume listing personnel and project experience in the field of air and hydronic system balancing.

B. Testing and balancing agency shall submit an inventory and calibration data of all instruments and devices in possession of the balancing agency to enable the Owner or his representative to evaluate the balancing agency's performance capability.

C. The testing and balancing agency shall submit to the Owner or the Owner's representative, upon acceptance of the contract, an AABC or NEBB "Quality Assurance Guaranty."

D. Within (30) days after acceptance of the contract, the testing and balancing agency shall submit to the Design Engineer a working agenda which will include procedures for testing and balancing each type of air and water flow system. The Test and Balance Report format will also be submitted indicating data to be recorded.

1.10 CONTRACT DOCUMENTS

A. Within (30) days after selection of the test and balance agency, the Construction Manager shall provide the agency with the following:

1. Construction Drawings
2. Equipment Specifications
3. Equipment Submittals

B. The testing and balancing agency shall be provided the following as issued or received:

1. Change Orders/Current Updated Construction Mechanical Drawings incorporating all revisions
2. Equipment Manufacturer's Submittal Data

3. Mechanical/Air Conditioning Contractor's Shop Drawings
4. Temperature Control Drawings
5. Project Schedule

1.11 NOTIFICATION AND SCHEDULING

A. A prebalance conference shall be held prior to job start as scheduled by the Owner or Owner's representative. Attendees at the meeting shall include representatives of the test and balance agency, General Contractor, Mechanical Contractor, Control Contractor, Owner and Mechanical Engineer.

B. The schedule for testing and balancing the HVAC system shall be established by the Owner or Owner's representative, in coordination with the testing and balancing agency on a critical path network.

C. The testing and balancing agency is responsible for initiating this continuing coordination to determine schedule for final testing and balancing services.

D. It will be necessary for the testing and balancing agency to perform its services in close coordination with the Mechanical Contractor, with all scheduling and deficiencies reported through the Owner or Owner's representative.

E. Before testing and balancing commences, the testing and balancing agency shall receive notification, in writing, from the Mechanical Contractor that the system is operational, complete, and ready for balancing.

F. A completed system exceeds physical installation: the Mechanical Contractor shall certify that all prime movers, fans, pumps, cooling towers, boilers, etc., are installed in good working order, and that full load performance has been preliminary tested.

G. The Mechanical Contractor shall certify in writing, that all equipment has been checked, started, adjusted by the manufacturer, and operated for the specified period of time.

1.12 COORDINATION WITH OTHER TRADES

A. To bring the HVAC system into a state of readiness for testing, adjusting and balancing, the Mechanical Contractor shall perform the following:

1. Air Distribution Systems

a. Ensure that all splitters, extractors, volume, smoke and fire dampers are properly located and functional. Dampers serving requirements of smoke, minimum and maximum outside, return, relief, and exhaust air shall provide tight closure and full opening, with a smooth and free operation.
b. Verify that all supply, return, exhaust, and transfer grilles, registers and diffusers are installed and operational.
c. Ensure that air handling systems, units, heat pumps, makeup air units and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc. are blanked and/or sealed to eliminate excessive bypass or leakage of air.
d. Ensure that all fans (supply, return, relief, and exhaust) are operating and free of vibration. All fans and drives shall be checked for proper fan rotation and belt tension. Overload protection shall be of proper size and rating.

A record of motor current and voltage shall be made to verify that the motors do not exceed nameplate rating.

e. Make any necessary changes to the sheaves, belts, and dampers, as required by the testing and balancing agency, at no additional cost to Owner.

f. Install clean filters prior to testing.

2. Water Circulating Systems

a. Check all pumps to verify pump alignment and rotation.

b. Ensure that systems are clean, with the proper strainer screens installed for normal operation.

c. Check all pump motors for current and voltage, to ensure that motors do not exceed nameplate rating.

d. Provide overload protection of proper size and rating.

e. Ensure that all water circulating systems shall be clean, full and free of air, that expansion tanks are set for proper water level, and that all air vents are installed at high points of systems and are operating.

f. Check and set operating temperature of heat exchangers to design requirements.

B. The Temperature Control Contractor shall perform the following:

1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water resets, and fire and freeze stats.

2. Verify that all controlling instruments are calibrated and set for design operating conditions.

3. Calibrate room thermostats after installation and before the thermostat control verification tests are performed. The test and balance agency shall verify the accuracy of final settings by taking temperature readings. The readings shall be in a typical conditioned space for each separately controlled zone.

4. The Control Contractor shall allow sufficient time in the project to provide assistance and instruction to the testing and balancing agency in the proper use and setting of control components such as, but not limited to, computers, static pressure controllers or any other device that may need setpoints changed so that the testing and balancing work can be performed.

C. The Mechanical Contractor, Temperature Control Contractor, and the suppliers of the HVAC equipment shall all cooperate with the testing and balancing agency to provide all necessary data on the design and proper application of the system components. In addition, they shall furnish all labor and materials required to eliminate any system deficiencies.

D. In coordination with the General Contractor, the testing and balancing agency shall arrange for an area of ample size and convenient location for storage of tools, equipment, and other items as required.

PART 2 PRODUCTS

2.01 GENERAL

A. The Construction Manager shall procure the services of an independent Balancing and Testing Contractor who specializes in the balancing and testing of heating, ventilating and air conditioning systems to balance and adjust, all moving equipment and air distribution and exhaust systems and test all water systems and equipment, as herein specified. All work by the Balancing Contractor shall be done under direct supervision of a qualified heating and ventilating Engineer employed by the Balancing Contractor. Balancing Contractor shall submit credentials and be approved prior to any contract award.

B. Balance and testing shall not begin until all HVAC systems have been completed and are in full working order, as determined by the Architect. Where construction is phased, the Testing and Balancing Contractor shall submit a plan of action which outlines how each phase will be balanced and how, when completed, the entire system will be verified to be tested and balanced. The Balancing Contractor shall coordinate his work with the HVAC and ATC Contractors, shall place all heating, ventilating and air conditioning systems and equipment into full operation, and continue the operation of same during each working day of adjusting and balancing.

C. The Balancing Contractor shall perform all tests as hereinafter specified, compile the test data, and submit five (5) copies of the complete test data to the Construction Manager for forwarding to the Architect for evaluation and approval.

D. The Construction Manager shall award the test and balance contract to the approved agency at the beginning of construction of the project to allow the Balancing Contractor to schedule this work in cooperation with the HVAC Contractor, ATC Contractor and other Trades involved and comply with completion data and requirements, as well as provide a list of areas where special requirements for balancing devices (dampers, valves) might occur.

E. The Balancing Contractor shall provide all testing instruments used for balancing air and water systems. Testing instruments shall have been calibrated within a period of six (6) months prior to balancing. Types, serial numbers and dates of calibration of all instruments shall be listed in the final air and water balance reports herein specified.

F. The Architect's, Engineer's and Owner's designated representatives shall be notified minimum five (5) days in advance of proceeding with balancing work to allow time for the witnessing of the testing, balancing and adjusting.

G. The Balancing Contractor shall provide all manpower, instruments, temporary connections and all other materials required to accomplish the balancing and testing as hereinafter specified. In the case of phased construction, the action plan shall include an explanation of all temporary facilities and their effect on the overall system.

H. The Balancing Contractor shall balance cooling systems in the air conditioning season and heating systems in the heating season. **This requirement is mandatory.**

I. In the event it becomes necessary for the Owner to balance the HVAC systems correctly, after the balancing is complete, the cost of this work will be back charged to the Balancing Contractor.

J. The facility is to remain occupied during the extent of the renovations. Due to the phased method of renovations (and many supply and exhaust fan systems being constant volume, the TBA Contractor will be required to re-balance and adjust all air and water systems at the end of each phase that has been modified. (Note; Existing fan systems support multiple phases and will require their air flow re-balancing to be revisited at the end of each phase and possibly multiple times within each phase.))

1. Scope is to include maintaining a general overall building positive pressurization during each phase.
2. Scope is to include air flow balancing adjustments as required to maintain the any existing occupied space's pressurization relationships to accommodate that program's use. Existing spaces that remain occupied with an existing positive pressurization shall remain positively pressurized (and negatively

2.02 SCHEMATIC SYSTEM DRAWINGS

A. Piping Systems

1. The Balancing Contractor shall prepare schematic diagrammatic drawings for the following systems:

   a. Chilled Water
   b. Hot Water

2. The drawings will be 1-line schematic representation of the systems as they are installed, indicating all major automatic control valves, strainers, pressure reducing valves, etc., as well as all water flow and energy meters.
3. The diagrams shall indicate, in addition to the graphic representation requirements outlined above, all pressure drops (design conditions and actual conditions) of each valve, strainer, meter, etc., as well as all flows at each meter.
4. The use of the Engineer's construction drawing diagrams can be utilized by the Balancing Contractor as the base of the diagrams required. However, the drawings will have to be updated by the Balancing Contractor for field modifications which may have occurred during construction.

B. Ductwork Systems

1. The Balancing Contractor shall prepare schematic diagrammatic drawings for the following:

   a. Supply air systems (all units)
   b. Return air systems (all units)
   c. All exhaust air systems including specialized exhaust systems

2. The drawings will be 1-line airflow schematics emanating from the air handling equipment, through shafts, to the first major split of duct branches on each floor. The drawings will indicate the air quantities measured at these major branches, pressure drop and any other pertinent information deemed necessary by the Architect.

3. In addition to the duct schematic drawings, the Balancing Contractor shall prepare individual schematic drawings for each air handling unit indicating the pressure drop of each component of the unit, including the discharge plenum and unit duct discharge and shall prepare composite schematic drawing of all "special pressure" rooms or spaces which shall show on one drawing, the supply, return and/or exhaust systems, flow rates (design and actual) and final offset pressure/CFM.
4. Balance “special pressure” spaces to the minimum differential pressure as scheduled:

a.	Protective isolation	+0.025” Water Gauge
b.	Infectious isolation	-0.025” Water Gauge (relative to Anti-room)
c.	Pharmacy	+0.025” Water Gauge
d.	Others Positive	+0.025” Water Gauge
e.	Others Negative	-0.025” Water Gauge
f.	Building Pressurization	+0.01” to +0.05” Water Gauge

C. The intent of the required documentation would be to clearly indicate the balancing and performance of the systems as they are installed. Furthermore, the above-required information will be utilized by the Owner for future renovation and/or alterations of the various systems. Therefore, the drawing content and presentation will be submitted to the Architect for review prior to actual commencement of the work. In the case of phased construction, the schematics shall indicate the limit of each phase and any temporary measures taken to obtain system performance.

D. The drawings shall be produced on AutoCAD latest, and a disc and one (1) set of reproducible vellums shall be submitted to the Owner through the Architect, for his use. All costs associated with the production of the documents shall be included under the Balancing Contractor's contract.

E. Test Code Drawings

1. Each report shall contain a single line drawing or drawings of the air distribution system with the fan system, applicable zoning, etc., indicated. Each and every outlet supply and return shall be indicated on this drawing by a number corresponding to the number of the outlet test sheet.

2.03 TEST FORMS USED BY BALANCING ENGINEERS AND TECHNICIANS SHALL BE SET UP TO INCLUDE THE FOLLOWING INFORMATION:

A. Each sheet shall have the job name and address, the name of the Balancing Contractor, Owner, Architect and Engineer, the instruments used to perform the test, and the name of the test Technician, date and time of test, outside db/wb temperatures.

B. All forms shall be submitted on a standard 8 1/2" by 11" good quality paper, bound together to form a complete report. All forms shall be submitted in typewritten form; handwritten forms are not acceptable. Cover of first sheet shall list the name of the job and the location of same. Copies of all forms shall be submitted to the Architect for review and acceptance prior to the work beginning.

C. Diffuser, Grille, Register, Fume Hoods, and All Types of Air Terminal Test Sheets

1. Each sheet shall be arranged in columns and all final sheets shall show the following data:

   a. Fan system.
   b. Room number or area designation.
   c. Outlet code number which shall correspond to code number.
   d. Size of outlet - manufacturer's listed data.
   e. Type of outlet per manufacturer's model designation.
   f. Manufacturer of outlet.
   g. Manufacturer's effective area for each size.
   h. Schedule FPM and required CFM of each outlet, individually for heating and cooling.
   i. Test resultant FPM and CFM of each outlet, individually for heating and cooling.
   j. Testing, setting and report of CFM settings for each terminal box, including pressure drop at each setting (heating and cooling).
   k. All rooms/spaces with ducted supply and return/exhaust are to have supply, return/exhaust quantities shown on the same sheet. All rooms are to have air quantities for supply, return/exhaust listed per individual room. Supply, return/exhaust readings shall be listed sequentially, with final CFM offset, or room pressure clearly identified.

D. Air Handling Equipment Test Sheets

1. Each sheet shall contain two (2) columns, one (1) for specified conditions and one (1) for test conditions obtained. When units tested are variable air volume (VAV) data shall be submitted for maximum and minimum air flows.
2. All final sheets shall list the following data:

   a. System fan number.
   b. Fan manufacturer and model number.
   c. Fan curve.
   d. Total CFM.
   e. Return air, CFM.
   f. Outside air, CFM.
   g. Total static pressure.
   h. Suction static pressure.
   i. Discharge static pressure.
   j. Motor manufacturer.
   k. Motor size, voltage, phase and RPM.
   l. Amperage nameplate rating.
   m. Final operating amperage.
   n. Fan RPM (supply).
   o. Fan RPM (return).
   p. Component pressure drop.

E. Exhaust and Ventilating Fan Test Sheets

1. Each sheet shall contain in two (2) columns, one (1) for specified conditions and one (1) for test conditions obtained. Variable volume systems data is to be submitted for both maximum and minimum air flows.

2. All final sheets shall list the following data:

   a. Exhaust fan system and exhaust fan number.
   b. Fan manufacturer.
   c. Fan curve.
   d. Size and model.
   e. Motor HP, voltage and phase.
   f. Changes made or recommended.
   g. Amperage nameplate rating.
   h. Final operating amperage.
   i. Fan RPM.
   j. Total CFM.
   k. Suction static, discharge static, total static.

F. Temperature Test Sheets (As Applicable For Each Air Handling Unit)

1. The temperature test sheets shall list both the specified conditions and the actual operating conditions in opposite columns. Items listed on this sheet shall be as follows:

   a. Cooling Cycle: Chilled Water

      1) Entering air db and wb temperature.
      2) Leaving air db and wb temperature.
      3) Outside air db and wb temperature.
      4) Chilled water supply temperature.
      5) Chilled water return temperature.
      6) Unit discharge temperature.

   b. Heating Cycle: Hot Water/Steam

      1) Entering air db temperature.
      2) Leaving air db temperature.
      3) Entering and leaving coil water temperatures/entering steam pressure.
      4) Outside air db and wb temperatures.
      5) Unit discharge temperature.

G. Pump Test Sheets

1. For each pump the following data shall be listed:

   a. Pump number and system name.
   b. Pump manufacturer and model number.
   c. Pump curve.
   d. Motor HP and RPM.
   e. Voltage - Nameplate, test.
   f. Amperage - Nameplate, test.
   g. GPM, rated, tested.
   h. Pressure rise rated, test.
   i. Inlet pressure, outlet pressure.
   j. Inlet temperature.
   k. Shut-off pressure.

H. Coil and All Other Heating Element Test Sheets (Unit Heaters, Reheat Coils, Reheat Boxes, Cabinet Unit Heaters)

1. For each element both the specified and test conditions shall be listed:
2. Inlet water temperature (hot/chilled water).
3. Inlet air temperature.
4. Outlet water temperature (hot/chilled water).
5. Outlet air temperature.
6. Pressure drop through unit.

I. Velocity and Pressure Test Sheets for Main and Branch Ducts

1. Duct location or designation.
2. Duct size.
3. Number of velocity readings.
4. Duct average velocity.
5. Total CFM.
6. Duct average static pressure.

J. Calibration of air flow measurement stations in cooperation and in conjunction with ATC contractor, provide all necessary pitot tube traverses and/or other air measurements necessary to field verify the accuracy of all installed air flow measurement stations at all air handling units, exhaust air handling units, return fans and cuts. Calibration reading s shall be taken at 100%, 75%, 50% of rated flow and a curve shall be prepared that indicates any deviation between air flow station readings and field readings at these floors.

PART 3 EXECUTION

3.01 AIR SYSTEM BALANCING AND TESTING PROCEDURES

A. The Balancing Contractor shall perform the following tests, and balance all systems in accordance with the following requirements after clean filters are installed in all filter banks before tests are performed:

1. Test and adjust blower RPM to achieve design requirements.

a. Test and record motor full load ampere.
b. Make pitot tube transverse of main supply, return and exhaust air ducts to obtain design CFM at fans.
c. Test and report system static pressure, suction and discharge.
d. Test and adjust system for design CFM recirculated air.
e. Test and adjust system for design CFM outside air.
f. Test and record entering and leaving air temperatures (db-wb cooling and db heating).
g. Adjust all main supply, return and exhaust air ducts to proper design CFM.
h. Adjust all zones and branches to proper design CFM, supply, return and exhaust systems.
i. Test and adjust each diffuser, grille, register, and constant volume box to within ±5% of design requirements.
j. Test and adjust all special pressure rooms to maintain pressure relationship indicated on the drawings and to the pressures specified herein. Note that air quantities on the drawing may have to be changed to satisfy the pressure relationship.

k. Identify and list size, type and manufacturer of diffusers, grilles, registers, and terminal volume boxes. Include information regarding coils where applicable.
l. Measure air quantities in main and branch ducts by traversing entire cross sectional area of duct with pitot tube. Ducts having velocities of 1000 feet per minute or more shall be measured with inclined manometers (draft gauge) or magnehelic gauges; ducts having velocities of less than 1000 per feet per minute shall be measured with micromanometers, hook gauges, or similar low pressure instruments. Openings in ducts for pitot tube insertion shall be sealed with snap-in plugs and covered with duct tape after air balance is complete. Diffuser, grille and register air quantities shall be determined by direct reading velocity meters in accordance with the manufacturer's recommendations.
m. Identify, adjust, balance and measure air quantities in all types of hoods or exhaust "trunks", where applicable. Identify systems by fan designation and room name.
n. Obtain design air quantities in main ducts by adjusting fans. Branch duct air quantities shall be adjusted by volume dampers. Dampers shall be permanently marked after air balance is complete to enable them to be restored to their correct position if disturbed at any time.
o. As part of this Contract, the Balancing Contractor shall change the pulleys, belts, and fixed sheaves to provide for permanent sheaves, pulleys and belts, based on the final balancing, in order to ensure proper air delivery of the various systems. The Balancing Contractor shall also make all necessary adjustments to vane axial fan blade pitch angle to achieve required airflow.
p. In cooperation with the ATC Contractor, determine the proper setpoint for all automatically operated dampers, air valves, static pressure sensors, inlet vane actuators, or other variable or controllable devices requiring coordination between Balancing Contractor and ATC Contractor. The Balancing Contractor shall determine the lowest system static setpoint possible that will deliver the proper air quantities to all outlets at the maximum cooling condition, and will adjust the fan system to operate at its most economical setting to achieve this static setpoint. Fans will be adjusted to the most economical setting by adjusting the fan speed (or blade pitch angle) with any variable volume devices in their maximum or wide-open position. Final static pressure setpoints are to be recorded in the test and balance report and listed for each unit.
q. Any dampers, safing of baffles required for final balancing, as determined by the Balancing Contractor the Architect, will be provided by the HVAC Contractor to ensure proper performance, at no extra cost to the Owner.

3.02 WATER SYSTEM BALANCING AND TESTING PROCEDURES

A. Preparation of the System for Water Testing and Balancing

1. The Balancing Engineer or Technician must prepare the water system for balancing in the following manner:

a. Open all valves to full position, including coil stop valves, return line balancing cocks and close all bypass valves, including system differential pressure bypass valve if applicable.
b. Remove, clean and/or replace all strainers.
c. Examine water in system to determine if it has been treated and is clean.
d. Check pump rotation, correct if necessary.
e. Check expansion tank to make sure it is not air bound and that the system is full of water.
f. Check all air vents at high points of water systems to make sure they are installed properly and are operating freely.

g. Make certain all air is removed from circulating system.
h. Check operation of differential automatic bypass valves, set valve in closed position.
i. Check and set operating temperature of systems to design requirements.
j. Complete air balancing must have been accomplished before water balance is begun.
k. Set all temperature controls so that all cooling coils are calling for full cooling and heating coils are calling for full heating.
l. Set hot and chilled water systems to proper GPM delivery.
m. Check leaving water temperature, return water temperature and pressure drop through all coils. Reset to correct design temperatures.
n. Balance each hot water coil, chilled water coil and all other heating elements.
o. After making adjustments to coils and other waterflow elements, reset settings at pumps, as required to obtain proper flows.
p. Determine system operating differential pressure and, in conjunction with the ATC Contractor, set any differential pressure valves for proper operation.
q. Upon completion of flow readings and coil adjustments, and after water balance is complete, permanently mark all balancing valves, cocks and flow meters so that they can be restored to their correct position if disturbed. Properly set memory stops on all balancing valves so equipped.
r. After the Balancing Contractor sets all waterflow balancing devices to proper design GPM, he shall mark the GPM flows on the piping schematic drawings.
s. The Balancing Contractor shall determine the lowest possible differential pressure control point possible for all variable speed pumping systems and for all differential pressure bypass control valves. In systems that have both variable speed pumping controlled by differential pressure and a differential pressure bypass valve, the Balancing Contractor shall assure, in conjunction with the ATC Contractor, that a minimum of 3 psig difference in setpoints is maintained between the two control settings with the differential pressure setpoint for the variable speed pumping system being the lower of the two settings.

3.03 INSTALLED ELEMENT TEST PROCEDURES

A. Element identification (location or number designation).

B. Required temperature drop corrected for actual entering air and water conditions.

C. Element adjusted until the required drop is obtained.

3.04 CONTROL SYSTEMS VERIFICATION

A. Verify all control devices are properly connected.

B. Verify all dampers, valves and other controlled devices are operated by the intended controller.

C. Verify all dampers and valves are in the position indicated by the controller (open, closed, modulating).

D. Verify the integrity of valves and dampers in terms of tightness of close off and full open positions.

E. Check all valves are properly installed in the piping system in relation to direction of flow and location.

F. Check calibration of all controllers.

G. Verify the proper application of all normally open and normally closed valves.

H. Check the location of all thermostats and humidstats for potential erratic operation from outside influences such as sunlight, drafts or cold walls.

I. Check the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. Control Contractor will relocate as deemed necessary by the testing and balancing agency.

J. Check the sequence of operation that any control mode is in accordance with approved shop drawings. Verify that only minimum simultaneous heating and cooling occurs. Observe that the control valves at the boiler/heat pump loop are properly sequenced.

K. Verify all controller setpoints meet the design intent.

L. Check all dampers for free travel.

M. Verify the operation of all interlock systems.

N. Perform all systems verification to ensure the safety of the system and its components.

3.05 SPECIAL SYSTEMS TESTING

A. Duct Leakage Testing

1. Testing shall be conducted before external insulation is applied and before ducts are connected.
2. Mechanical Contractor to close off and seal all openings in the duct section to be tested.
3. Each section shall be tested by the Mechanical Contractor in accordance to the leakage class as specified under Section 233100 and SMACNA Standards. All tests shall be witnessed and documented by the TAB Contractor.

B. Sound and Vibration Testing

1. Sound

a. Sound level readings shall be taken in at least (10) locations in the building with an octave band analyzer.
b. The test data for each area will be recorded on noise criteria curves indicating the decibel level read in each frequency band, the NC level required, and the NC level measured.
c. Readings shall be taken at night in order to reduce the ambient noise level.
d. The testing and balancing agency will submit the test data and test equipment data to the Architect and Engineer for their review and include the approved forms in the testing and balancing report.

2. Vibration

a. Vibration field measurements shall be taken as required for each circulating water pump, air handling unit, and fan driven by a motor over 10 HP.

b. Readings shall include shaft alignment, equipment vibration, bearing housing vibration, foundation vibration, and building structure vibration.
c. Readings shall be made using portable equipment capable of filtering out unwanted frequencies.
d. Maximum vibration at any point listed above shall not exceed criteria listed in the ASHRAE Handbook, HVAC Systems and Application, Chapter 52 "Sound and Vibration Control", Table 26 "Equipment Vibration Criteria", unless otherwise specified. Readings shall be taken with vibration isolation blocked solid to the foundation.

C. Building Pressure Testing

1. Test shall be performed in conjunction with the ATC contractor.
2. Test shall be done in both heating and cooling modes of operation.
3. Provide an allowance of 350 hours for testing Building Pressurization and miscellaneous tasks (i.e. troubleshooting building pressurization issues, pre-testing for local authorities, field measurements for Engineer support in systems troubleshooting, etc.).

3.06 SYSTEM PERFORMANCE VERIFICATION

A. At the time of final inspection, the test and balance agency shall recheck, in the presence of the Owner's representative, specific and random selections of data, air quantities, and air motion recorded in the Certified Report.

B. Points and areas for recheck shall be selected by the Owner's representative.

C. Measurement and test procedures shall be the same as approved for work forming basis of Certified Report.

D. Selections for recheck, specific plus random, will not normally exceed 25% of the total number tabulated in the report, except that special air systems may require a complete recheck for safety reasons.

E. If random tests elicit a measured flow deviation of 10% or more from that recorded in the Certified Report listings, by 10% or more of the selected recheck stations, the report is rejected, all systems shall be readjusted and tested, new data recorded, new Certified Report submitted, and new inspection tests made, all at no additional cost to Owner.

F. Following system verification of the Certified Report by the Owner's representative, the settings of all valves, splitters, dampers, and other adjustment devices shall be permanently marked by the testing and balancing agency so that adjustment can be restored if disturbed at any time. Devices shall not be marked until after system verification.

3.07 OPPOSITE SEASON TEST

A. The testing and balancing agency shall perform an inspection of the HVAC system during the opposite season from that in which the initial adjustments were made. The testing and balancing agency shall make any necessary modifications to the initial adjustments to produce optimum system operation.

3.08 RECORD AND REPORT DATA

A. The test and balance report shall be complete with logs, data and records as required herein. All logs, data and records shall be typed on white bond paper and bound. The report shall be certified accurate and complete by the testing and balancing agency's certified balancing engineer.

B. Six (6) copies of the test and balance report are required and shall be submitted to the Owner or the Owner's representative.

C. The report shall contain the following general data in a format selected by the testing and balancing agency.

1. Project number.
2. Contract number.
3. Project title.
4. Project location.
5. Project Architect.
6. Project Mechanical Engineer.
7. Test and Balance Agency.
8. Balancing Engineer.
9. General Contractor.
10. Mechanical Contractor.
11. Date tests were performed.
12. Certification.

D. The test and balance report shall be recorded on report forms conforming to the recommended forms in AABC National Standards. At a minimum, the report shall include:

1. Preface: A general discussion of the system, any abnormalities and problems encountered.
2. Instrumentation List: The list of instruments including type, model, manufacturer, serial number, and calibration dates.
3. System Identification: In each report the supply, return and exhaust openings and traverse points shall be numbered and/or lettered to correspond to the numbers and letters used on the report data sheets.
4. Air Handling Equipment (Heat Pumps, Makeup Air, Roof Top Units, etc.)

   a. Manufacturer, model number, and serial number.
   b. All design and manufacturer related data.
   c. Total actual CFM by traverse if practical; if not practical, the sum of the outlets may be used, or a combination of each of these procedures. For specific systems, such as ones with diversity, see the AABC National Standards.
   d. Suction and discharge static pressure of each fan, as applicable.
   e. Outside air and return air total CFM.
   f. Actual operating current, voltage, and brake horsepower of each fan motor.
   g. Final RPM of each fan.
   h. Fan and motor sheave manufacturer, model, size, number of grooves, and center distance.
   i. Belt size and quantity.
   j. Static pressure controls final operating setpoints.

5. Pumps

    a. Manufacturer, size, and serial number.
    b. All design and manufacturer's related data.
    c. Pump operating suction and discharge pressure and final total dynamic head.
    d. No flow (pump discharge valve closed) suction and discharge pressure and corresponding total dynamic head. This procedure is to determine actual impeller size.
    e. Rated and actual operating current, voltage, and brake horsepower of each pump motor.
    f. Submit pump curve showing design, operating, and no-flow points of operation.

6. Heat Exchangers

    a. Manufacturer and model number.
    b. All design and manufacturer's related data.
    c. Service and location.
    d. Actual pressure drop and related GPM – condenser water side.
    e. Actual pressure drop and related GPM – heat pump side.
    f. Entering and leaving temperatures condenser water and heat pump water.
    g. Temperature control setting.

7. Electric Heating

    a. Manufacturer and model number.
    b. All design and manufacturer rated data.
    c. Actual operating current and voltage.
    d. Coil location and identification number.

END OF SECTION

SECTION 230713

DUCT INSULATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Section, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all duct insulation, vapor barriers, jackets, finishes, adhesives, cements and accessories to make a complete and insulated system of all ductwork, fittings, joints, offsets and accessories specified herein.

B. All insulation system materials shall conform to the maximum flame spread/smoke developed ratings specified herein.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Steel and Plate.
2. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and plate (Metric).
3. ASTM C 518 – Standard Test method for Steady-State Heat Flux Measurements and Thermal Insulating and Finishing Cement.
4. ASTM C 553 – Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
5. ASTM C 612 – Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
6. ASTM C 921 – Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
7. ASTM C 1071 – Standard Specification for Thermal and Acoustical Insulation (Glass, Fiber, Duct Lining Material).
8. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
9. ASTM E 96 – Standard Test Methods for Water Vapor Transmission of Materials.
10. ASTM E 162 – Standard Test Method for Surface flammability of Materials Using a Radiant Heat Energy Source.

11. ASTM G 21 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
12. NFPA 96 – Ventilation Control and Fire Protection of Commercial Cooking Operations.
13. NFPA 255 – Standard Method of Test of Surface Burning Characteristics of Building Materials.
14. SMACNA (DCS) – HVAC Duct Construction Standards – Metal and Flexible.
15. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials.
16. ANSI/ASHRAE 90.1 - Energy Conservation in New Building Design.

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer’s Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.06 QUALITY ASSURANCE

A. All insulation materials, finishes, coatings, cements, tapes, jackets and other insulation accessories shall have minimum composite or individual fire hazard ratings as well as thickness and "C" values conforming to State Building Codes which control building construction materials that may be used on this project. Where specification requirements exceed the Code requirements, the specification shall govern.

B. Insulation for the various duct systems and associated equipment shall be composed of materials which are non-combustible and/or provide a fire resistive system of insulation which complies with the applicable Code having jurisdiction. Generally, it is required that fire hazard ratings shall not exceed the following, except as noted:

1. Flame Spread Rating: 25 (No Exceptions)
2. Smoke Developed Rating: 50

C. All fire hazard ratings shall be as determined by NFPA 255 "Method of Test of Surface Burning Characteristics of Building Materials", ASTM E84 or UL 723.

D. All insulation materials herein specified shall be used subject to the manufacturer's temperature limitations and their compatibility with other materials.

E. Installation of all insulation work shall be executed by a qualified Insulation Contractor who is thoroughly experienced in this particular type of work and who has adequate facilities and equipment for installation of all insulation work herein specified and who is familiar with the requirements of the Code enforcing Authorities as to fire hazard rating.

F. The finished installation shall present a neat and workmanlike appearance with all jackets smooth, with all vapor barriers sealed and intact.

G. Where insulation is specified for ductwork, insulate similarly all collars, dampers, edges, joints, etc. connected to system subject to heat loss or gain. Do not cover damper actuators or other maintenance points on equipment unless identified on the insulation with removable access panels or covers.

1.07 REGULATORY REQUIREMENTS

A. Conform to maximum flame spread/smoke developed rating of 25/50 in accordance with ASTM E 84, NFPA 255, or UL 723.

1.08 DELIVERY, STORAGE AND PROTECTION

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

B. All materials shall be stored in a dry area free from moisture and debris.

1.09 ENVIRONMENTAL REQUIREMENTS

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

B. Maintain temperature before, during and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 MANUFACTURERS ACCEPTABLE FOR PRODUCT TYPES INDICATED CONTINGENT UPON PRODUCTS' COMPLIANCE WITH THE SPECIFICATIONS

A. Insulation:

1. Manville Corporation.
2. Owens-Corning Fiberglass Corporation.
3. Armstrong World Industries, Incorporated.
4. Certainteed Corporation.
5. Knauf

B. Mastics and adhesives:

1. Childers Products Company.
2. H. B. Fuller Company, Foster Products Division.
3. 3M Company Adhesives, Coatings and Sealers.
4. Armstrong World Industries, Incorporated.
5. Ruston Plant.
6. Chicago-Mastic
7. Insul-Coustic
8. St. Clair Rubber
9. Vimasco
10. Baldwin-Ehret-Hill

C. PVC fitting covers:

1. Manville, Corporation.
2. Ceel-Co.
3. Certainteed, Corp.
4. Cell Co. Plastics

2.02 FACED FLEXIBLE FIBER GLASS INSULATION

A. Faced flexible fiber glass duct insulation shall be equal and equivalent to Certainteeed Fiberglas Faced Duct Wrap, Type 75 having an approximate density of 0.75 lb./cu.ft. and an approximate thermal conductivity of 0.30 at 75° F.

B. Insulation shall be tightly wrapped on the duct work with all circumferential joints butted and longitudinal joints laped 2 inches and stapled. All joints shall be sealed with approved adhesive. Adhere insulation to ducts with 4 inch wide strips of an approved bonding adhesive, at 18 inches on center. Additionally, secure insulation to bottom of rectangular ducts over 24 inches wide with weld pins or stickclips at no more than 18 inches on center. Alternative means of securing insulation to ducts will be permitted, subject to the manufacturer's recommendations and the Architect's written approval.

C. Insulation shall be butted with facing overlapping all joints at least 2 inches and sealed with approved fire retardant vapor barrier adhesive. All breaks, punctures and pin penetration in facing, shall be sealed with vapor barrier tape per the manufacturer’s published installation instructions.

2.03 RIGID FIBERGLASS BOARD INSULATION

A. Rigid fiberglass board insulation shall be equal to Owens-Corning Fiberglas 25 with ASJ having an approximate density of 3 lbs./cu.ft. and an approximate thermal conductivity of 0.25 at 75°F.

B. The insulation shall be applied by use of weld pins or stick clips. Such fasteners shall be spaced 3 inches from each corner of the board with intermediate pins spaced no more than 12 inches on center. Pin caps shall be covered with a round vapor seal patch that matches the jacket on the ASJ board.

C. Ducts, plenums and equipment having sharp bend shall have the insulation scored as required to conform to the curved surfaces to provide a neat and workmanlike appearance when finished.

D. All insulation edges and joints shall be sealed with a fire retardant vapor barrier adhesive, reinforced with a vapor barrier tape similar to that of the board facing. Tape shall be 3 to 5 inches wide as recommended by the particular manufacturer.

E. The above specified insulation will be used in all areas, and it is intended that the finish present a neat and uniform appearance as to color and workmanship.

2.04 2 HOUR RATED DUCT INSULATION SYSTEM

A. The noted duct shall be insulated with Super Firetemp Type M Insulation System.

B. The system shall consist of a 2 hour UL rated assembly for zero (0) clearance to adjacent building materials. It shall include a hanging and support system with rated cleanout doors as required by NFPA 96.

C. The duct enclosures shall be “Super Firetemp” as manufactured by the Johns Manville Corp. Product shall be installed in multiple layers in accordance with manufacturer’s instructions to provide a UL listed 2 hour assembly. The encapsulation board shall be a non-combustible, inorganic fire-proofing board, composed of hydrous calcium silicate and reinforcement fiber. The fireboard shall have a minimum density 28 lbs/cu. ft., compressor strength of 900 psi at maximum 10% deformation, R-value (75°F mean) per inch of 1.7 and be rated for continuous service at 1800°F.

2.05 INSULATION FACING

A. Code ASJ: All service jacket composed of high intensity white chemically treated Kraft paper reinforced with fiberglass yarn and mesh and laminated to aluminum foil with a fire retardant adhesive. Longitudinal laps and butt strips shall be a minimum of 3 inches. Jacket shall be paintable.

B. Code FSKL: 0.35 mil aluminum foil reinforced with fiberglass yarn reinforcing scrim and laminated to chemically treated fire resistive Kraft paper having a minimum 35 pound per inch width tensile strength when tested in accordance with ASTM D 828. Water vapor permeability 0.04 perms. Longitudinal laps and butt strips shall be a minimum of 3 inches.

C. Code WPJ: Weather-Proof Jacketing: Venture Clad Plus 1579CW as manufactured by Venturetape Corp., Rockand, MA or equivalent as manufactured by Polyguard Products of Tampa, FL. Flexible self-adhering, zero- permeability insulation jacket composed of a minimum15 mil. thick fabric-reinforced laminate to provide weather and vapor barrier function and all-weather mechanical protection. Product to be minimum of 13 ply with 100% coverage of acrylic self-adhesive suitable for field application in all ambient temperatures. Provide with embossed aluminum finish product characteristics to include 25/20 flame/smoke rating per ASTM E84 test, 80lb puncture resistance per ASTM D1000 test, 16lb tear strength per ASTM D62, and 100oz/in adhesive shear strength per PSTC-107. Provide complementary seam sealing tape by same manufacturer.

2.06 ADHESIVES

A. Code ADH-2: Fast-drying vinyl base coating and lagging adhesive. Similar to Childers CP-50A HV2.

B. Code ADH-3: Fast-drying neoprene base adhesive for lap joints of foil-faced facing applied insulation. Similar to Childers CP-82.

C. Code ADH-4: Adhesive for use in adhering fiberglass board or blanket insulation to equipment. 3M Company Insulation Adhesive No. 35 or 38 non-flammable adhesive.

2.07 CAULKING COMPONENTS

A. Code CC-1: For use with foam glass and/or joint sealant applications. Flexible elastomeric vapor barrier sealant. Similar to Childers CP-76.

2.08 MASTICS

A. Code MAS-1: Vapor barrier mastic made with an elastomeric resin. For indoor use. Similar to Childers CP-30.

B. Code MAS-2: A non-water vapor barrier asphaltic emulsion coating, breathing type, for above ground installations. Similar to Childers CP-10.

C. Code MAS-3: Vapor barrier mastic made with an elastomeric resin. For outdoor use.

2.09 TIE WIRE

A. Tie wire for securing insulation in place shall be type 304 stainless steel annealed steel wire of gauge and proper spacing as recommended by the insulation manufacturer. Wire shall be drawn up tightly enough to become embedded in the insulation and the ends of the loop twisted, bent over, and pressed into the insulation so as to leave no ends protruding.

2.10 BANDING

A. 3/8 inch x 0.02 inch type 304 stainless steel for pipe insulation.

B. 3/4 inch x 0.02 inch type 304 stainless steel for additional insulation jackets.

2.11 WIRE MESH

A. Wire mesh shall be one inch by No. 20 BGW hexagonal mesh galvanized.

B. Expanded metal: Expanded metal shall be 1/2 inch Hi-Rib metal lath of copper bearing steel.

2.12 TAPE

A. Lead foil tape, where specified, shall be 3M Company Lead Foil Tape No. 422, 4 mil thick, acrylic adhesive, 2 inch wide.

B. Vinyl plastic tape, silver gray, flame resistant, vapor barrier sealant tape on rigid and flexible insulation material for warm or cold air ducts. Similar to 3M Company Duct Sealing Tape No. 474.

C. Aluminum foil tape, dead soft aluminum foil, point seal on stick pin, metal patching, moisture barrier, heat reflecting and general sealing on aluminum facing foil. Similar to 3M Company Aluminum Foil Tape No. 425.

2.13 STAPLES

A. Staples shall be galvanized clad outward clinching insulation staples.

2.14 INSULATING CEMENT

A. Insulating cement shall be a mineral-fiber (wool) ASTM C 195 base material having essentially the same insulating characteristics as the adjacent insulation. Similar to PABCO High Temperature Insulating Cement. Insulating cement shall be applied in layers to a maximum thickness of 1/2 inch. Each layer shall be allowed to dry thoroughly before subsequent layers are applied.

2.15 FINISHING CEMENT

A. Finishing cement ASTM C 449 shall be diatomaceous silica thermal insulating materials with a suitable proportion of heat resistant binder, hydraulic setting insulating cement capable of withstanding maximum temperature of 700 degrees Fahrenheit. When mixed with water it shall be a plastic mix suitable for trowel applications and shall present a hard, smooth and durable surface after drying. Similar to PABCO No. 127.

B. Combination insulating and finishing cement:

1. Similar to Ryder One Coat or equal.

C. Welding studs:

1. Welding studs shall be capacitor type split pin or TCP tipped insulation pins with speed clips. Similar to Nelson Stud Welding Spec. 28.

D. Corner angles on insulation of ducts, plenums and equipment in finished areas shall be formed of 28 gauge, 1 inch by 1 inch aluminum adhered to heavy Kraft paper having 2 inch by 2 inch by 2 inch wings to protect external corners under glass cloth jackets.

1. Corner beads shall be 26 gauge galvanized steel with 2 ½ inch wings (exposed ducts on roof).

PART 3 EXECUTION

3.01 INSTALLATION OF INSULATION

A. All insulation shall be applied by experienced insulating contractors in accordance with best Trade practice.

B. Test, inspect and clean all surfaces of ductwork to be insulated before applying insulation.

C. Take all possible precautions to protect work of other Trades. Provide protective covering as required to accomplish this end. This Trade shall be responsible for returning all equipment and material to its original new condition and appearance where damage occurs due to his neglect.

D. All ductwork shall have been tested and approved prior to installation of insulation.

E. All ductwork and plenum or surfaces, where subject to condensation on the outside, shall be insulated including vapor seal finish.

F. All surfaces to be insulated shall be clean, dry and free from dirt and scale when insulation is being applied. Insulation shall be dry at the time of installation and before and during the process of finished application.

G. Butt ends will not be allowed. However, where required and approved by Architect, jacket material shall be pasted over exposed ends and banded to give a neat and finished appearance. Exposed fiberglass material will not be permitted.

H. Surfaces of insulation shall be smooth, even and true to line with jackets drawn tight and smoothly secured. Scrap pieces of insulation shall not be used where a full length section will fit.

I. The methods of application of insulation, finishes, adhesives, cements, accessories are generally specified under the material headings of these specifications. Where not specifically detailed, it is intended that they are equal or exceed the manufacturer's published recommendations, existing at time of bid openings, subject to the approval of the Architect.

J. Butt covering neatly to walls, floors, ceiling. Apply band at end and position so band covers gap between surface and insulation where exposed.

K. Fastenings: Provide where required to securely hold insulation. Apply adhesive and weld pins and/or stick clips on exposed risers to prevent slipping and turning of insulation.

L. Thickness of insulation shall not be compromised due to piping interferences, improper installation or any other reason.

3.02 DUCTWORK EXPOSED TO WEATHER

A. When duct installation, sealing and testing is completed by the Mechanical Contractor, the Insulation Contractor shall cover all ducts exposed to weather with insulation in accordance with the insulation specification and Table 4.1 below but in no case shall this be less than 3" thick fiber glass rigid board insulation with vapor barrier for ductwork. Insulation shall be installed in one piece and where applicable shall have mitered corners to fit tightly over the sheet metal. When insulation application is completed, the entire installation shall be over-wrapped with Code WPJ waterproof weather jacket.

1. Installation of the WPJ (Additional Jacket) is to be in strict accordance w/ manufacturers installation guidelines. Ductwork to be tested to assure 0% leakage prior to installation.

PART 4 SCHEDULES

4.01 DUCTWORK INSULATION SCHEDULE

Service	Type Insulation and Thickness (Inches)	Facing	Additional Jacket
Outside Air Intake Ducts & Relief Plenums, Supply/Return Air Ductwork (exposed to view)	Rigid Fiberglass Board - 2" **See Note 1 below**	ASJ	
Boxes, Sound Attenuators, Plenums, Diffuser Plenums, Diffusers, all parts of the Supply System (except where exposed to view)	Flexible Fiberglass w/Vapor Barrier - 2" **See Note 1 below**	FSKL	
Return Air Ductwork in such non-conditioned spaces, such as Mechanical Rooms, Crawl Spaces	Flexible Fiberglass w/Vapor Barrier - 2" **See Note 1 below**	FSKL	
Louver Blank-off Panels	Rigid Fiberglass Board - 3" **See Note 2 below**	FSKL	
Exposed to View: Interior installed exhaust ductwork within 15'-0" of the point of discharge through the building exterior envelope	Rigid Fiberglass Board - 2" **See Note 1 below**	ASJ	
Concealed: Interior installed exhaust ductwork within 15'-0" of the point of discharge through	Flexible Fiberglass w/Vapor Barrier 2"	FSKL	

Service	Type Insulation and Thickness (Inches)	Facing	Additional Jacket
the building exterior envelope	**See Note 1 below**		
Ductwork: Supply, Exhaust, Return and other, where located outside of the building	Rigid Fiberglass Board - 3” **See Note 2 below**	FSKL	WJP
Others not scheduled with system temperatures below 60°F or above 90°F	Flexible Fiberglass w/Vapor Barrier 2”	ASJ	
All 2 hour Fire Rated Ductwork	Super Firetemp Type M System – 3”	N/A	

NOTES:

1. The installed R shall be R-6 or higher without considering any air films.
2. The installed R shall be R-10 or higher without considering any air films.

A. HVAC Ductwork Insulation Schedule General Notes

1. Provide vapor barrier on all ductwork insulation.
2. Ductwork exposed to weather shall be insulated with external insulation using double the thicknesses scheduled hereinbefore, up to 24 inches beyond the point where ducts (supply and return) enter the building. Provide weatherproof jacket as hereinafter specified.
3. The 2 Hour Rated ductwork shall be insulated with a NFPA approved insulation system installed in accordance with specific manufacturer’s instructions.

END OF SECTION

SECTION 230716

EQUIPMENT INSULATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all equipment insulation, vapor barriers, jackets, finishes, adhesives, cements and accessories to make a complete and insulated system of all equipment, flanges and accessories as specified herein.

B. All insulation system materials shall conform to the maximum flame spread/smoke developed ratings specified herein.

C. Where equipment has removable heads, then insulation shall have removable insulated covers. Do not cover any equipment nameplates.

D. Insulate the following

1. All equipment and accessories shall be insulated as herein specified.
2. Heat exchangers, expansion and compression tanks, air separators.
3. Flash tanks.
4. Condensate pump receivers. Blowdown tank.
5. Pressure reducing valves.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ASTM A 666 – Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar.
2. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Steel and Plate.
3. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and plate (Metric).
4. ASTM C 177 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by
5. Means of the Guarded Hot Plate Apparatus

6. ASTM C 195 – Standard Specification for Mineral Fiber Thermal Insulating Cement.
7. ASTM C 240 – Standard Test Methods of Testing Cellular Glass Insulation Block.
8. ASTM C 449/C 449M – Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
9. ASTM C 518 – Standard Test method for Steady-State Heat Flux Measurements and Thermal Insulating and Finishing Cement.
10. ASTM C 533 – Standard Specification for Calcium Silicate Block and Pipe Terminal Insulation.
11. ASTM C 534 – Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
12. ASTM C 552 – Standard Specification for Cellular Glass Thermal Insulation.
13. ASTM C 553 – Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
14. ASTM C 592 – Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
15. ASTM C 612 – Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
16. ASTM C 921 – Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
17. ASTM D 1056 – Standard Specification for Flexible Cellular Materials – Sponge ore Expanded Rubber.
18. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
19. ASTM E 96 – Standard Test Methods for Water Vapor Transmission Materials.
20. NFPA 225 – Standard Method of Test of Surface Burning Characteristics of Building Materials.
21. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials.
22. ANSI/ASHRAE 90.1 - Energy Conservation in New Building Design

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer’s Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

D. Contractor’s Installation Details

1. Submit job specific details and/or drawings indicating methods of insulating specific pieces of equipment such as but not limited to, chilled water pumps, condensate receivers, exposed roof-top piping, etc.

1.06 QUALITY ASSURANCE

A. All insulation materials, finishes, coatings, cements, jackets and other insulation accessories shall have minimum composite or individual fire hazard ratings as well as thickness and "C" values conforming to State Building Codes which control building construction materials that may be used on this project. Where specification requirements exceed the Code requirements, the specification shall govern.

B. Insulation for the equipment shall be composed of materials which are non-combustible and/or provide a fire resistive system of insulation which complies with the applicable Code having jurisdiction. Generally, it is required that fire hazard ratings shall not exceed the following, except as noted:

1. Flame Spread Rating: 25 (No Exceptions)
2. Smoke Developed Rating: 50

C. All fire hazard ratings shall be as determined by NFPA 255 "Method of Test of Surface Burning Characteristics of Building Materials", ASTM E84 or UL 723.

D. All insulation materials herein specified shall be used subject to the manufacturer's temperature limitations and their compatibility with other materials.

E. Installation of all insulation work shall be executed by a qualified Insulation Contractor who is thoroughly experienced in this particular type of work and who has adequate facilities and equipment for installation of all insulation work herein specified and who is familiar with the requirements of the Code enforcing Authorities as to fire hazard rating.

F. The finished installation shall present a neat and workmanlike appearance with all jackets smooth, with all vapor barriers sealed and intact.

1.07 REGULATORY REQUIREMENTS

A. Conform to maximum flame spread/smoke developed rating of 25/50 in accordance with ASTM E 84, NFPA 255, or UL 723.

B. Conform to local Energy code.

1.08 DELIVERY, STORAGE AND PROTECTION

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

B. All materials shall be stored in a dry area free from moisture and debris.

1.09 ENVIRONMENTAL REQUIREMENTS

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

B. Maintain temperature before, during and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 GENERAL

A. MANUFACTURERS ACCEPTABLE FOR PRODUCT TYPES INDICATED CONTINGENT UPON PRODUCTS' COMPLIANCE WITH THE SPECIFICATIONS

1. Insulation:

a. Manville Corporation.
b. Owens-Corning Fiberglass Corporation.

c. Armstrong World Industries, Incorporated.
d. Certainteed Corporation.
e. Knauf
f. Rock Wool Manufacturing co.
g. McNeil Inc.

2. Mastics and adhesives:

a. Childers Products Company.
b. H. B. Fuller Company, Foster Products Division.
c. 3M Company Adhesives, Coatings and Sealers.
d. Armstrong World Industries, Incorporated.
e. Ruston Plant.
f. Chicago-Mastic
g. Insul-Coustic
h. St. Clair Rubber
i. Vimasco
j. Baldwin-Ehret-Hill

3. PVC fitting covers:

a. Manville, Corporation.
b. Ceel-Co.
c. Certainteed, Corp.
d. Cell Co. Plastics

4. Reusable covers

a. Insulation Technology, Inc

2.02 MATERIALS AND COMPONENTS

A. Calcium Silicate Block Insulation

1. Calcium silicate block insulation shall be Owens-Corning, Kaylor or Manville Thermo-12. Insulation shall have a density of 11 lbs./cu.ft., a thermal conductivity of 0.37 at 200°F mean temperature, and shall be suitable for application on surfaces which reach 1200°F.
2. All block insulation shall be applied in layers not exceeding 1 1/2 inches thick. Insulation shall be secured with wire and covered with 1/2 inch thick finishing cement. All corners of insulation shall be protected by metal corner beads.
3. Nameplates and inspection stamps shall not be covered. 26 gauge galvanized metal collars shall be provided at manhole and openings for controls and nameplates and stamps and the covering shall be neatly finished thereto.

B. Insulkote

1. Insulkote ST as manufactured by Manville, shall be applied on dry cement (no primer is required). Hexagonal wire mesh reinforcement shall be used. Troweling should be done firmly to make sure the coating is thoroughly forced through the mesh. Material shall not be applied in thicknesses greater than 1/8 inch. Application to a greater thickness may cause slumping while there is still solvent in the coating.
2. Wire mesh reinforcement shall be provided.

3. Insulation material and application shall be in strict accordance with the manufacturer's procedures and recommendations.

C. Rigid Fiberglass Board Insulation

1. Rigid fiberglass board insulation shall be equal to Owens-Corning Fiberglas 25 with ASJ having an approximate density of 6 lbs./cu.ft. and an approximate thermal conductivity of 0.25 at 75°F.
2. Equipment having sharp bend shall have the insulation scored as required to conform to the curved surfaces to provide a neat and workmanlike appearance when finished.
3. All insulation edges and joints shall be sealed with a fire retardant vapor barrier adhesive, reinforced with a vapor barrier tape similar to that of the board facing. Tape shall be 3 to 5 inches wide as recommended by the particular manufacturer.

D. Mineral Wool Semi-Rigid Board

1. Mineral wool semi-rigid board insulation shall be Rock Wool, McNeil, Inc. or Knauf Insulation. Insulation shall have a density of 6 lbs./cu.ft., a thermal conductivity of 0.30 at 200°F mean temperature, and shall be suitable for application on surfaces which reach 1200°F.
2. All mineral wool semi-rigid board insulation shall be applied in layers not exceeding 1 1/2 inches thick. Insulation shall be secured with wire and covered with 1/2 inch thick finishing cement. All corners of insulation shall be protected by metal corner beads.
3. Nameplates and inspection stamps shall not be covered. 26 gauge galvanized metal collars shall be provided at manhole and openings for controls and nameplates and stamps and the covering shall be neatly finished thereto.

2.03 INSULATION FACING

A. Code ASJ: All service jacket composed of high intensity white chemically treated Kraft paper reinforced with fiberglass yarn and mesh and laminated to aluminum foil with a fire retardant adhesive. Longitudinal laps and butt strips shall be a minimum of 3 inches.

B. Code FSKL: 0.35 mil aluminum foil reinforced with fiberglass yarn reinforcing scrim and laminated to chemically treated fire resistive Kraft paper having a minimum 35 pound per inch width tensile strength when tested in accordance with ASTM D 828. Water vapor permeability 0.04 perms. Longitudinal laps and butt strips shall be a minimum of 3 inches.

2.04 ADDITIONAL INSULATION JACKET

A. ADJ-1: Approximately 6 ounce per square yard glass cloth jacket with thread count of 5 strands per square inch.

B. ADJ-2: Approximately 2 ounce per square yard glass cloth jacket with thread count of 10 strands by 10 strands per square inch. Jacket shall be used for covering pipe and pipe fittings.

C. ADJ-3a: 0.016 inch thick embossed aluminum jacket conforming to ASTM B-209 with a 1 mil factory applied polykraft moisture barrier. Longitudinal joints shall be placed at the side of the pipe facing downward at either the 4 o'clock or 8 o'clock position so as to shed water. Aluminum fitting covers, two piece elbows, tees, valve and flange covers, etc., with a 1 mil polykraft or acrylic vapor barrier.

D. ADJ-3b: 0.020 inch thick embossed aluminum jacket confirming to ASTM B-209 with a 1 mil factory applied polykraft moisture barrier. Longitudinal joints shall be placed at the side of the pipe facing downward at either the 4 o'clock or 8 o'clock position so as to shed water. Aluminum fitting covers, two piece elbows, tees, valve and flange covers, etc., with a 1 mil polykraft or acrylic vapor barrier.

E. ADJ-4: 20 mil PVC jacket suitable for all types of paint. Similar to Manville Zeston 25/50.

F. ADJ-6 A finish jacket of an Asbestos-free and woven as high temperature, heat-resistant fabric. Lagging Cloth having a treated weight of 24 oz./sq.yd. Material shall be suitable for a sustained operation at 1100°F.

G. ADJ-7 0.16-inch thick type T-316 stainless steel jackets. Alloys shall form to ASTM A-240. System shall have a 3-mil polycraft barrier.

2.05 ADHESIVES

A. Code ADH-1: Fibrous adhesive, non-flammable, quick setting adhesive for calcium silicate. Similar to Childers CP-97, 98.

B. Code ADH-2: Fast-drying vinyl base coating and lagging adhesive. Similar to Childers CP-50A HV2.

C. Code ADH-3: Fast-drying neoprene base adhesive for lap joints of foil-faced facing applied over pipe insulation. Similar to Childers CP-82.

D. Code ADH-4: Adhesive for use in adhering fiberglass board or blanket insulation to pipe and equipment. 3M Company Insulation Adhesive No. 35 or 38 non-flammable adhesive.

2.06 CAULKING COMPONENTS

A. Code CC-1: For use with foam glass and/or joint sealant applications. Flexible elastomeric vapor barrier sealant. Similar to Childers CP-76.

2.07 MASTICS

A. Code MAS-1: Vapor barrier mastic made with an elastomeric resin. For indoor use. Similar to Childers CP-30.

B. Code MAS-2: A non-water vapor barrier asphaltic emulsion coating, breathing type, for above ground installations. Similar to Childers CP-10.

C. Code MAS-3: Vapor barrier mastic made with an elastomeric resin. For outdoor use.

2.08 TIE WIRE

A. Tie wire for securing insulation in place shall be type 304 stainless steel annealed steel wire of gauge and proper spacing as recommended by the insulation manufacturer. Wire shall be drawn up tightly enough to become embedded in the insulation and the ends of the loop twisted, bent over, and pressed into the insulation so as to leave no ends protruding.

2.09 BANDING

A. 3/8 inch x 0.02 inch type 304 stainless steel for pipe insulation.

B. 3/4 inch x 0.02 inch type 304 stainless steel for additional insulation jackets.

2.10 WIRE MESH

A. Wire mesh shall be one inch by No. 20 BGW hexagonal mesh galvanized.

B. Expanded metal: Expanded metal shall be 1/2 inch Hi-Rib metal lath of copper bearing steel.

2.11 TAPE

A. Lead foil tape, where specified, shall be 3M Company Lead Foil Tape No. 422, 4 mil thick, acrylic adhesive, 2 inch wide.

B. Vinyl plastic tape, silver gray, flame resistant, vapor barrier sealant tape on rigid and flexible insulation material for warm or cold air ducts. Similar to 3M Company Duct Sealing Tape No. 474.

C. Aluminum foil tape, dead soft aluminum foil, point seal on stick pin, metal patching, moisture barrier, heat reflecting and general sealing on aluminum facing foil. Similar to 3M Company Aluminum Foil Tape No. 425.

2.12 STAPLES

A. Staples shall be galvanized clad outward clinching insulation staples.

2.13 INSULATING CEMENT

A. Insulating cement shall be a mineral-fiber (wool) ASTM C 195 base material having essentially the same insulating characteristics as the adjacent insulation. Similar to PABCO High Temperature Insulating Cement. Insulating cement shall be applied in layers to a maximum thickness of 1/2 inch at one time. Each layer shall be allowed to dry thoroughly before subsequent layers are applied.

2.14 FINISHING CEMENT

A. Finishing cement ASTM C 449 shall be diatomaceous silica thermal insulating materials with a suitable proportion of heat resistant binder, hydraulic setting insulating cement capable of withstanding maximum temperature of 700 degrees Fahrenheit. When mixed with water it shall be a plastic mix suitable for trowel applications and shall present a hard, smooth and durable surface after drying. Similar to PABCO No. 127.

B. Combination insulating and finishing cement:

C. Similar to Ryder One Coat or equal.

2.15 WELDING STUDS

A. Welding studs shall be capacitor type split pin or TCP tipped insulation pins with speed clips. Similar to Nelson Stud Welding Spec. 28.

2.16 ACCESSORIES AND FASTENING MATERIALS

A. Corner angles on insulation of equipment in finished areas shall be formed of 28 gauge, 1 inch by 1 inch aluminum adhered to heavy Kraft paper having 2 inch by 2 inch by 2 inch wings to protect external corners under cloth jackets.

2.17 REMOVABLE/REUSABLE INSULATION COVERS

A. Pressure reducing valves operating above 200°F shall be insulated with reusable insulation covers as described in this specification.

B. The materials, construction techniques and methods of application described in this specification are for conservation of heat, ease of maintenance and personnel protection.

C. Reusable insulation covers shall be custom built and shall conform to the shape of the fitting or valve being insulated.

D. Identification of reusable covers shall be by means of a permanently attached, stainless steel tag secured to the outer surface of the cover. The identification legend, which shall be mechanically embossed on the tag, shall locate the fitting the cover was designed for. It shall also contain information adequate to reorder the cover from the manufacturer.

E. Reusable covers shall be similar to Insulation Technology, Inc., Heat Holder LD-1000, 2 inch thick fiber glass mat insulation. LD-1000 shall be an off-white color, have non-combustible wool with long, resilient, inorganic glass fibers, and shall be bonded with a thermosetting resin. Insulation shall be encased in an inner and outer jacket of 550T Teflon impregnated fiberglass fabric suitable for temperatures up to 500°F. Fabric shall weigh a minimum of 14 oz./sq.yd. and have a nominal thickness of 0.013 inch. Fabric shall also pass UL 214 Flammability Test. Fabric color shall be gray.

F. Covers shall be sewn simultaneously with (2) parallel rows of double sewn seams of (10) stitches per inch. Stainless steel quilting pins and hooks shall be included on each cover.

G. Covers shall be installed after adjacent pipe and fitting insulation and jacketing is in place. Covers shall be overlapped a minimum of 2 inches on pipe insulation. Once in place, covers shall be tightened by Velcro straps sewn into each cover.

PART 3 EXECUTION

3.01 INSTALLATION OF INSULATION

A. All insulation shall be applied by experienced Insulating Contractors in accordance with best Trade practice.

B. Do not cover vent petcocks, grease fittings or other maintenance points on equipment unless identified on the insulation with removable access panels or covers.

C. No equipment nameplates shall be covered. The insulation shall be cut back and a 26 galvanized “picture frame” installed to accept the abutting edges of the insulation to leave the nameplate data exposed to view.

D. Test, inspect and clean all surfaces to be insulated before applying insulation.

E. Take all possible precautions to protect work of other Trades. Provide protective covering as required to accomplish this end. This Trade shall be responsible for returning all equipment and material to its original new condition and appearance where damage occurs due to his neglect.

F. All equipment and accessories shall have been tested and approved prior to installation of insulation.

G. All equipment surfaces, where subject to condensation or heat loss on the outside, shall be insulated.

H. All surfaces to be insulated shall be clean, dry and free from rust and scale when insulation is being applied. Insulation shall be dry at the time of installation and before and during the process of finished application.

I. Butt ends will not be allowed. However, where required and approved by Architect, jacket material shall be pasted over exposed ends and banded to give a neat and finished appearance. Exposed insulation material will not be permitted.

J. Surfaces or insulation shall be smooth, even and true to line with jackets drawn tight and smoothly secured. Scrap pieces of insulation shall not be used as filler pieces.

K. The methods of application of insulation, finishes, adhesives, cements, accessories are generally specified under the material headings of these specifications. Where not specifically detailed, it is intended that they are equal or exceed the manufacturer’s published recommendations, existing at time of bid openings, subject to the approval of the Architect.

L. Butt covering neatly to walls, floors, ceiling. Apply band at end and position so band covers gap between surface and insulation where exposed.

M. Fastenings: Provide where required to securely hold insulation.

N. Thickness of insulation shall not be compromised due to interferences, improper installation or any other reason.

PART 4 SCHEDULES

4.01 EQUIPMENT INSULATION SCHEDULE

Service	Type Insulation and Thickness (Inches)	Facing	Additional Jacket
All Expansion, Compression Tanks and Air Separators	Calcium Silicate Block 1		ADJ-6
Flash Tanks and Condensate Tanks,	Calcium Silicate Block 3		ADJ-6
Hot water pumps	Fiberglass 3		Same as piping
Blowdown Tanks	Calcium Silicate Block 3		ADJ-6
Tanks	Calcium Silicate Block 3		ADJ-6
Blowdown Tanks	Calcium Silicate Block 3		ADJ-6
Blowdown separator	Calcium Silicate Block 3		ADJ-6
Chilled Water Pumps	Armaflex 3	Formed Covers w/Velcro Fastening	Same as piping
Pressure Reducing Valves	Custom Cover Fiberglass Mat 2	Heat-Holder LD-1000	
Heat Exchanger	Calcium Silicate Block 3		ADJ-6
Other	Fiberglass 3	FSKL	Same as piping

A. HVAC Insulation Schedule Notes

1. Refer to jacket specifications for finish covering to be installed on calcium silicate insulation in finished areas.
2. Where "Finishing Cement" finishes are scheduled, refer to specifications for Cement herein for materials, method of application, thickness, etc.

END OF SECTION

SECTION 230719

HVAC PIPING INSULATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all piping insulation, vapor barriers, jackets, finishes, adhesives, cements and accessories to make a complete insulated system for all piping, valves, fittings, joints, offsets and flanges specified herein.

B. All insulation system materials shall conform to the maximum flame spread/smoke developed ratings specified herein.

C. Hard insulation material shall be provided at all hangers.

D. Insulate the following:

1. All scheduled piping, all valves, fittings, elbows, flanges and accessories.
2. All piping exposed to weather including provision of additional weatherproof jacket.
3. All cold water make-up piping and valves. All drain and overflow piping receiving cold water. Piping to/from expansion/compression tanks.
4. All vents and blow-offs in mechanical rooms and elsewhere within reach of personnel.
5. Piping jacket covers.
6. All heat traced piping.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Section of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ASTM A 666 – Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar.
2. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Steel and Plate.
3. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and plate (Metric).
4. ASTM C 177 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.

5. ASTM C 195 – Standard Specification for Mineral Fiber Thermal Insulating Cement.
6. ASTM C 240 – Standard Test Methods of Testing Cellular Glass Insulation Block.
7. ASTM C 449/C 449M – Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
8. ASTM C 518 – Standard Test method for Steady-State Heat Flux Measurements and Thermal Insulating and Finishing Cement.
9. ASTM C 533 – Standard Specification for Calcium Silicate Block and Pipe Terminal Insulation.
10. ASTM C 534 – Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
11. ASTM C 547 – Standard Specification for Mineral Fiber Pipe Insulation.
12. ASTM C 552 – Standard Specification for Cellular Glass Thermal Insulation.
13. ASTM C 578 – Standard Specification for Preformed, Cellular Polystyrene Thermal Insulation.
14. ASTM C 591 – Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
15. ASTM C 610 – Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation.
16. ASTM C 795 – Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
17. ASTM C 921 – Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
18. ASTM D 1056 – Standard Specification for Flexible Cellular Materials – Sponge ore Expanded Rubber.
19. ASTM D 1667 – Standard Specification for Flexible Cellular Materials – vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).
20. ASTM D 1784 – Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
21. ASTM D 2842 – Standard Test Method for Water Absorption of Rigid Cellular Plastics.
22. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
23. ASTM E 96 – Standard Test Methods for Water Vapor Transmission Materials.
24. NFPA 225 – Standard Method of Test of Surface Burning Characteristics of Building Materials.
25. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials.
26. ANSI/ASHRAE 90.1 – Energy Conservation in New Buildings.
27. 2003 International Mechanical Code
28. 2009 IECC

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

D. Installation Graphic Details.

1.06 QUALITY ASSURANCE

A. All insulation materials, finishes, coatings, cements, jackets and other insulation accessories shall have minimum composite or individual fire hazard ratings as well as thickness and "C" values conforming to State Building Codes which control building construction materials that may be used on this project. Where specification requirements exceed the Code requirements, the specification shall govern.

B. Piping insulation for the various piping systems and associated equipment shall be composed of materials which are non-combustible and/or provide a fire resistive system of insulation which complies with the applicable Code having jurisdiction. Generally, it is required that fire hazard ratings shall not exceed the following, except as noted:

1. Flame Spread Rating 25 (No Exceptions)
2. Smoke Developed Rating: 50

C. All fire hazard ratings shall be as determined by NFPA 255 "Method of Test of Surface Burning Characteristics of Building Materials", ASTM E84 or UL 723.

D. All insulation materials herein specified shall be used subject to the manufacturer's temperature limitations and their compatibility with other materials.

E. Installation of all insulation work shall be executed by a qualified Insulation Contractor who is thoroughly experienced in this particular type of work and who has adequate facilities and equipment for installation of all insulation work herein specified and who is familiar with the requirements of the Code enforcing Authorities as to fire hazard rating.

F. The finished installation shall present a neat and workmanlike appearance with all jackets smooth, with all vapor barriers sealed and intact.

G. Where insulation is specified for piping, insulate similarly all connections, vents, drains and any piping connected to system subject to heat loss or gain. Do not cover vent petcocks, cleanouts or other maintenance points on equipment unless identified on the insulation with removable access panels or covers.

H. All chilled water system piping, components and accessories are to be insulated in a manner so as to provide a complete, uninterrupted vapor barrier.

1.07 REGULATORY REQUIREMENTS

A. Conform to maximum flame spread/smoke developed rating of 25/50 in accordance with ASTM E 84, NFPA 255, or UL 723.

1.08 DELIVERY, STORAGE AND PROTECTION

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

B. All materials shall be stored in a dry area free from moisture and debris.

1.09 ENVIRONMENTAL REQUIREMENTS

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

B. Maintain temperature before, during and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 MANUFACTURERS ACCEPTABLE FOR PRODUCT TYPES INDICATED CONTINGENT UPON PRODUCTS' COMPLIANCE WITH THE SPECIFICATIONS

A. Insulation:

1. Manville Corporation.
2. Owens-Corning Fiberglass Corporation.
3. Armstrong World Industries, Incorporated.
4. Certainteed Corporation.
5. Knauf

B. Elastomeric insulation

1. Armacell

C. Mastics and adhesives:

1. Childers Products Company.
2. H. B. Fuller Company, Foster Products Division.
3. 3M Company Adhesives, Coatings and Sealers.
4. Armstrong World Industries, Incorporated.
5. Ruston Plant.
6. Chicago-Mastic
7. Insul-Coustic
8. St. Clair Rubber
9. Vimasco
10. Baldwin-Ehret-Hill

D. Pipe insulation of hanger and support:

1. Pipe Shields, Inc.
2. Rilco Manufacturing Company.
3. Elcen Metal Products Company.
4. Power Piping Company.
5. NPS Industries.

E. PVC fitting covers:

1. Manville, Corporation.
2. Ceel-Co.
3. Certainteed, Corp.
4. Cell Co. Plastics

2.02 GENERAL

A. Adhesives and insulation materials: Composite fire and smoke hazard ratings maximum 25 for flame spread and 50 for smoke developed for pipe insulation. Adhesives to be waterproof when cured.

B. The installation of thermal insulating materials coverings and coatings containing asbestos fibers is forbidden.

C. Insulation shall not be chemically reactive to the metal over which it is applied. Insulation installed on steel shall be neutral or slightly alkaline. Insulation installed on aluminum shall be neutral or slightly acidic.

2.03 MATERIALS AND COMPONENTS

A. Fiberglass insulation:

1. Pre-molded pipe fiberglass: Recommended temperature to 850 degrees Fahrenheit with facing. Molded in one piece split or hinged circular sections in three foot lengths for piping and tubing. Insulation shall be made from long, fine, glass fibers bonded together with a thermosetting resin. Insulation shall have a minimum density of 4.0 pounds per cubic foot and a K value of 0.23 at 75 degrees Fahrenheit mean temperature. Insulation furnished with facing as specified below and as indicated in insulation schedule. Insulation similar to Owens-Corning Type SSL-II. Pressure sensitive tapes using rubber based or acrylic based adhesives are not permitted.
2. Pipe and tank fiberglass: Recommended temperature to 450 degrees F with facing. Insulation shall be made from long, fine, glass fibers bonded together with a thermosetting resin. Insulation shall have a minimum density of 3 pounds per cubic foot and a k-valve of 0.27 btu in/(Hr sq.ft. degree F) at 75 degrees F main temperature. Insulation furnished with facing as specified below and as indicated in insulation schedule. Insulation similar to Manville pipe and tank insulation. Pressure sensitive tapes using rubber based or acrylic based adhesives are not permitted.
3. Flexible fiberglass: Recommended temperature to 250 degrees Fahrenheit. Glass fibrous flexible blanket insulation having density of 0.75 pounds per cubic foot and a K value of 0.30 at 75 degrees mean temperature. Insulation furnished with facing as specified below and indicated in insulation schedule. Insulation and jacket similar to Owens-Corning Type SSL-II.
4. Use pipe and tank fiberglass only when premolded pipe fiberglass is not available. Pipe and tank insulation shall not be used on pipe sizes 24 inches and smaller.

B. Hydrous Calcium Silicate Pipe Insulation

1. Molded, rigid, asbestos free, hydrous calcium silicate water resistant pipe insulation shall be Owens-Corning Fiberglas Kaylo 10 or Manville Thermo-12, molded to dimensional standards conforming to the pipe. Insulation shall have an approximate density of 11 lbs./cu.ft., an approximate thermal conductivity of 0.41 at 200°F mean temperature and shall be suitable for application on surfaces which reach 1200°F. Additional jacket, as hereinafter specified, shall be applied in the field. This material shall be used in finished and concealed areas. In all areas, insulation shall have all joints made with an approved insulation cement to prevent heat leakage through joints. Insulation shall be secured by wire on 9 inch centers.

2. Valves, flanges and fittings occurring in lines insulated with calcium silicate insulation shall be covered with fabricated, mitered segments of molded calcium silicate of thickness equal to insulation on adjacent pipe, wired in place and made smooth with a thin coat of insulating cement. Fittings on pipes 2 inches and smaller may be insulated with insulating cement to a thickness equal to that of adjacent pipe insulation. All fittings shall be finished with glass fabric embedded in fire retardant adhesive

C. Mineral Wool Pipe Insulation

1. Molded, rigid, asbestos free, mineral wool, water resistant pipe insulation shall be Rock Wool Delta, molded to dimensional standards conforming to the pipe. Insulation shall have an approximate density of 8 lbs./cu.ft., an approximate thermal conductivity of 0.29 at 200°F mean temperature and shall be suitable for application on surfaces which reach 1200°F. Additional jacket, as hereinafter specified, shall be applied in the field. This material shall be used in finished and concealed areas. In all areas, insulation shall have all joints made with an approved insulation cement to prevent heat leakage through joints. Insulation shall be secured by wire on 9 inch centers.
2. Valves, flanges and fittings occurring in lines insulated with mineral wool insulation shall be covered with fabricated, mitered segments of molded mineral wool of thickness equal to insulation on adjacent pipe, wired in place and made smooth with a thin coat of insulating cement. Fittings on pipes 2 inches and smaller may be insulated with insulating cement to a thickness equal to that of adjacent pipe insulation. All fittings shall be finished with glass fabric embedded in fire retardant adhesive

D. Closed-Cell Elastomeric

1. Insulation material shall be a flexible, closed-cell elastomeric insulation.
2. The product shall meet the requirements as defined in ASTM C 534.
3. Insulation materials shall have a closed-cell structure to prevent moisture from wicking which makes it an efficient insulation.
4. Insulation material shall be manufactured without the use of CFCs, HFCs or HCFCs.
5. Insulation material shall be formaldehyde free, low VOCs, fiber free, dust free and resists mold and mildew.
6. Materials shall have a flame spread index of less than 25 and a smoke-developed index of less than 50 when tested in accordance with ASTM E 84, latest revision.
7. In addition, the product, when tested, shall not melt or drip flaming particles, the flame shall not be progressive and all materials shall pass simulated end-use fire tests.
8. Materials shall have a maximum thermal conductivity of 0.27 Btu-in./h-ft2- °F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions. F. Materials shall have a maximum water vapor transmission of 0.08 perm-inches when tested in accordance with ASTM E 96, Procedure A, latest revision.

E. Insulation facing:

1. Code ASJ: All service jacket composed of high intensity white chemically treated Kraft paper reinforced with fiberglass yarn and mesh and laminated to aluminum foil with a fire retardant adhesive. Longitudinal laps and butt strips shall be a minimum of 3 inches.
2. Code FSKL: 0.35 mil aluminum foil reinforced with fiberglass yarn reinforcing scrim and laminated to chemically treated fire resistive Kraft paper having a minimum 35 pound per inch width tensile strength when tested in accordance with ASTM D 828. Water vapor permeability 0.04 perms. Longitudinal laps and butt strips shall be a minimum of 3 inches.

F. Additional insulation jacket:

1. ADJ-1: Approximately 6 ounce per square yard glass cloth jacket with thread count of 5 strands per square inch.
2. ADJ-2: Approximately 2 ounce per square yard glass cloth jacket with a thread count of 10 strands by 10 strands per square inch. Jacket shall be used for covering pipe and pipe fittings.
3. ADJ-3a: 0.016 inch thick aluminum jacket conforming to ASTM B-209 with a 1 mil factory applied polykraft moisture barrier. Longitudinal joints shall be placed at the side of the pipe facing downward at either the 4 o'clock or 8 o'clock position so as to shed water. Aluminum fitting covers, two piece elbows, tees, valve and flange covers, etc., with a 1 mil polykraft or acrylic vapor barrier.
4. ADJ-3b: 0.020 inch thick aluminum jacket conforming to ASTM B-209 with a 3 mil factory applied polykraft moisture barrier. Longitudinal joints shall be placed at the side of the pipe facing downward at either the 4 o'clock or 8 o'clock position so as to shed water. Aluminum fitting covers, two piece elbows, tees, valve and flange covers, etc., with a 3 mil polykraft or acrylic vapor barrier.
5. ADJ-4: 20 mil PVC jacket suitable for all types of paint. Similar to Manville Zeston 25/50.
6. ADJ-6 A finish jacket of an Asbestos-free and woven as high temperature, heat-resistant fabric. Lagging Cloth having a treated weight of 24 oz./sq.yd. Material shall be suitable for a sustained operation at 1100°F. Calcium silicate piping for generator exhaust piping shall also be jacketed with corrugated aluminum.
7. ADJ-7: 0.16-inch thick type T-316 stainless steel jacket. Alloys conforming to ASTM A-240. System shall have a 3-mil polykraft vapor barrier.

G. Adhesives:

1. Code ADH-1: Fibrous adhesive, non-flammable, quick setting adhesive for calcium silicate. Similar to Childers CP-97, 98.
2. Code ADH-2: Fast-drying vinyl base coating and lagging adhesive. Similar to Childers CP-50A HV2.
3. Code ADH-3: Fast-drying neoprene base adhesive for lap joints of foil-faced facing applied over pipe insulation. Similar to Childers CP-82.
4. Code ADH-4: Adhesive for use in adhering fiberglass board or blanket insulation to pipe and equipment. 3M Company Insulation Adhesive No. 35 or 38 non-flammable adhesive.

H. Caulking components:

1. Code CC-1: For use with foam glass and/or joint sealant applications. Flexible elastomeric vapor barrier sealant. Similar to Childers CP-76.

I. Mastics:

1. Code MAS-1: Vapor barrier mastic made with an elastomeric resin. For indoor use. Similar to Childers CP-30.
2. Code MAS-2: A non-water vapor barrier asphaltic emulsion coating, breathing type, for above ground installations. Similar to Childers CP-10.
3. Code MAS-3: Vapor barrier mastic made with an elastomeric resin. For outdoor use.

J. Tie wire:

1. Tie wire for securing insulation in place shall be type 304 stainless steel annealed steel wire of gauge and proper spacing as recommended by the insulation manufacturer. Wire shall be drawn up tightly enough to become embedded in the insulation and the ends of the loop twisted, bent over, and pressed into the insulation so as to leave no ends protruding.

K. Banding:

1. 3/8 inch x 0.02 inch type 304 stainless steel for pipe insulation.
2. 3/4 inch x 0.02 inch type 304 stainless steel for additional insulation jackets.

L. Wire mesh:

1. Wire mesh shall be one inch by No. 20 BGW hexagonal mesh galvanized.
2. Expanded metal: Expanded metal shall be 1/2 inch Hi-Rib metal lath of copper bearing steel.

M. Tape:

1. Lead foil tape shall be 3M Company Lead Foil Tape No. 422, 4 mil thick, acrylic adhesive, 2 inch wide.
2. Vinyl plastic tape, silver gray, flame resistant, vapor barrier sealant tape on rigid and flexible insulation material for warm or cold air ducts. Similar to 3M Company Duct Sealing Tape No. 474.
3. Aluminum foil tape, dead soft aluminum foil, point seal on stick pin, metal patching, moisture barrier, heat reflecting and general sealing on aluminum facing foil. Similar to 3M Company Aluminum Foil Tape No. 425.

N. Staples:

1. Staples shall be galvanized clad outward clinching insulation staples.

O. Insulating cement:

1. Insulating cement shall be a mineral-fiber (wool) ASTM C 195 base material having essentially the same insulating characteristics as the adjacent insulation. Similar to PABCO High Temperature Insulating Cement. Insulating cement shall be applied in layers to a maximum thickness of 1/2 inch at one time. Each layer shall be allowed to dry thoroughly before subsequent layers are applied.

P. Finishing cement:

1. Finishing cement ASTM C 449 shall be diatomaceous silica thermal insulating materials with a suitable proportion of heat resistant binder, hydraulic setting insulating cement capable of withstanding maximum temperature of 700 degrees Fahrenheit. When mixed with water it shall be a plastic mix suitable for trowel applications and shall present a hard, smooth and durable surface after drying. Similar to PABCO No. 127.

Q. Combination insulating and finishing cement:

1. Similar to Ryder One Coat or equal.

R. Welding studs:

1. Welding studs shall be capacitor type split pin or TCP tipped insulation pins with speed clips. Similar to Nelson Stud Welding Spec. 28.

PART 3 EXECUTION

3.01 PREPARATION

A. No insulation shall be applied until the surfaces of the equipment to be insulated are thoroughly cleaned and until pipes and equipment to be insulated have been leak tested and proven tight and accepted by the Engineer.

B. Insulation shall not be applied to piping or equipment until authorization is given to the Contractor by the Engineer. Contractor shall submit a request for authorization. If any insulation is applied without first obtaining authorization, it will be the Contractor's responsibility to remove the insulation and apply it again if so directed.

C. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

D. The execution of the insulation work shall be in strict accordance with the best practices of the trade and with the specifications.

E. The insulation shall be handled and applied in a manner that will not adversely affect its structural or insulating properties.

F. The installation instructions provided by the insulation material manufacturer of all materials specified in this Section shall be followed when installing these materials. Where the specifications are in conflict with manufacturers' instructions, such conflicts shall be brought to the attention of the Engineer for a decision.

G. Welding operations will not be permitted on certain specific items of equipment, piping and components for the application of studs, pins, support rings, angles, etc. Contractor shall obtain permission in writing from the Engineer to perform any welding.

H. Coat to seal all insulating cement and calcium silicate surfaces with primer similar to Childers CP-53 or equal before applying any mastic coating.

3.02 PIPING INSULATION INSTALLATION

A. Ensure insulation is continuous through interior walls. Pack around pipes with fire proof self-supporting insulation material, fully sealed. Insulation on all cold surfaces where vapor barrier jackets are specified must be applied with a continuous, unbroken vapor seal. Hangers, supports, anchors, and other heat conductive parts that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation.

B. Insulate fittings, valves, unions, flanges, and strainers. Do not insulate flexible connections and expansion joints. Terminate insulation neatly with PVC or aluminum end caps.

C. Pre-molded fiberglass insulation for straight pipes shall be applied, neatly fitted around piping and sealed with adhesive ADH-3. Adhesive shall be applied to only one side of each joint and shall not be applied to the pipe surface.

D. Where two sections of pipe insulation butt together provide a 3 inch wide butt strip of same facing material as adjacent insulation facing. Adhere neatly in place using adhesive ADH-3.

E. All pipe elbows shall be insulated with short radial and mitered pieces of board or block insulation or pre-molded pieces of pipe insulation. Each piece shall be butted tightly against the adjoining piece and all joints, seams, voids and irregular surfaces shall be filled with insulating cement finished to a smooth, hard and uniform contour. Coat with MAS-1 mastic and reinforce with ADJ-2 additional jacket. In addition, place a fitted PVC cover (ADJ-4) over insulated elbow exception. Tape elbow to adjoining insulation.

F. All valves and fittings shall be insulated with pre-molded fittings, sectional pipe insulation, or blocks of the same material and thickness as used for the adjacent pipe. Flange insulation shall overlap the adjoining pipe insulation by not less than the thickness of the pipe insulation. Sectional pipe covering or block insulation shall be cut to fit, and each section butted closely to the next and held in place with tie wire.

G. Fittings on pipe lines in finished and concealed areas shall be covered with pre-molded fiberglass pipe fitting insulators Insul-Coustic or equal, where sizes are available, otherwise, use mitercut segments of molded pipe insulation, wire in place with joints and raw edges sealed with adhesive and smoothed out with a coat of insulating cement.

H. On cold pipes the fittings shall be finished with (2) coats of an approved vapor barrier mastic, reinforced with glass cloth extending 2 inches onto adjacent pipe insulation. Hot pipes shall be finished in a similar manner except the mastic need not be of the vapor barrier type.

I. Insulation shall cover the entire surface of the fittings and bodies of the valves up to and including the bonnets, and to the valve stuffing box studs, bolts, or nuts. All joints, seams, and irregular surfaces shall be filled with insulating cement. The insulated surfaces shall be covered with a 1/4 inch thick layer of finishing cement and heavily coated with vapor barrier mastic MAS-1 for cold services and mastic MAS-2 for hot services and reinforced with ADJ-2 additional jacket. Mastic shall be trowelled to a smooth and well-shaped contour compatible with adjoining pipe insulation jackets as specified.

J. Use ADJ-4 covers over fittings and flanges everywhere except when ADJ-3a, ADJ-3b, or ADJ-5 is specified.

K. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship on all joints of all piping.

L. All instrument connections for thermometers, thermocouples, gauges, test connections, flow meters, etc., on insulated pipes, vessels, or equipment shall be insulated. The insulation shall be shaped at these connections by tapering it to and around the connection with insulating cement and finishing with finishing cement, vapor barrier adhesive, applicable mastic, or caulking compound.

M. Where removable flange and valve insulation is required or specified, installation shall conform to the following:

1. Removable flange insulation shall be made from sectional pipe insulation of the same thickness as that on the adjoining pipe or from block insulation 1/2 inch thinner than the pipe insulation and finished with insulating cement. Insulation jackets shall be the same as adjoining pipe insulation unless indicated otherwise.
2. When flange covers are made from sectional pipe insulation, they shall enclose the flanges and be long enough to extend at least 2 inches over the adjacent pipe insulation on each side of the flange. The space between the flange cover and the pipe insulation shall be filled with insulating cement. Secure the flange cover in place with stainless steel banding.
3. When flange covers are made from block insulation, they shall be made in two halves. Each half shall consist of mitered blocks wired to 1/2 inch galvanized hardware cloth mesh. This wire frame, with its attached insulation, shall then be secured to the flanges with tie wire. The insulation cover shall be long enough to extend at least 2 inches over the adjacent pipe insulation on each side of the flange. The space between the flange cover and the pipe insulation shall be filled with insulating cement. The whole flange cover assembly shall be finished with 1/2 inch of insulating cement applied in two coats. After the first coat is dry, the second coat shall be trowelled to a smooth hard finish. All surfaces shall then be finished with jackets as specified in the schedule.
4. Removable valve insulation covers shall be constructed in the same manner as for flanges with the following exception; the two part section shall be divided on the vertical center line of the valve body, bonnet, flange or joint.
5. When specified to insulate the complete valve, the hand wheel or lug wrench shall be removed to accommodate the valve bonnet box. The valve bonnet box shall be constructed in a one piece closure, one end closed, one end opened to fit up to the valve body insulation. Securing the valve and bonnet box sections, sealing and pointing of the insulation shall be done in same manner as specified for flange covers.
6. Unless indicated as removable, a permanent installation as previously specified shall be used.
7. Protect insulation on piping 2 ½" and up where supported in hangers by means of calcium silicate rigid pipe insulation or jackets. Saddles or shaped galvanized steel pieces approximately 10" long by half the circumferences of insulated pipe.
8. All piping shall have been tested and approved prior to installation of insulation.
9. All piping or surfaces where subject to condensation on the outside shall be insulated including vaporseal finish.

PART 4 SCHEDULES

4.01 PIPING INSULATION SCHEDULE: (ASJ = "All-Service-Jacket")

Service	Type Insulation and Thickness (Inches)	Facing	Additional Jacket* (See Note G)
LPS Steam Up to 1-1/2” 1-1/2” to 6” 6” & Up	Molded Fiber Glass 1 1/2 2 3 1/2	 ASJ ASJ ASJ	 ADJ-4 at Fittings & Elbows
Hot Water Heating & Condensate Water Up to 1-1/2” 2” & Up	Molded Fiber Glass 1 1/2 2	 ASJ ASJ	 ADJ-4 at Fittings & Elbows
Chilled Water Up to 2” 2 1/2” & Up	Molded Fiber Glass 1 1/2 2	 ASJ ASJ	ADJ-4 at Fittings & Elbows
Condensation Drains & Vents, Cold Water Make-up	Molded Fiber Glass 1	 ASJ	ADJ-4 at Fittings & Elbows
Blowdowns and Condensate (All Pressures) 1/2” to 2” 2 1/2” & Up	Molded Fiber Glass 1 1 1/2	 ASJ ASJ	ADJ-4 at Fittings & Elbows
Piping with Heat Trace	Molded Fiber Glass 3”	ASJ	ADJ-3b
All outdoor piping	Two times thickness scheduled except heat traced		ADJ-3b
All pipe within equipment room	As scheduled		ADJ-3b
Others not scheduled	Molded Fiber Glass 1	ASJ	

*Including elbows, fittings, valves, complete system.

A. Refer to jacket specifications for finish covering to be installed on calcium silicate insulation in finished areas.

B. Where "Finishing Cement" finishes are scheduled, refer to specifications for Cement herein for materials, method of application, thickness, etc.

C. Provide vapor barrier on all cold water and rainwater piping.

D. Piping exposed to weather shall be insulated with pipe insulation using double the thicknesses scheduled hereinbefore, up to 24 inches beyond the point where pipes enter the building. Provide weatherproof jacket as hereinafter specified.

E. Equipment drains and floor drains from cooling coils as well as drinking fountain waste shall be insulated 6 feet downstream from connection point.

F. At Contractors option, Mineral Wool Pipe Insulation may be utilized in lieu of Calcium Silicate Insulation. Mineral Wool Pipe Insulation thickness shall be as listed in Table 4.1 for Calcium Silicate Insulation.

G. In Mechanical spaces, the additional jacket requirement for indoor installations shall apply only to piping within 8-0” of finished floor or catwalks.

END OF SECTION

SECTION 232000

HVAC PIPING AND JOINTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all steam and condensate piping, fittings, flanges, unions, bolting, gaskets, welding, and threading for all main piping network, branches and connections to all fuel fired HVAC and electrical equipment and systems to make complete and operations systems.

B. All systems shall be installed in accordance with local code including vent piping and relief discharge termination points.

C. Secure all permits and local/state approvals for the installation of all components included under this Section.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. ASME: American Society of Mechanical Engineers

C. NFPA: National Fire Protection Association

1. NFPA 54: National Fuel Gas Code

D. ANSI: American National Standards Institute

1. A13.1: Scheme for Identification of Piping Systems
2. B16.1: Cast Iron Pipe Flanges and Flanged Fittings
3. B16.3: Malleable Iron Threaded Fittings
4. B16.4: Cast Iron Threaded Fittings
5. B16.5: Pipe Flanges and Flanged Fittings
6. B16.9: Factory Made Wrought Steel Butt Weld Fittings
7. B16.11: Forged Steel Fittings, Socket Weld and Threaded
8. B16.15: Cast Bronze Threaded Fittings
9. B16.18: Cast Copper Alloy Solder Joint Pressure Fittings
10. B16.20: Metallic Gaskets for Pipe Flanges

11. B16.21: Now Metallic Flat Gaskets for Pipe Flanges
12. B16.22: Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
13. B16.24: Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, 300, 400, 600, 800, 1500 and 2500
14. B182.1 Square and hex bolts and screws
15. B182.2 Square and hex nuts
16. B16.39: Malleable Iron Threaded Pipe Unions
17. B16.42: Ductile Iron Pipe Flanges and Flanged Fittings
18. B31.1: Power Piping
19. B36.10: Welded and Seamless Wrought Steel Pipe
20. Z49.1: Safety in Welding and Cutting

E. AWWA: American Waterworks Association

1. C104/A21.4: Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water
2. C110/A21.10: Ductile Iron and Gray Iron Fittings for Water
3. C111/A21.11: Rubber Gasket Joints for Ductile Iron Pipe and Threaded Flanged
4. C151/A21.51: Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand Lined Molds, for Water or Other Liquids
5. C153/A21.53: Ductile Iron Compact Fittings, 3" thru 6", for Water and Other Liquids
6. C200: Steel Water Pipe 6" and Larger
7. C205: Cement Mortar Protective Lining and Coating for Steel Water Pipe
8. C206: Field Welding of Steel Water Pipe
9. C207: Steel Pipe Flanges for Waterworks
10. C208: Dimensions For Fabricated Steel Water Pipe Fittings
11. C600: Standard for Installation of Ductile Iron Water Mains and Their Appurtenances
12. C606: Standard for Grooved and Shouldered Joints
13. C210: Liquid Epoxy Coating System for the Interior and Exterior of Steel Water Pipes

F. CISPI: Cast-Iron Soil Pipe Institute

1. 301: Hubless Cast Iron Sanitary System: With No-Hub Pipe and Fittings

G. ASTM: American Society for Testing and Materials

1. A 47: Ferritic Malleable Iron Castings
2. A 53: Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
3. A 74: Cast Iron Soil Pipe and Fittings
4. A 105/A105M: Forgings, Carbon Steel, for Piping Components
5. A 106: Seamless Carbon Steel Pipe for High-Temperature Service
6. A 135: Electric-Resistance-Welded Steel Pipe
7. A 153: Zinc Coating (Hot Dip) on Iron and Steel Hardware
8. A 183: Carbon Steel Track Bolts and Nuts
9. A193: Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
10. A194: Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
11. A197: Cupola Malleable Iron
12. A 234/A23AM: Pipe Fittings of Wrought Carbon Steel and Alloy / Rev A: Steel for Moderate and Elevated Temperature
13. A 307: Carbon Steel Bolts and Studs, 60000 PSI Tensile Strength
14. A 312: Standard for Seamless and Welded Austenitic Stainless Steel Pipe.
15. A 536: Ductile Iron Castings

16. A 568: Steel, Sheet Carbon and High-Strength Low-Alloy / Rev A: Hot-Rolled and Cold-Rolled, General Requirements
17. A 795: Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
18. B 32: Solder Metal
19. B 43: Seamless Red Brass Pipe, Standard Sizes
20. B 75: Seamless Copper Tube
21. B 88: Seamless Copper Water Tube
22. C 564: Rubber Gaskets for Cast Iron Soil Pipe and Fittings
23. D 2000: Standard Classification System for Rubber Products in Automotive Application
24. F 36: Compressibility and Recovery of Gasket Materials
25. F 37: Sealability of Gasket Material
26. F 38: Creep Relaxation of a Gasket Material
27. F 146: Fluid Resistance of Gasket Materials
28. F 104: Non-metallic Gasket Materials
29. F 152: Tension Testing of Nonmetallic Gasket Materials
30. C 33: Standard Specification for Concrete Aggregates
31. D-2122: Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
32. D-2513: Standard Specification for Thermoplastic Gas Pressure / Rev. B: Pipe, Tubing and Fittings
33. D-1248: Standard Specification for Polyethylene Plastic Molding and Extrusion Materials
34. D-3350: Polyethylene Plastic Pipe and Fittings Materials

H. Copper Development Association

1.05 SUBMITTALS

A. See Section 232000 and General Conditions for additional information.

B. Product Data: Include date on pipe materials, steam/condensate specialties, pipe fittings and accessories. Provide manufacturers catalogue information and mill certificates.

C. Welders Certificate: Include welder's certification of compliance with ASME (BPV IX).

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

E. Project Record Documents: Record actual locations of all piping, valves, traps and valve tag numbers.

F. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable designation.

G. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

H. Provide piping plans to a minimum scale of 1/4" - 1'-0".

1.06 QUALITY ASSURANCE

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

B. All grooved joint

1. Couplings, fittings, valves, and specialties shall be the products of a single manufacturer.
2. Grooving tools shall be of the same manufacturer as the grooved components.

C. Welders: Certify in accordance with ASME (BPV IX).

1.07 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 code for installation of steam and condensate piping systems including specialties.

B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

C. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.08 DELIVERY, STORAGE AND HANDLING

A. Protect piping systems and specialties from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.09 ENVIRONMENTAL

A. Do not install piping when environmental conditions are outside the specific limitations of the referenced codes and manufacturer's recommendations.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide all piping, fittings, flanges, couplings, unions, bolting, gaskets, welding, threading and soldering for main piping network, branches and connections to equipment as shown on the drawings and as required to provide complete systems. All piping, fittings and accessories shall conform to the appropriate Service Pipe Schedule as specified hereinafter.

1. Acceptable manufacturers contingent on compliance with the specifications.

a. Pipe

1) Steel

a) U.S. Steel
b) AK Steel

2) Ductile Iron

a) U.S. Pipe
b) Atlantic Pipe

3) Copper

a) Cambridge Lee
b) Cerro

b. Fittings

1) Welded Fittings

a) Anvil
b) Weld Bend
c) Hackney

2) Iron Fittings

a) Anvil
b) Flagg
c) Ward

3) Steel

a) Vogt
b) Velan

4) Grooved Piping

a) Victaulic Company of America
b) Engineer-approved equal

B. General

1. All pipe and fitting shall be new, first quality material suitable for continuous operation under the conditions specified. All material shall be in conformance with ANSI Standards.
2. All pipe shall be a product of the United States of America. Mill certificate shall be provided as required.
3. All piping shall be clearly marked with material specification.
4. All pipe and material shall comply with the requirements and recommended practices of ASME B31.1 Power Piping Code (latest Edition and Addenda).
5. Elbows shall be long radius ANSI B16.9 unless otherwise specified.
6. Fittings shall be used at all branch connections from headers.
7. Acceptable fittings shall be tees. "Weldolets", "Threadolets", "Mechanical T" and "Sockolets" will also be allowed as specified. Fishmouth or shaped nipples will <u>not</u> be allowed.
8. Provide drains at low points and vents at high points of all piping systems and between pumps and check valves.
9. Steam pipes shall be provided with drip legs and traps at all low points and as otherwise specified.
10. Steam service as specified herein shall include steam trap piping to and including shut-off valve on trap discharge and relief valve discharge.
11. Condensate service shall start at the connection to the main valve where the branch to the steam trap starts.

12. Lubricants used for the installation of grooved couplings shall be approved in writing by the coupling manufacturer.
13. All pipe and fittings with threaded ends shall have IPS threads cut clean and true and in conformance with the ANSI B1.20.1.
14. Threaded pipe and fittings shall be made up with special care to avoid marring or damaging pipe and fitting surfaces.
15. All threaded joints in steel and iron pipe shall be made up with pipe thread compound or other compound suitable for design temperature and pressure of piping. All threaded joints in copper pipe shall be made up with Teflon pipe tape, petroleum gas grade, wound on male threads, clockwise as viewed from end of pipe.
16. Provide high temperature brass, bronze steel or cast ductile iron (as appropriate) dielectric unions or flanges between dissimilar pipe materials to prevent galvanic action, as required. Gaskets shall be suitable for operation up to design temperature of the piping.
17. No joints shall be "backed-off" to align pipe and fittings.
18. Gauge lines shall be stainless steel with compression fittings.
19. Piping for compressed air for controls shall be copper.
20. Use "Never-Freeze" Copper Anti-Seize by Frederickseal or similar on all flange bolts. Torque all bolts to suitable values using torque wrenches.
21. All condensate piping and steam piping in inaccessible shafts, trenches, or tunnels shall be socket weld 2" and below.

2.02 SERVICE PIPE SCHEDULE

Service	**Type**	**Grade**	**Wall**		**Joints (Minimum Sch. Shall match Wall)**		**Test Pressure**
			to 10"	**12" & Up**	**2" and Less**	**2½" & Up**	**PSIG**
Chilled water supply and return	A106 or A53 Seamless or ERW	A or B	Sch.40	Standard 0.375"	Threaded	Butt Welded or Grooved Note 3	225 Note 4
Hot water supply and return	A106 or A53 Seamless or ERW	A or B	Sch.40	Standard 0.375"	Threaded	Butt Welded or Grooved Note 3	225 Note 4
Pumped condensate	A106 or A53 Seamless or ERW	A or B	Sch.80	Extra Strong 0.5"	Threaded	Butt Welded	225
Low pressure steam (0 to 15 psig)	A106 or A53 Seamless or ERW	A or B	Sch.40	Standard 0.375"	Threaded Malleable	Butt Welded	225
Low pressure condensate return	A106 or A53 Seamless or ERW	A or B	Sch.80	Extra Strong 0.5"	Threaded Note 1	Butt Welded	225
Make-up and fill (up to 190°F on grooved)	Hard Drawn Copper	ASTM B88	Type L		95-5 Solder	Silver Brazed or Grooved Note 3	225 Note 4
Miscellaneous atmospheric vents (up to 190°F on grooved)	A53	A or B	Sch.40	Standard 0.375"	Threaded Note 2	Butt Welded or Grooved Note 3	225 (with air)
Miscellaneous drains 2½" & up (up to 190°F on grooved)	A53	A or B	Sch.40	Standard 0.375"		Butt Welded or Grooved Note 2, 3	225

Service	Type	Grade	Wall		Joints (Minimum Sch. Shall match Wall)		Test Pressure
			to 10"	12" & Up	2" and Less	2½" & Up	PSIG
Miscellaneous drains to 2"	Hard Drawn Copper	ASTM B88	Type L		DWV 95-5 Solder		225
Refrigerant system	Hard Drawn Copper	ASTM B280	Type L		Silver Brazed	Silver Brazed	---
Contractor option Chilled water 2” or Less	Hard Drawn Copper	ASTM B280	Type L	None	Silver Brazed		225 Note 4
Contractor option Hot water 2” or Less	Hard Drawn Copper	ASTM B280	Type L	None	Silver Brazed		225 Note 4
Contractor option Condenser water 2” or Less	Hard Drawn Copper	ASTM B280	Type L	None	Silver Brazed		225
Other piping (up to 190°F on grooved)	A106 or A53 Seamless or ERW	A or B	Sch.80	Extra Strong 0.5"	Threaded Malleable	Butt Welded or Grooved Note 3	325

Note 1: In concealed inaccessible location provide socket welded.

Note 2: Outdoor portion of piping shall be painted with a high temperature rust inhibiting primer and two coats of high temperature enamel paint (color shall be black unless otherwise selected by the architect).

Note 3: Grooved piping systems of standard wall or lighter shall be roll grooved according to Victaulic roll groove specification standards. On piping heavier than standard wall, cut grooving required per the manufactures cut groove specification standard. Gasket must be selected for intended service. Grooved piping shall not be utilized within the vertical shafts nor above inaccessible ceilings.

Note 4: At Contractor’s option, the Viega ProPress System may be utilized for 3” and smaller hot water, make-up and chilled water service.

2.03 FITTINGS

A. For Steel Pipe

1. 2 1/2" and Larger, Butt Welded

a. Butt weld, same weight as piping.
b. ANSI A234 WPB
c. ANSI B16.9
d. Branch Connections:

1) Equal to main and to (2) pipe sizes smaller shall be welded tees.
2) Three (3) pipe sizes and smaller than main:

a) 2 1/2" and larger: weldolets or Tee
b) To 2": Thread-O-Lets, sock-o-let or Tee.

2. 2" and Smaller Screwed

   a. Cast Iron: A126 ANSI B16.1, B16.4

      1) 125 lb., wsp
      2) 250 lb., wsp where noted

   b. Malleable Iron: A47, A197, ANSI B16.3

      1) 150 lb., wsp. Galvanized for fill and make-up water galvanized piping.
      2) 150 lb. wsp.
      3) 300 lb. wsp where noted

   c. Carbon Steel: A105, ANSI B16.11
   d. Cast iron drainage: ANSI B16.12
   e. Galvanized for galvanized piping.
   f. Ductile Iron: ASTM A395. Contractor has option to furnish 300 lb. ductile iron in lieu of 250 lb. cast iron or 300 lb. malleable iron.

3. Mechanical Couplings and Fittings: Contractor's option to provide mechanical couplings and fittings in lieu of welded fittings and joints for water service not exceeding 190°F in exposed areas and mechanical rooms or runs above ceiling tile or drop ceiling that provide access.

   a. Mechanical Couplings: Ductile iron, ASTM A536, Grade 65-45-12, for following working pressures with standard wall pipe:

      Note: With the use of these coupling and fittings, the contractor shall include molded insulation similar to Pro-Tec-T-Kotes, Dallas, Texas.

      1) Up To 6" IPS: 700 psi
      2) 8" to 12" IPS: 400 psi
      3) 14" to 24" IPS: 350 psi
      4) 26” to 42” IPS 300 psi

         a) Grooved type or steel shoulder ends.

            (1) Bolts: Oval Neck Track Type, ASTM A449

         b) Gaskets: EPDM, ASTM D2000,

            (1) Similar to Victaulic Grade “EHP” EPDM for 2½” to 8”
            (2) Similar to Victaulic Grade “E” EPDM for 10” and 12”
            (3) Similar to Victaulic Flushseal® Grade "E" EPDM for 14” and larger

         c) Lubricant:

            (1) Suitable for service and submitted for approval with written approval from coupling manufacturer stating it is acceptable and does not affect guarantee.

5) Rigid Type:

a) Up to 12”: Housings cast with offsetting, angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.

(1) 21/2” through 8”

(a) Similar to: Victaulic Style 107.

(2) 10” through 12”

(a) Similar to: Victaulic Style 07.

b) 14” to 24”:

(1) Wide profile housings with lead-in chamfer on key.
(2) Key shall fill the wedge shaped groove to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.
(3) Similar to: Victaulic AGS Style W07.

6) Flexible Type Couplings:

a) Up to 12”: Use in locations where vibration attenuation and stress relief are required.

(1) 21/2” through 8”

(a) Similar to: Victaulic Style 177.

(2) 10” through 12”

(a) Similar to: Victaulic Style 77.

b) 14” to 24”: Wide profile housings with lead-in chamfer on key. Key designed to fit into the AGS groove and allow for linear and angular movement, vibration attenuation, and stress relief. Victaulic AGS Style W77.

7) Flange Adapters:

a) Up to 12”: Flat face, for direct connection to ANSI

(1) Class 150

(a) Similar to: Victaulic Style 741

(2) Class 300

(a) Similar to: Victaulic Style 743

b) 14” to 24”: Flat face, AGS Adapter Nipple, for direct connection to ANSI Class 150 flanged components.

(1) Similar to: Victaulic Style W45.
(2) Similar to: Victaulic Style 741

b. Fittings:

1) Grooved type, ductile iron ASTM A536 as specified for couplings to 12". For 12" to 24", steel ASTM A234, rated 300 psi working pressure.
2) Up to 12”: Grooved type, ductile iron ASTM A536 as specified for couplings; steel ASTM A234; or factory fabricated from carbon steel pipe conforming to ASTM A53; rated working pressure equal to adjoining couplings.
3) 14” to 24”: AGS grooved type, ductile iron ASTM A536 as specified for couplings; steel ASTM A234; or factory fabricated from carbon steel pipe conforming to ASTM A53; rated working pressure equal to adjoining couplings, grooved ends.

c. Bolted Branch Outlet

1) Branch reductions on 2" through 8" header piping. Bolted branch outlets shall be manufactured from ductile iron conforming to ASTM A-536, Grade 65-45-12, with synthetic rubber gasket, and heat treated carbon steel zinc plated bolts and nuts conforming to physical properties of ASTM A-183. Victaulic Style 920 / 920N.

d. Companion Pipe Grooving: As per coupling and fitting manufacturer's recommendations.

1) Grooves shall be applied using approved grooving tools fitted with coordinated roll sets.

e. If any other lubricant or other manufacturers gaskets are used at the site, all gaskets at all joints shall be replaced.
f. No mechanical couplings shall be used in inaccessible location such as above plaster ceilings without access doors.
g. Couplings may be used above ceiling tiles or drop ceilings.
h. If access doors are used at each joint in shafts, door shall clearly access joints.

1) The Mechanical Contractor shall furnish doors, coordinate each location, and obtain written approval for each location from the Architect.

i. All steel elbows shall be long radius or greater.
j. The following **are not** acceptable:

1) Products similar to Victaulic Fit products.
2) Products similar to reducing coupling.
3) Press fit products.

k. Valves shall meet the valve specification and may be grooved.

B. For Copper Tubing

1. Solder Joint: Wrought Copper, ANSI B16.22 or Cast Bronze B16.18.

a. 2" and less

1) Silver brazing alloy.

b. 2½" and larger

1) Silver brazing alloy.

a) For refrigerant piping and where noted: Silver brazing alloy, similar to Handy and Harman Easy-Flo.

2. Compression and Flared Fittings: Cast brass, ANSI B16.26.
3. Grooved Joint Couplings and Fittings 2-1/2” and Larger:

a. Couplings

1) Shall consist of two ASTM A536 ductile iron housing segments cast with offsetting, angle-pattern bolt pads to provide system rigidity, coated with copper-colored alkyd enamel.

b. Gaskets:

1) Shall be pressure-responsive, synthetic rubber EPDM, Rated for 250°F,
2) Similar To Victaulic Grade-EHP EPDM
3) Secured together with plated steel bolts and nuts, ASTM A183 or A449. Couplings shall be manufactured to connect copper tubing sized tube and fittings. Victaulic Style 607.

c. Grooved end fittings

1) Shall be wrought copper conforming to ASTM B75 or B152 per ANSI B16.22, or bronze castings conforming to ASTM B584 per ANSI B16.18. Fittings shall be manufactured to copper tubing sizes with grooves designed to accept Victaulic Style 607 couplings. Flaring of tube and fitting ends to IPS dimensions is not permitted.

C. For Red Brass Pipe: Standard cast bronze, banded, threaded, ANSI B16.15.

2.04 FLANGES

A. For Steel Pipe

1. Welded: Weld neck, ANSI B16.5.

a. 150 lb. Wsp
b. 300 lb. Wsp
c. 400 lb. Wsp

2. Screwed

a. Standard Cast Iron: ANSI B16.1
b. Extra Heavy Cast Iron: ANSI B16.1

3. Match connecting flange class and facing.
4. Grooved Joint Flange Adapters

a. Ductile iron, flat face, for direct connection to ANSI 150 flanges. Victaulic Style 741 or W741.
b. Ductile iron, flat face for direct connection to ANSI Class 300 flanges. Victaulic Style 743.

B. For Copper Tube

1. Grooved Joint Flange Adapters

a. Ductile iron coated with copper-colored alkyd enamel, flat face, for direct connection to ANSI Class 150 flanges. Victaulic Style 641.

2.05 FLANGE GASKETS

A. One-piece ring type 1/16" thick, except as noted.

B. Suitable for temperature, pressure and service of system.

C. Compressed compound fiber type for the following:

1. Low pressure steam and condensate return and pumped discharge.
2. Hot water.
3. Cold water.

D. Spiral wound Type 304 stainless steel with flexible graphite fill for:

1. Medium and High Pressure Steam systems.
2. Condensate systems.

E. For Joints of Dissimilar Metals

1. Isolating gaskets, sleeves, and washers between flanges, bolts and nuts.
2. Gaskets, similar to DuPont Teflon.

2.06 UNIONS

A. For Steel Pipe

1. Malleable iron 300 lb. wsp

a. Ground Jacket Seat: Brass-to-iron, black or galvanized to match piping.

2. Forged steel, 2000, 3000 lb. WOG class, bronze-to-steel or steel-to-steel seats, where noted or required for service.

3. Unions are not required on installations using grooved connections. The couplings shall serve as unions.

B. For Red Brass Pipe

1. All bronze, 150 lb. wsp, ground joint seat.

PART 3 INSTALLATION

3.01 PIPING INSTALLATION

A. General

1. Provide all piping systems as shown on the drawings and otherwise required to make a complete, workable and neat job, installing all valves, appurtenances, grooved joint couplings, unions and gaskets.
2. The Contractor shall use care arranging all piping as shown on the drawings and shall carefully examine the arrangements where offsets are indicated and shall follow details as shown.
3. All piping shall be run to true alignment generally parallel or perpendicular to adjacent building walls, floors and ceilings and with uniform grades and spacing so as to present a neat and workmanlike appearance.
4. Care shall be paid to the exact locations for all piping and equipment with respect to equipment, ducts, conduits, slabs, beams and lighting fixtures, so as to provide maximum access to all mechanical and electrical equipment in the buildings.
5. Close coordination and cooperation shall be exercised with other Trades in locating the piping and equipment in the best interests of the Owner.
6. The drawings and specifications covering other work to be done in the buildings shall be carefully studied and arrangements made to avoid conflict.
7. The drawings shall be followed where they are definite and provided such procedure causes no objectionable conditions or does not conflict with other Trades, Laws, Regulations or recommendations of equipment manufacturers.
8. The drawings are intended to indicate the sizes of piping connections and if certain sizes are omitted, or unclear, obtain additional information before proceeding.
9. The minimum pipe size shall be 3/4” with the exception of a few areas that are specifically documented to be smaller.
10. Rough in for all equipment requiring connections to the Mechanical work. Obtain all necessary data on exact locations, sizes, connections, fittings and arrangements and exact routings as may be required for proper installation.
11. Bushings shall not be used for reducers. Reducing fittings shall be used for all changes in pipe size and shall be as follows:

    a. Horizontal water piping: Eccentric flat on top for venting.
    b. Horizontal steam and condensate piping: Eccentric flat on bottom for drainage.
    c. Vertical water or steam: Concentric.

12. Unions, grooved joint couplings or flanges shall be provided in conjunction with all equipment, coils, control valves and specialties in all pipe lines and at all points necessary to provide reasonable access to the piping systems.
13. Ends of all pipes shall be reamed clean and all pipes shall be straightened before erection and measures shall be taken to preserve this cleanliness after erection.
14. Support piping independently at all equipment so that the equipment is not stressed by piping weight or expansion.

15. Arrange piping for maximum accessibility for maintenance and repair, locate valves for easy access and operation.
16. Provide dielectric unions, waterway fittings or flanges between dissimilar pipe materials to prevent galvanic action as required.
17. Provide proper provision for expansion and contraction in all portions of pipe work, to prevent undue strains on piping or apparatus connected.
18. Provide double swings at riser transfers and other offsets to take up expansion. Arrange riser branches to take up motion of riser.
19. Branch runouts to equipment shall have a minimum of (3) elbows, adequately spaced.
20. Copper tubing and galvanized steel shall not be mixed in any one run of piping, except as otherwise specified herein.
21. During construction, temporarily close open ends of pipes with sheet metal caps or duct tape to prevent debris from entering piping systems.
22. Provide extra heavy pipe for nipples where unthreaded portion of pipe is less than 1 1/2" long.
23. Use of close nipples is not permitted.

B. Joints in piping systems

1. For all services, shall be made tight and leakproof against test pressures.
2. Leaks in screwed or flanged joints which cannot be eliminated by normal wrench tightening methods shall be repaired at the joint.
3. Under no circumstances shall caulking be allowed.
4. No joints shall be backed off to align pipe fittings.

C. All piping connections to equipment shall be:

1. Made with offsets.
2. Provided with unions, grooved joint couplings and/or flanges so arranged that the equipment can be serviced or removed without dismantling the piping.
3. If equipment, becomes air bound or stratified:

    a. All necessary modifications to the piping system required to rectify the condition permanently shall be made to piping and equipment, furring, floors, walls, etc., at the Contractor's expense.

D. Pipe pitch, unless otherwise indicated on the drawings, shall be as follows:

1. Steam and condensate: 1" in 40'-0", down in direction of flow.
2. Steam riser branches and undripped connections: 1” in 10’-0”, up in direction of steam flow.

    a. Up to 1" pipe: 1" in 40'-0", up in direction of flow.
    b. 1 1/4" larger: 1" in 100'-0", up in direction of flow.

3. Condensation Drainage:

    a. Preferred: 1/4 in./ft., down in direction of flow.
    b. Minimum: 1/8 in./ft., down in direction of flow.

E. Drain connections at low points in water piping and where noted:

1. In equipment rooms:

a. To 3" pipe: 3/4" ball valve.
b. 4" to 8": 1 1/2" ball valve.
c. 10" and larger: 2 1/2" ball valve.

2. Other areas:

a. 1/2" ball valve with pressure rated capped hose connection unless clearly documented to be larger such as strainer assemblies.

F. Manual air vents at high points and where required to expel air:

1. To 3" pipe: line size air chamber, 12" long, 1/2" ball valve.
2. 4" to 8": line size air chamber, 6" long, 1/2" ball valve.
3. 10" and larger: line size pipe cap, 1/2" ball valve.

G. Copper tubing and galvanized steel shall not be mixed in any one run of piping, except as otherwise specified herein.

H. During construction, temporarily close open ends of pipes with sheet metal caps or duct tape to prevent debris from entering piping systems.

I. Steam

1. At low points of steam lines provide traps adequately sized to collect condensate.
2. All supply mains shall be dripped and trapped on any vertical lift.
3. Provide capped full sized dirt pockets at all traps, riser heels, and wherever dirt and scale may accumulate.
4. To meet job conditions, mains shall be set up (with drip connections to return line) to maintain headroom and clear other pipes as hereinbefore specified. System is to be arranged to secure venting of air to the return line at all low points in steam mains, without permitting ingress of air.
5. All apparatus subject to high temperature differentials and high steam demand loads such as steam-water heat exchangers shall have vacuum breakers installed.
6. Where condensate piping, to meet job conditions, may have to set down under stoops, doors, etc., and again rise after passing these, the sets shall be made with 45° fittings and with Y-laterals at each end, with brass plugs to permit easy cleaning of trapped portions of pipe.
7. At any points where return mains have to rise again, after being depressed, provide overhead "air lines" (not smaller than 1" in size) and connect the (2) high sides.
8. Any turns in water sealed lines shall be made with crosses, with brass plugs in unused outlets to facilitate cleaning.

J. Grooved joints

1. Shall be installed in accordance with the manufacturer's latest installation instructions.

    a. When a torque is stamped on the joint or listed in the installation instructions for that type of joint. The joint shall be tightened to that minimum torque with a torque wrench.
    b. A torque wrench shall be available to test any such joint at the Engineer's request.

2. All fittings and joints shall be of the same Manufacture.
3. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
4. Gaskets shall be verified as suitable for the intended service prior to installation.
5. Gaskets shall be molded and produced by the coupling manufacturer.
6. Gaskets lubricant shall be produced by the coupling manufacturer.
7. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products.
8. The manufacturer's representative shall periodically visit the jobsite and review installation.
9. Contractor shall remove and replace any joints deemed improperly installed.

K. Refrigerant Piping and Connections

1. Provide all refrigeration piping, including thermal expansion valves, driers, moisture indicator sight glasses, shutoff valves, controls, gauges, insulation and other appurtenances, as required to complete the refrigeration system.
2. Piping connections to the units shall be fitted with flexible pipe fittings and renewable unions.
3. The HVAC Contractor shall triple evacuate and field charge entire refrigeration system.
4. All labor and materials required for evacuation, charging, as well as commissioning of the refrigerant systems, shall be provided by the HVAC Contractor.
5. The refrigerant piping arrangement shall be in strict accordance with manufacturer's recommendations.
6. Provide shop drawings indicating sizes and all required components and accessories for Architect's review prior to ordering equipment or installation.
7. All refrigerant piping exposed to weather outside the building shall be properly supported in a manner to allow expansion and contraction.
8. All sleepers provided shall be secured and their installation shall be as directed and approved by the Architect.
9. Refrigerant piping joints:

    a. Shall be made with cadmium free 45% silver brazing filler metal having a melting point of 1225°F.
    b. Joint flux, if used, shall be compatible with materials.
    c. The outside surface at end of pipe and inside surface of fittings shall be thoroughly cleaned with steel wool or emery cloth, and cut pipe ends shall be reamed and all burrs shall be removed.
    d. Care shall be taken to ensure the entry of foreign particles into the system does not occur.
    e. While brazing, purge piping with low pressure nitrogen to prevent interior oxidation and to dry the system.

f. Caution must be taken to continuously ventilate the work area and to avoid allowing nitrogen to concentrate in an enclosed area thereby expelling all of the oxygen and causing asphyxiation.

10. Traps shall be factory fabricated one-piece fittings or field assembled 45°-90°-45° elbows. Do not use 90°-90°-90° elbows.

3.02 WELDING

A. All welding done under this Contract:

1. Shall be performed by experienced welders in a neat and workmanlike manner.
2. All welding done shall be in accordance with ASME B31.1 Power Piping Code for High Temperature Systems (HPS/MPS) and ASME B31.9 Building Service Piping for all other HVAC Piping (LPS and steam condensate, chilled water, condenser water, hot water) (latest Edition and Addenda).
3. The Contractor shall furnish to the Owner for approval and record the following:

a. Welding Procedure Specifications (WPS) for each procedure to be used
b. Procedure Qualification Record (PQR)
c. Welding Operator Qualification Tests (WPQ) for each welder to be employed.

4. Welders

a. Documents shall be on forms similar to the forms referenced in the ASME Boiler & Pressure Vessel Code, Section IX, latest edition.
b. These records shall be furnished to the Owner for this project not less than (2) weeks, prior to any welding.
c. All welders to be employed by the Contractor on this work shall be certified in accordance with the above.
d. The Mechanical Contractor shall test welders to these procedures within (3) months of the work beginning to certify them for this work.
e. The above forms shall be clearly marked specifically for the Contractor's use and certified by the appropriate personnel.
f. Documents prepared for other's use are not allowed.
g. Failure to provide these forms to the satisfaction of the Owner, or his representative, will result in the replacement of the Mechanical Contractor with one who can meet these requirements, at no additional cost to the Owner.
h. No delays or cost increases to the overall project schedule will be accepted due to non-compliance with the above by the Mechanical Contractor.

B. Mitered elbows are not permitted. Odd angle elbows shall be cut from long radius elbows.

C. The weld reinforcement shall be not less than 1/16" nor more than 1/8" above the normal surface of the joined sections.

D. The reinforcement shall be crowned at the center and shall taper on each side to the surface being joined.

E. The exposed surface of the weld shall present a workmanlike appearance and shall be free of depressions below the surface of the joined members.

F. No welding of any kind shall be done when the temperature of the base metal is lower than 50°F.

G. Material to be welded during freezing temperatures shall be made warm and dry before welding is started.

H. Temperature of metal shall be "warm to the hand", or approximately 60°F.

I. Inspection:

1. Welds will be inspected visually by supervisory representatives of the Architect and the Contractor.
2. Any weld judged defective by the Architect from a visual inspection shall be cut out and tested in the presence of the Owner or his representative. In the event any welder consistently produces a high percentage of unsatisfactory production welds, he shall be discharged at the request of the Owner, even though he is able to produce satisfactory welds when especially tested.
3. Removal and replacement of test coupons and samplings shall be done at the expense of the Contractor.
4. The Owner reserves the right to ultrasonically or radio-graphically test any welds for full penetration.

J. Paint all external surfaces of welds with a high temperature paint prior to insulation being applied.

K. Store all 7018 electrodes in rod oven once original container is opened.

L. Welds in all high pressure steam and high temperature hot water (350°F or greater)

1. Shall be X-ray tested.
2. This X-ray shall be performed by an independent testing company.
3. Testing company shall employ certified weld inspectors.
4. The welds shall meet the X-ray requirements in ANSI B31.1.
5. The independent inspection services shall be provided by the Mechanical Contractor.

3.03 CLEANING AND BLOWING OUT

A. The equipment and piping installed under this Section shall be blown out under pressure and cleaned of foreign matter

1. Provide temporary connections where necessary
2. All cleaning shall be complete before the system is placed in service.
3. Precautions shall be used to prevent foreign matter from getting into equipment and piping during construction.
4. The supplier of water treatment equipment and chemicals shall recommend and furnish chemicals for the purpose of cleaning and blowing out of all systems.
5. All chemicals, materials, instruments and labor shall be provided by the Contractor.

B. The surfaces of all equipment and piping shall be clean upon completion of the work.

C. All pipe line strainers shall be cleaned immediately before being turned over to the Owner for acceptance.

D. During cleaning process, hammer welds to remove scale, weld slag and other debris.

3.04 TESTING

A. Furnish all labor, material, instruments, supplies and services and bear all costs for the accomplishment of the tests herein specified.

B. Correct all defects appearing under test and repeat the tests until no defects are disclosed; leave the equipment clean and ready for use.

C. Perform all tests other than herein specified which may be required by Legal Authorities or by Agencies to whose requirements this work is to conform.

D. Furnish all necessary testing apparatus, make all temporary connections and perform all testing operations required, at no additional cost to the Owner.

E. All equipment and piping installed under this Contract shall be tested and found tight. Insulated or otherwise concealed piping shall be tested before being closed in. All leaking joints shall be corrected, retested and found tight.

F. Tests shall conform to the requirements of Local Codes but shall not be less than the equivalent of the tests called for herein.

G. Threaded joints that leak shall not be seal-welded to correct leakage.

H. Tests performed shall not relieve the Contractor of his responsibility for leaks which may develop after the tests are made.

I. All piping systems shall be subjected to a hydrostatic test at the scheduled test pressure for a period of (4) hours without drop in pressure.

J. All oil piping shall be subject to a test with oil at 225 PSIG for a period of (4) hours without drop in pressure.

K. Tests of piping systems shall be conducted before connections to equipment are made and before piping is covered, buried or otherwise concealed.

L. Systems found to have leaks shall be subjected to further tests when faulty joints have been repaired or replaced.

M. Welded joints shall be subjected to a hammer test while under pressure.

END OF SECTION

SECTION 232123

HVAC HYDRONIC PUMPS AND ACCESSORIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all pumps for all systems which are part of the building HVAC systems. This shall include all accessories specified in this Division and as shown on the drawings.

B. All pumps shall be new and manufactured for the specific purpose of circulating chemically treated water to the building HVAC systems.

C. All pumps, circulators and system components shall be installed in accordance with state and local codes.

D. Secure all permits and local/state approval for the components as specified and included under this Section.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. NEMA MG1 – Motors and Generators; National Electrical Manufacturers Association.
2. NEMA OS1 – Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports; National Electrical Manufacturers Association; 1989.
3. NFPA 70 – National Electrical Code.
4. UL 778 – Standard for Motor-Operated Water Pumps.
5. ASME – Section VIII, Unfired Pressure Vessels.

C. Reference Standards

1. AFBMA: Anti-Friction Bearing Manufacturers Association.

   a. 1-84 - Terminology for Anti-Friction Ball and Roller Bearings and Parts.
   b. 9-84 - Load Ratings and Fatigue Life for Ball Bearings.
   c. 11-78 -Load Ratings and Fatigue Life for Roller Bearings.

d. 20-77 -Metric Ball and Roller Bearings Conforming to Basic Boundary Plans.

2. ASTM: American Society for Testing and Materials.

a. A 48-Gray Iron Castings.
b. B 62-Standard Specification for Composition Bronze or Ounce Metal Castings.
c. B 584-Standard Specification for Copper Alloy Sand Castings for General Applications.

3. HI: Hydraulics Institute.

a. Hydraulic Institute Standards.

4. ANSI B15.1
5. OSHA: Occupational Safety and Health Administration, U.S. Department of Labor.

1.05 SYSTEM DESCRIPTION

A. Provide base mounted, horizontal axial split-case, or vertical mounted split-case, double-suction, single-stage centrifugal pumps, or base mounted, single-stage end suction radial pumps, as shown on the drawings. Capacity, RPM, head and electrical motor characteristics shall be as scheduled on the drawings.

1.06 SUBMITTALS

A. See Section 230500 and General Conditions for additional information.

B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics, connection requirements and all dimensional data including operating weights.

C. Manufacturer's Installation Instructions: Indicate hanging and/or support requirements and recommendations.

D. Millwright's Certificate: Certify that base mounted pumps have been aligned.

E. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions and replacement parts list.

F. In addition to items specified elsewhere provide:

1. Large scale certified pump curves indicating operating points.
2. Detailed motor data.
3. Detailed coupling data
4. Detailed seal data.
5. All pump construction data.
6. Detailed bearing data.
7. Base details
8. Dimensioned pump and motor drawing.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing, assembly and field performance of pumps, with minimum three (3) years of documented experience.

B. Alignment: Base mounted pumps shall be aligned by qualified millwright.

1.08 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by UL 778 testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

B. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.09 DELIVERY, STORAGE AND HANDLING

A. All pumps shall be delivered in containers and shall be kept in a dry and protected area.

B. All pumps shall be given 2 coats of rust-resistant paint at the factory prior to installation.

1.10 ENVIRONMENTAL

A. Do not paint or install pumps when environmental conditions are outside the specific limitations of the referenced codes and manufacturer's recommendations.

PART 2 PRODUCTS

2.01 MANUFACTURERS ACCEPTABLE FOR PRODUCT TYPES INDICATED CONTINGENT UPON PRODUCTS' COMPLIANCE WITH THE SPECIFICATIONS

A. Base mounted pumps:

1. Bell and Gossett.
2. Aurora Pump Division.
3. Peerless Pump.
4. Weinman.
5. PACO
6. Taco

B. In-line circulators:

1. Bell and Gossett.
2. Aurora Pump Division.
3. Thrush Products, Inc.
4. Weinman
5. Armstrong
6. Taco

C. Expansion Tanks

1. Bell and Gossett
2. Amtrol
3. Wessel
4. Armstrong
5. Taco

D. Air Separators

1. Bell and Gossett
2. Amtrol
3. Spirotherm
4. Wessel
5. Taco

2.02 PUMPS GENERAL

A. Statically and dynamically balance rotating parts.

B. Construction shall permit complete servicing without breaking pipe or motor connections.

C. Pumps to operate at 1750 rpm unless scheduled or specified otherwise.

D. Pumps of the same type shall be from one pump manufacturer.

E. Motors shall be in accordance with Section Motors, unless otherwise specified.

F. Provide guards around shafts and couplings in accordance with OSHA and ANSI recommendations.

G. All parts shall be suitable for variable frequency drives; including but not limited to motor, pump, all pump components, coupling, and base.

H. Design and performance requirements:

1. Scheduled design flow, design head, pump efficiency, and motor horsepower are minimum acceptable.
2. Scheduled design brake horsepower and speed are maximum acceptable.
3. Pump curve shall rise continuously from maximum flow to cut off.
4. Shut-off head shall be approximately 20 percent greater than design head, unless otherwise indicated in pump schedules.
5. Pump brake horsepower not to exceed motor horsepower rating over entire operating range (from shut-off to run-out). Motor shall not operate in service factor
6. Suitable for parallel operation.
7. Pumps shall operate within the preferred operation region as defined by the Hydraulics Institute.
8. Select pump for operation at or near peak efficiency.
9. Cavitation-free at all points on curve.
10. Impeller diameter shall not exceed 90 percent of the maximum cutwater diameter.
11. Vibration levels of pump shall be within the vibration limits established by hydraulic institute.

2.03 BASE MOUNTED PUMPS

A. Type: Centrifugal, single or multi-stage where noted, base mounted flexible coupled, single or double suction as noted.

1. Casing:

a. Casing shall be constructed of cast iron ASTM A 48 Class 30A or better.
b. Casing shall be rated for 1.25 times the scheduled working pressure with a minimum rating of 150 psig.
c. Cast iron castings shall be sound and free of shrink holes, blow holes, cracks, scale, blisters and other defects.
d. Casing shall have flanged suction and discharge per ANSI B16.1 for sizes 2-1/2 inch and larger. Smaller sizes shall be threaded connections.
e. Casing shall have a tapped and threaded plug for an air vent.
f. Casing shall be provided with a threaded drain plug at the lowest point.
g. Casing shall be provided with a seal flush connection.
h. Casing wearing rings shall be replaceable and constructed of bronze ASTM B 584 or ASTM B 62.
i. Casing shall be base supported.
j. Casing shall be vertically or horizontally split as indicated.

2. Impeller:

a. Impeller shall be constructed of one piece bronze ASTM B 584 or ASTM B 62.
b. Fully enclosed design.
c. Impeller shall be keyed to the shaft and secured with a stainless steel, 300 series washer and bolt. Bolt to tighten in direction opposite rotation of impeller.
d. Dynamically balanced for smooth, low vibration operation over the operating range from shut-off to run out.
e. Impeller shall be provided with replaceable wear rings.

3. Shaft:

a. Shaft shall be solid stainless steel AISI 316 turned, ground and polished and ring gauged for accuracy.
b. Shafts shall be polished to a minimum 16 microinch finish.
c. Shaft deflection shall not exceed 0.002 inches in the round.

4. Shaft sleeve:

a. Design such that there is no contact between the pump shaft and the pumped liquid.
b. Shaft sleeve shall be stainless steel, AISI 316.
c. Provide O-ring or gasket to prevent leakage of pumped liquid.

5. Shaft seals:

a. Mechanical type.

1) Stainless steel hardware and spring.
2) EPT rings, carbon rotating face against a tungsten carbide nickel binder seat.

3) Seals shall be balanced type for all pumps with 100 psig or greater suction pressure.
4) API 610 seal number: USTFM. Similar to John Crane Type 1 or 2 material code **$0_{(28)}$-$P_{(66)}$-1- $0_{(15)}$-1**.
5) Provide a bypass line from the discharge side of the pump casing to the seal faces. Design to ensure adequate flushing and proper lubrication.

b. Provide Doxie or equal cyclone separator on seal flushing lines on all pumps with a head of 25 PSIG or greater.

6. Bearings:

a. Grease lubricated ball bearings.
b. L-10 life minimum 100,000 hours.

7. Motor:

a. Refer to Section 230513 – Motors and Controllers for requirements.

8. Drive coupling:

a. Flexible coupling with OSHA and ANSI type coupling guard.
b. Suitable for variable speed drive.
c. Suitable for system duty, fluid, and service temperature.

9. Similar to T.B. Woods (the coupling service factor shall not be less then 2).

a. Base:

1) Cast iron or fabricated steel base with drip rim and tapped NPT connection for drain.
2) Common base for pump and motor.

10. Painting:

a. Pump components shall be thoroughly degreased, deburred and sandblasted as required before the application of any primers or paint.
b. Prime coat components before assembly; finish coat after assembly.

11. Nameplate:

a. Provide pump with a nameplate constructed of 18-8 stainless steel securely fastened to pump casing by stainless steel pins.
b. Locate nameplate for easy visibility.

12. The rating conditions and other data below, as a minimum, shall be clearly stamped on the nameplate.

a. Manufacturer, address, telephone number.
b. Pump model number.
c. Pump serial number.
d. Size (including impeller diameter scheduled in inches).
e. Type.

f. Equipment designation as listed on the pump schedule.
g. Flow scheduled (gallons per minute).
h. Dynamic head scheduled (feet of water).
i. Efficiency (percent).
j. Shut-off head (feet of water).
k. Speed (RPM).

2.04 IN-LINE CIRCULATOR

A. Casing: Bronze cast iron rated for 125 psi working pressure.

B. Impeller: Bronze.

C. Shaft: Hardened alloy steel with integral thrust collar and oil lubricated bronze sleeve bearings.

D. Seal: Carbon rotating against a stationary ceramic seat.

E. Provide additional pipe supports to support weight of pump, motor, fittings and accessories.

2.05 EXPANSION AND COMPRESSIONS TANKS

A. Provide expansion and compression tanks, air separator and other pump hydronic accessories, as shown and as scheduled on the drawings.

B. Tanks shall be the pressurized captive air bladder type.

C. Provide replaceable elastomeric bladder suitable for a maximum operating temperature of 240°F

D. Provide integral steel base ring for vertical mounting.

E. Tanks shall be constructed and certified to ASME Section VIII

1. Pressure rating150 psig
2. Temperature of 240°F

F. Provided with charging valve enclosure, remote air connector coupling, system connection and lifting rings.

G. Tanks shall be provided with factory applied rustproof coat of paint to the exterior of tanks.

2.06 AIR SEPARATORS

A. Provide air separator with flanged inlet and outlet connections.

1. Provided with drain connection with valve.
2. Shall be tangential type.
3. Bottom blow down.
4. Full size removable strainer.

B. Pressure drop shaft be 1 foot of water and maximum velocity shall be 4 fps.

2.07 MAKEUP AND RELIEF VALVES

A. See Specification Section 230519.20.

PART 3 EXECUTION

3.01 PUMP INSTALLATION

A. Pumps shall be installed so as to ensure easy accessibility for service or removal and replacement of all components such as, but not limited to, impellers, motors, drive couplings, bearings, strainers, other pump appurtenances and isolators.

B. The Contractor shall receive and inspect all pumps and motors to ensure they are received without defect.

C. All defective or damaged pumps shall be returned to the manufacturer by the Contractor for replacement.

D. The Contractor shall properly protect all equipment to prevent damage from water, dirt, etc. Protection shall include temporary plastic wrap to keep equipment in original factory condition.

E. Set pump on concrete base, anchor, level and grout according to manufacturer's instructions. Where specified or where indicated in the equipment schedule on the mechanical drawings provide vibration isolators under pump base.

F. Provide line sized shutoff valve and strainer on suction and line sized silent check valve and flow control balancing valve on discharge unless otherwise noted on mechanical drawings.

G. Decrease from line size, with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and over.

H. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation and operate within 25 percent of midpoint of published maximum efficiency curve.

I. Refer to pump detail on mechanical drawings for other accessories to be provided.

J. Provide drains for bases and stuffing boxes piped to and discharging over floor drain. Provide air cock and drain connection on horizontal pump casings.

K. Manufacturer representative shall check, laser align, and certify base mounted pumps 25 motor horsepower and over, before start-up. Pump and drive shall be aligned in accordance with Hydraulic Institute Standards.

L. Pumps shall be installed so as to ensure easy accessibility for service or removal and replacement of all components such as, but not limited to, impellers, motors, drive couplings, bearings, strainers, other pump appurtenances, isolators, and flex connections.

M. The Contractor shall receive and inspect all pumps and motors to ensure they are received without defect. All defective or damaged pumps shall be replaced.

N. The Contractor shall properly protect all equipment to prevent damage from water, dirt, etc.

3.02 EXPANSION TANK

A. Provide where indicated in the drawings.

B. Install in accordance with manufacturer's installation instructions.

C. Change with air to the specified pressure prior to the system fill.

3.03 AIR SEPARATOR

A. Provide where indicated on the drawings.

B. Install in accordance with manufacturer's instructions.

END OF SECTION

SECTION 232223

STEAM AND CONDENSATE SPECIALTIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all steam and condensate specialties and equipment to make complete and operations systems.

B. All systems shall be installed in accordance with local code including vent piping and relief discharge termination points.

C. Secure all permits and local/state approvals for the installation of all components included under this Section.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ANSI: American National Standards Institute
2. A13.1: Scheme for Identification of Piping Systems
3. B16.1: Cast Iron Pipe Flanges and Flanged Fittings
4. B16.3: Malleable Iron Threaded Fittings
5. B16.4: Cast Iron Threaded Fittings
6. B31.1: Power Piping
7. B36.10: Welded and Seamless Wrought Steel Pipe
8. ASTM: American Society for Testing and Materials

    a. A 234/A23AM: Pipe Fittings of Wrought Carbon Steel and Alloy / Rev A: Steel for Moderate and Elevated Temperature
    b. A 395 – Standard Specification for Ferric Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
    c. F 36: Compressibility and Recovery of Gasket Materials
    d. F 37: Sealability of Gasket Material
    e. ASME

f. ASME (BPV IX) – Boiler and Pressure Vessel Code, Section IX – Welding and Brazing Qualification
g. ASME B16.3 – Malleable Iron Threaded Fittings Class 150 and 300
h. ASME B16.18 – Cast Copper Alloy Solder Joint Pressure Fittings
i. ASME B16.22 – Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
j. ASME B31.1 – Code for Power Piping
k. ASME B31.9 – Building Services Piping; (with Addenda)

1.05 DESCRIPTION

A. All specialties shall be a product of the United States of America. Mill certificate shall be provided as required.

1.06 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

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

C. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.07 QUALITY ASSURANCE

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

1.08 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 code for installation of steam and condensate piping systems including specialties.

B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

1.09 DELIVERY, STORAGE AND HANDLING

A. Provide temporary end caps and closures piping and fittings. Maintain in place until installation.

B. Protect piping systems and specialties from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.10 ENVIRONMENTAL

A. Do not install piping when environmental conditions are outside the specific limitations of the referenced codes and manufacturer's recommendations.

PART 2 PRODUCTS

2.01 STEAM TRAPS

A. Acceptable manufactures subject to compliance with the specifications:

1. Armstrong
2. Sarco
3. Velan
4. Strong

B. Provide steam traps at all low points of the low pressure steam systems, at equipment and as shown on the drawings and required by job conditions. Steam traps used for equipment using low pressure steam (LPS) shall be the closed float and thermostatic type.

C. Float and thermostatic type traps shall have cast iron body, ASTM A278, Class 30. Pipe connections shall be in the body and the entire trap mechanism attached to the cap. Float and mechanism shall be stainless steel with heat treated chrome steel valve. The float shall be Heliarc welded to avoid introduction of dissimilar metals. The thermostatic air vent shall be a balanced pressure phosphor bronze disc diaphragm type with stainless steel valve and seat.

D. Traps shall be sized by SHEMA ratings with applicable safety factor applied. See execution section.

E. The HVAC Contractor shall submit orifice size/capacity characteristic for each trap furnished, dimensional and sectional drawings, and list of materials of construction.

F. A suitable strainer with blow-off valve shall be installed ahead of each steam or drain trap.

G. Monovalve float and thermostatic traps shall have a built-in strainer and check valve, stainless steel float, trim and pivots, cast iron body and stainless steel highly sensitive, bi-metal element with stellited seat made of hard stainless steel with mirror finish and ball bearing precision.

H. Drip points shall be provided at the ends of mains and at points where a rise in elevation is required, whether such traps are shown on the drawings or not, to suit the job installation conditions. Provide a dirt pocket of suitable size and length as detailed on the drawings fit with a cap. Drip traps shall be 3/4" size unless otherwise indicated.

I. The Contractor, in addition to all traps shown or called for by notes on the drawings and specified herein, shall provide ten (10) 1" (one inch) size additional trap assemblies for each pressure category included in his base bid price, to be installed in areas as directed by the Architect in the field. This price shall include all valving and accessories detailed on the drawings, as well as 20 linear feet of 1" pipe, thermal insulation and the labor and material to make connections to condensate mains.

2.02 CONDENSATE PUMP SETS (ELECTRIC)

A. Acceptable manufactures subject to compliance with the specifications:

1. Flotronics
2. Shipco
3. Skidmore
4. Domestic

B. Furnish and install according to details and schedule on the drawings and manufacturer's instructions, duplex condensate pump sets.

C. All controls for the pump operation shall be prewired and unit shall need a single electrical connection to be fully operational.

D. Unit shall consist of cast iron receiver, inlet strainer, (2) pumps (maximum 2'-0" NPSH each), float switches, electrical controls and accessories, as follows:

1. Receiver shall be manufactured of close grained cast iron. The receiver shall be equipped with externally adjustable 2-pole float switch, water level gauge and eye bolts. Pressure gauges shall be provided in the field by the Contractor.
2. A cast iron inlet strainer with vertical self-cleaning bronze screen and large dirt pocket and (1) dial thermometer with well shall be mounted on the receiver. The screen shall be easily removable for cleaning, requiring no additional floor space for servicing.

3. The centrifugal condensate pumps shall be flanged mounted on the receiver. Provide bronze isolation valves between each pump and the receiver. The isolation valves shall be of the design that allows the entire pump and motor assembly to be removed for service, including the lower half of the pump case for wear ring replacement without draining the receiver. Pumps shall be close coupled vertical design, permanently aligned, bronze fitted and shall be equipped with stainless steel shaft, enclosed bronze impeller, renewable bronze case ring and mechanical shaft seal. Each pump shall be close coupled to a vertical dripproof motor. Pump capacities, motor HP and RPM, electrical characteristics and receiver size shall be as scheduled on the drawings. The unit manufacturer shall furnish, mount on the pump unit and wire a NEMA 4X control cabinet with piano hinged door and grounding lug, containing the following:

E. Disconnect switch and cover interlock to ensure complete electrical deactivation of the entire condensate handling system.

F. Magnetic starters (each having [3] overload relays) with fused line protection for each pump. Magnetic starters shall be designed to NEMA Standards and shall be as manufactured by General Electric, Westinghouse or Square D.

G. (2) Auto-Off-Test (A-O-T) selector switches.

H. Control circuit transformer having fused and grounded secondary when motor voltage exceeds 120V.

I. Numbered terminal strip.

J. Pump running lights.

K. Hour meters.

L. High level alarm and switch with auxiliary contacts for tie-in to BMS.

M. Condensate return system controls shall be provided by the unit manufacturer, as follows:

1. When the level in the unit receiver rises to a preset high level, a mechanical alternator shall be provided to alternately activate the condensate pumps when the H-O-A selector switch is placed in the automatic position.

2. When the pump has discharged the water and the condensate level in the receiver recedes to a preset low level the alternator will deactivate and stop the pump.
3. If the condensate level in the receiver should continue to rise, with the lead pump running, to a second high level, the alternator will activate the second pump and will continue to operate both pumps until the water level recedes to the preset low level at which point the pumps will be deactivated.
4. The operation of each pump may be tested by moving the A-O-T selector switch to "test". When test is complete the selector switch shall be placed in "automatic" position.

N. Unit shall have factory installed wiring which shall be numbered for easy identification and the numbers shall coincide with those shown on the wiring diagrams.

O. The unit shall be factory tested as a complete unit. The pump manufacturer shall furnish complete elementary and connection wiring diagrams, piping diagrams, installation and operation instructions.

2.03 FLASH TANKS

A. Acceptable manufactures subject to compliance with the specifications:

1. Modern welding.
2. Armstrong
3. Wessel

B. Provide flash tanks as indicated on the drawings. Each tank shall be ASME rated. All seams shall be continuously welded.

C. The minimum ASME rating shall be 125 PSIG unless scheduled greater.

D. The minimum vent size shall be 6”.

E. Tanks shall have (1) shop and (1) field coat of iron oxide primer. Provide tappings and supports as required and shown on the drawings. Tank shall have minimum 1/4" thick walls and shall be fully insulated.

F. Provide trap arrangement, relief valve and vent (pipe to atmosphere) and connections to low pressure steam, as shown on the drawings.

2.04 STEAM SEPARATOR

A. Acceptable manufactures subject to compliance with the specifications:

1. Spence
2. Wright Austin
3. Penn Separator Corp.
4. Sarco
5. Boylston Steam Specialty Co.

B. Pressure rating ANSI class to match the service.

C. Provided with drip assembly.

D. Unit shall be a minimum of 99.0% efficient removing particulate and liquid 10 microns or larger in size.

PART 3 EXECUTION

3.01 GENERAL

A. Install in accordance with manufacturers recommendations.

B. Install in accordance with all applicable codes.

3.02 STEAM TRAPS

A. General

1. Provide drip trap assemblies as follows:

a. Steam piping

1) Maximum of 75 feet intervals.
2) At rising points in piping
3) At the bottom of all vertical pipes.
4) At all steam entrance points at building wall.

B. Traps

1. Provide dirt pockets at all traps.

a. Dirt pockets shall be a minimum of 12 inches long.

2. Provide union on both sides.
3. Provide inlet with strainer
4. Provide discharge check valve.
5. Provide discharge shut off valve.
6. Locate traps.

a. So all traps can be accessed for replacement and maintenance.
b. At steam equipment.
c. Verify size, number, and locations.
d. Locate so as not to be subject to freezing.
e. For domestic hot water heaters coordinate with plumbing and install temperature regulators provided by plumbing.

7. Connect to the appropriate condensate return system.

C. Sizing

STEAM TRAP SIZING					
SYSTEM	**SERVICE**	**QUANTITY**	**TYPE**	**SAFETY FACTOR (EA. Trap)**	**MAXIMUM PRESSURE DROP**
LPS	Modulating Equipment	1	F&T	300%	1 psi
LPS	Convection Heating	1	F&T	200%	1 psi
LPS	End of main drips	1	F&T	300%	1 psi
LPS	Drips on Main to 6"	1	F&T	300%	1 psi
LPS	Drips on Main 8" & up	2	F&T	300%	1 psi

1. Minimum trap size shall be ¾”.

3.03 FLASH TANKS

A. Provide as indicated and as required by field installation.

B. Provide a minimum of 6” vent unless indicated on the documents to be larger.

3.04 CONDENSATE PUMPS (ELECTRIC)

A. Install per manufacturer’s instructions.

B. Test control and operation.

3.05 TESTING

A. Furnish all labor, material, instruments, supplies and services and bear all costs for the accomplishment of the tests herein specified. Correct all defects appearing under test and repeat the tests until no defects are disclosed; leave the equipment clean and ready for use.

B. Perform all tests other than herein specified which may be required by Legal Authorities or by Agencies to whose requirements this work is to conform.

C. Furnish all necessary testing apparatus, make all temporary connections and perform all testing operations required, at no additional cost to the Owner.

D. All equipment and piping installed under this Contract shall be tested and found tight. Insulated or otherwise concealed piping shall be tested before being closed in. All leaking joints shall be corrected, retested and found tight. Such tests shall conform to the requirements of Local Codes but shall not be less than the equivalent of the tests called for herein. Threaded joints that leak shall not be seal-welded to correct leakage.

E. Tests performed shall not relieve the Contractor of his responsibility for leaks which may develop after the tests are made.

F. All piping systems shall be subjected to a hydrostatic test at 1 1/2 times operating pressure measured at the highest point in the system, for a period of (4) hours without drop in pressure. Note: Operating pressure for Low Pressure Steam Service; 15 PSIG.

G. Tests of piping systems shall be conducted before connections to equipment are made and before piping is covered, buried or otherwise concealed.

H. Systems found to have leaks shall be subjected to further tests when faulty joints have been repaired or replaced.

I. Welded joints shall be subjected to a hammer test while under pressure.

3.06 STEAM SEPARATOR

A. Install in accordance with manufactures recommendations in the locations specified. Shown on plans and/or detailed.

B. Pipe drip assembly.

END OF SECTION

SECTION 233100

SHEET METAL WORK AND ACCESSORIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install a complete system of air distribution, including accessories, to all areas indicated on the contract documents.

B. Create, coordinate and submit 1/4" scale Coordination Drawing in accordance with Section 230500 and 230510 3D Building Information Modeling.

C. Provide all ductwork, fittings and accessories to make a complete and operational system in all respects.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel.
2. ASTM A 1008/A 1008M – Standard Specification for Steel, Sheet, Carbon, Cold Rolled, Commercial Quality.
3. ASTM A 1011/A 1011M – Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality.
4. ASTM A 653/A 653M – Standard Specification for Steel Sheets, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.
5. ASTM A 666 – Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
6. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
7. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
8. ASTM C 443 – Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
9. ASTM C 443M – Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets (Metric).

10. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.
11. NFPA 90B – Installation of Warm Air Heating and Air Conditioning Systems.
12. SMACNA (LEAK) – HVAC Air Duct Leakage Test Manual.
13. SMACNA (DCS) – HVAC Duct Construction Standards – Metal and Flexible.
14. UL 181 – Factory-Made Air Ducts and Connectors.

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: Provide data for duct materials, duct connectors and all accessories. Include sound attenuator test data in accordance with ASTM E477.

C. The Sheet Metal Contractor shall submit duct fabrication standards and methods of installation, in compliance with SMACNA and these specifications, for review and approval by the Architect, clearly indicating the combination of metal gauges and reinforcement intended for use for each pressure classification. Duct fabrication shall not be allowed until a satisfactory review of this Standard has been performed and fabrication drawings have been reviewed and coordinated. MERELY SUBMITTING COPIES OF THE SMACNA PRESSURE CLASS TABLES DOES NOT COMPLY WITH THIS REQUIREMENT.

D. Provide scaled ductwork fabrication drawings. Fabrication drawings shall be double line and as a minimum include elevations, dimensions, sizes, all offsets rises and drops, air distribution devices.

E. Provide scaled ductwork coordination drawings for all floors and systems in accordance with Section 230500, Submittals.

F. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA – HVAC Air Duct Leakage Test Manual.

G. Manufacturer's Installation Instructions: Indicate special procedures for glass fiber ducts.

H. Manufacturer's Certificate: Certify that installation of glass fiber ductwork meet or exceed recommended fabrication and installation requirements.

I. Project Record Documents: Record actual locations of ducts, duct fittings and all accessories. Record changes in fitting location and type. Show additional fittings used.

1.06 QUALITY ASSURANCE

A. All ducts and fittings shall be manufactured by a sheet metal fabrication company whose primary business experience is the manufacture of commercial and industrial quality ducts and fittings. Sheet Metal Contractor shall have adequate experience of building ductwork of the types required for this project as well as successful experience with projects of similar scope. Bids from sheet metal shops which do not meet the specified requirements shall not be acceptable.

B. **No Ductmate, Ward, Nixon or similar factory made slip-on connections will be permitted.**

1.07 ENVIRONMENTAL REQUIREMENTS

A. Do not install duct sealants when temperature is less than those recommended by sealant manufacturers.

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

C. Confirm duct sealant materials meet LEED requirements.

PART 2 PRODUCTS

2.01 SHEET METAL WORK

A. General

1. Acceptable Manufacturers (Provided they are in compliance with these specifications)

a. Sheet Metal

1) All ducts and fittings shall be manufactured by a sheet metal fabrication company whose primary business experience is the manufacture of commercial and industrial quality ducts and fittings. Sheet Metal Contractor shall have adequate experience of building ductwork of the types required for this project as well as successful experience with projects of similar scope. Bids from sheet metal shops which do not meet the specified requirements shall not be acceptable.

2) All branch duct connections shall be made by clinch lock using clinch collars.

b. Sheet Metal Accessories

1) Access Doors

a) Ruskin
b) Air Balance
c) Hart and Cooly
d) Ductmate
e) Elgen

2) Flexible Connectors

a) Ventlock
b) Elgen Manufacturing
c) Duro Dyne
d) Ventglass
e) Elgen

3) Fire Dampers

a) Ruskin
b) Prefco

c) Air Balance
d) Greenheck Fan Corp.
e) Nailor Industries
f) NCA Manufacturing Inc.

4) Fire/Smoke Dampers

a) Ruskin
b) Prefco
c) Air Balance
d) Greenheck Fan Corp.
e) Nailor Industries

5) Smoke Dampers

a) Ruskin
b) Prefco
c) Air Balance
d) Greenheck Fan Corp.
e) Nailor Industries

6) Automatic Dampers Airfoil

a) Ruskin
b) Greenheck Fan Corp.
c) Nailor Industries
d) T.A. Morrison & Co. Inc. (TAMCO)
e) Air Balance
f) NCA Manufacturing Inc.

7) Balancing Dampers (OBD)

a) Ruskin
b) Young Regulator
c) Prefco
d) Greenheck Fan Corp.
e) Air Balance
f) Nailor Industries
g) NCA Manufacturing Inc.

8) Small Balancing Damper less than 48x12

a) Ruskin
b) Young Regulator
c) Ventlock
d) Duro Dyne

2. Unless otherwise noted, all supply, return and exhaust air ductwork of all types shall be constructed of galvanized sheet metal based on the "Pressure Class" indicated in the "Minimum SMACNA Construction Standards" table found hereinafter.

3. The drawings are diagrammatic and indicate the arrangements of the principal apparatus, ductwork and piping and shall be followed as closely as possible. Because of the scale of the drawings, it is not possible to show all offsets, rises, drops, rises, fittings, accessories, etc. The Contractor shall carefully investigate the structure, finish conditions, and the work of other trades affecting the work and arrange ductwork, piping, equipment, accessories, etc. accordingly. Provide the best possible arrangement so as to provide the maximum headroom and access to apparatus while providing the minimum resistance to airflow. This work and any extra fittings and offsets required shall be included in the project without extra charge.
4. In addition to sheet metal ductwork provided under this Contract furnish and/or install accessories and devices furnished by others, including but not limited to smoke detectors. Provide and install miscellaneous sheet metal work including safing, mixing baffles, and blank off panels at unused louver areas.
5. All duct systems specified to be installed under this Contract, shall conform to the drawings, specifications, Standards, details and recommendations of the latest edition of SMACNA "HVAC Duct Construction Standards - Metal and Flexible"; and "Round and Industrial Duct Construction Standards" (hereinafter referred to as Duct Manual). Where the building code references a specific edition of SMACNA "HVAC Duct Construction Standards - Metal and Flexible", then that edition shall be followed. Where the requirements under this Section exceed the requirements of the Duct Manual and/or SMACNA Interpretations of the Duct Manual, the specification shall govern. Wherever the word "should" appears, replace with the word "shall".
6. The Sheet Metal Contractor shall submit duct fabrication standards and methods of installation, in compliance with SMACNA and these specifications, for review and approval by the Architect, clearly indicating the combination of metal gauges and reinforcement intended for use for each pressure classification. Duct fabrication shall not be allowed until a satisfactory review of this Standard has been performed. MERELY SUBMITTING COPIES OF THE SMACNA PRESSURE CLASS TABLES DOES NOT COMPLY WITH THIS REQUIREMENT.
7. All galvanized steel sheet metal shall conform to ASTM A653/A653M (G-90), having not less than 0.90 oz. of zinc (total for both faces) per each square foot of sheet, and be of lock-forming quality. All other duct materials shall be as hereinafter specified as applicable to this Contract.
8. The Sheet Metal Contractor shall install all duct mounted smoke detectors and provide proper cross trade layout coordination to allow for appropriate service/access requirements.
9. The Sheet Metal Contractor shall furnish and install all plenums with automatic or manual dampers attached to louvers.
10. The Sheet Metal Contractor shall provide enclosures for all structural columns/cross bracing/steel beams penetrating or contained within plenums.

    a. This sheet metal enclosure shall match plenum construction for:

        1) Pressure class.
        2) Leakage class.
        3) Material.

11. The Sheet Metal Contractor shall fabricate and install all Generator intake and relief plenums to be single wall construction. Generator Intake and relief Plenums shall be insulated on the outside of the plenum of the plenum with 2” Rigid Fibergalss Board insulation with FSKL facing as specified in section 230713.
12. The Sheet Metal Contractor shall fabricate and install all canopy hoods, flexible "elephant trunk" exhaust outlets as detailed or noted in the Construction Documents.

13. There will be no supply and/or return air system ductwork internally lined unless otherwise noted.
14. The Sheet Metal Contractor shall clean and provide temporary caps on all ductwork during installation to prevent dust, dirt and debris from entering ducts during construction, including during shipping, handling and storage in the field.
15. All shop applied fabrication labels shall be applied to the exterior of the ducts. The Sheet Metal Contractor shall remove any material applied to the inside of the ducts before installation.
16. All inline fans shall have companion flanges intake and discharge for removal for servicing.
17. Seal all joints to VAV/VCV/SAV/EV in the field, including reheat coils and sound attenuators.

2.02 DUCT CONSTRUCTION

A. Duct Construction Schedule

Minimum SMACNA Construction Standards						
Ductwork Location	**Pressure Class Inches W.G.**	**Seal Class**	**Leakage Class**	**Material**	**Sound Lining**	**Table Notes**
Supply from Air Handling units to terminal boxes	±6	A	4	G-90	No	
Supply from terminal boxes to outlets	±2	A	4	G-90	No	
Return from Air Handling units to terminal boxes	-6	A	4	G-90	No	
Return from outlets to terminal boxes	-2	A	4	G-90	No	2
Exhaust from Exhaust Air Handling units to terminal boxes	-6	A	4	G-90	No	
Return to Air Handling units constant volume systems.	-4	A	4	G-90	No	
Supply from Air Handling units constant volume systems	±4	A	4	G-90	No	
Soiled docks exhaust, isolation room exhaust, general lab exhaust, general central sterile exhaust, med gas storage room, convenience pantry exhaust.	-3	A	4	G-90	No	2, 4
Toilet exhaust	-3	A	4	G-90	No	2
General exhaust	-3	A	4	G-90	No	2
Hood exhaust/bench slots/biohazard exhaust	-6	A Welded	0.5	316L S.S.	No	
Plenums	±4	A	4	Same as Ducts	As In-dictated	2, 5
Stair/Elevator pressurization	+3	A	4	G-90	No	2
Other	±3	A	4	G-90	No	2

Table Notes
2 Ductwork in the following locations shall be constructed of aluminum or stainless steel and continuously welded (Joints & Seams) and pitched back to the outlets. · Within 20'-0" of a shower area exhaust. · Within 20'-0" downstream and 5'-0" upstream of a duct humidifier. · Within 20'-0" of a sterilizer area exhaust. · Within 20'-0" of a cartwasher exhaust. · Within 20'-0" of a locker room and within room (exhaust).
3 Pitch horizontal duct back to hood equipment where exhaust originates. 4 Sound lining shall not be provided at exhaust fans serving wet exhausts, isolation exhaust, radioactive exhaust or biohazard exhaust. 5 Ductwork in the following locations shall be pitched back to the outside.

2.03 ADDITIONAL CONSTRUCTION REQUIREMENTS

A. Minimum Requirements

1. The minimum gauge for any steel duct shall be 24 gauge except when specified heavier.
2. The minimum thickness of any aluminum duct shall be 0.040".
3. The minimum diameter of any tie rod shall be 1/2".
4. The maximum tie rod spacing shall be 42" unless specifically engineered in accordance with the SMACNA Industrial Rectangular Duct Standard.
5. When tie rods intersect, they shall be welded to each other.
6. No ductwork shall be constructed to less than ±2" w.g. This means nothing is constructed to a standard between –2" w.g. and +2" w.g.
7. **Duct dimensions indicated are clear inside dimensions. The sheet metal dimensions shall be increased to accommodate internal liner where liner is required.**

B. All joints and seams in all ductwork and casings shall be sealed to SMACNA Seal Class "A". In finished areas, sealing compound shall be neatly applied to exposed ductwork and bands shall be provided over, to cover the sealant.

1. Some SMACNA constructions may not be suitable for the leakage classes specified even though they may meet the pressure class and should not be used.
2. Seal class A Welded means all welded (i.e. transverse joints, longitudinal seams, spiral seams, fire dampers, volume dampers or any accessories) and in addition it means continuously welded.
3. All sealants, adhesives and coatings shall be of approved kinds and qualities for each point of application, complying with recommendations for the use and storage.
4. The method of installation and materials for sealing the ductwork shall be submitted by the Sheet Metal Contractor for review and approval by the Architect, as part of the ductwork construction standards and installation submittal.
5. All screw holes in duct shall be sealed to include, but not limited to, joints, seams, connections, strap hangers, hangers, etc.

C. All longitudinal seams in all ductwork in excess of +2" w.g. or less than -2" w.g pressure class shall be made with formed Pittsburgh locks.

D. Grooved seam/flat lock/pipe lock joining methods is restricted to 2" W.G. pressure class only.

E. Button punch-snap lock seams are not to be used.

F. Concealed stainless steel ductwork shall have an ASTM mill rolled No. 1 or No. 2 D finish. Exposed stainless steel ductwork shall have an ASTM mill rolled No. 2 B finish, or higher grade as required by the Architect, with all welds ground smooth and final brushed with stainless steel wire brushes. All welds on exposed stainless steel ductwork shall be free of stain, burn-through, or discoloration to the satisfaction of the Architect.

G. Tie rods shall not be used in any plenum or large duct requiring internal access or use as an access pathway.

H. All ductwork required to be removable shall be companion flanged SMACNA Type T-22 for ductwork constructed to SMACNA Metal Duct Standard and companion flanged in accordance with Industrial Standards for ductwork required to be constructed to Industrial Standards.

I. Elbows

1. Radius elbows shall be used wherever possible. Where it is impossible or impractical to install a 1.5 times width to centerline radius of elbow (full radius elbow) lesser radii configurations shall be used, each with "radius-proportional" splitter vanes permanently installed within. No radius shall be less than 1.0 times the width. Provide square elbows in rectangular ducts with double thickness vanes with a minimum radius of 4 1/2". Square elbows may only be used when radius elbows will not fit and where specifically approved by the Architect prior to fabrication and/or as required by coordination shop drawings. All offsets shall be of the radium type.

J. Auxiliary Drain Pans

1. Provide 1-1/2” deep auxiliary drain pans under any units with cooling coils located above hung ceilings.
2. Pans shall be 6” larger then equipment in all directions.
3. This includes but not limited to all fan coil units.
4. Drains shall be piped to floor drains or utility sinks.

K. Ducts Exposed to Weather

1. For all ducts exposed to weather, after all ducts and joints are sealed and tested as specified herein, apply all over and around the same areas of possible leakage (joints), an approved sealer system, so that ductwork outside the building shall be installed in a manner to result in less than 0.5 leakage class.
2. Exposed ductwork shall be insulated and weather-protected by the Insulation Contractor after the installation is completed and tested.

   Note: Refer to Section 230713 for duct insulation and roofing covering for ducts exposed to weather, under the insulation specification.

L. Provide baffles and/or diffusion plates as required in all air handling units, to ensure proper air mixing, coil velocities and air distribution across filters or coils as determined in the field by the Architect, at no additional cost to the Owner.

M. It is the intent of this specification to provide a duct system with minimum resistance to airflow. All take-offs shall be throated and transitions made as gradually as possible. "Bullhead" or sharp take-offs shall not be acceptable.

N. In addition to SMACNA requirements, ductwork in return systems without boxes, ductwork in supply systems without boxes, ductwork in exhaust systems without boxes, ductwork in any Constant Volume System and/or ductwork downstream of VAV, supply, return or exhaust boxes or valves shall be provided with:

1. Volume dampers in all branch takeoffs and in all main branches and ducts of all ductwork systems (supply, return and exhaust) for properly regulating and balancing airflow to all terminal outlets, for all duct sizes, whether shown on the drawings or not. **The above requirement is mandatory.**

    a. Dampers and operators shall be similar to as manufactured by Young Regulator.

    b. Provide manual adjustable rectangular opposed blade dampers with factory installed locking hand quadrants extended 2" for all dampers installed in externally insulated duct.
    c. Dampers shall be manufactured approximately 5/16" smaller in width and 1/8" smaller in height than size of duct in which they are installed; e.g., nominal damper size is 24" x 10", actual size is approximately 23-11/16" x 9-7/8".
    d. Damper frame shall be constructed of #6063 extruded aluminum reinforced channel with minimum thickness of .050". Opposed damper blades shall be #6063 extruded aluminum with minimum thickness of .50" and shall include reinforcing ribs. Each blade shall be supported in the damper frame by individual Teflon axle bearings, and shall be driven by stainless steel connecting slide linkage controlled by 3/8" square steel control shaft. When installed in stainless steel duct systems, the dampers shall be constructed of all stainless steel components.
    e. All manual volume dampers handles shall be flagged with brightly colored ribbon tape, extending a minimum of 6” down from the handle, to enhance visibility. Ribbons shall not be installed in areas without ceilings.

2. Volume dampers shall be provided upstream for all Air Terminal Boxes and Exhaust/Supply venture valves where excessive system pressure is greater than exceeds the range of the equipment and/or associated controls operating limits.
3. Provided with a means for remote adjustment

    a. All balancing dampers that are:

        1) Inaccessible for adjustment, including those isolated by mechanical obstructions (e.g. piping, conduit, cable trays, other ductwork, etc.).
        2) Above drywall ceilings
        3) Above plaster ceilings
        4) Where specified
        5) Where noted on the drawings.

4. Remote operators.

    a. Cable remote Operators shall be installed within the neck of the air device for access through the removable core of the air device.

        1) Provide Young Regulator Bowden Cable Control kit for remote, internally mounted, worm gear operator volume dampers.

            a) Provide stainless steel cable and control wire.

b) Acceptable manufacturers subject to compliance with the specifications.

(1) Young Regulator.

b. Wireless remote balancing damper

1) The adjustment mechanism hardware and installation shall in all cases conform to the project governing building codes.
2) The contractor shall provide air balancing dampers in primary and branch zones and serving individual air devices as indicated and/or specified in the contract documents.

a) Balancing dampers shall be located upstream from air outlets a *minimum* of six feet.

(1) In no instance shall any damper be installed:

(a) At supply diffuser necks
(b) At linear diffuser plenum inlets.

b) Ceiling access doors for balancing damper access shall not be allowed at any location without prior written approval of the architect.
c) All balancing dampers that are inaccessible for adjustment, including those isolated by mechanical obstructions (e.g. piping, conduit, cable trays, other ductwork, etc.) shall be provided with a means for remote adjustment.
d) The damper–controller shall have a built–in test mechanism that, prior to installing the ceilings that will quickly and positively verify:

(1) That the installed dampers work correctly.
(2) With a clear visual indication at the controller.

e) The Contractor shall indicate as–built duct drawings:

(1) The final location of all inaccessible air balancing dampers
(2) All remote connector locations.

f) The remote damper adjustment mechanism shall be the wireless controlled.
g) Total enclosure of components and cables
h) All above–ceiling components shall be plenum–rated with a minimum UL94–5VA classification.

(1) Power/signal cables to the actuators shall be easily extendable in “daisy chain” fashion in increments up to 150 feet.

i) When merging several actuators power/signal cables for control from a common location, remote panels shall be provided in the node capacity required, and with each tagged to its respective damper.

(1) Equal to the Zipset “RP Series”

(2) When panels are located in public view, the look and finishes shall be approved by the Architect.

j) Acceptable manufacturers subject to compliance with the specifications.

(1) The Zip Group LLC.

(a) Similar to Zipset “TE Series”

O. All rectangular dampers shall be opposed blade and each shall be controlled by an approved galvanized locking quadrant indicating the damper position, as detailed on the drawings.

1. Volume dampers installed into ductwork that is specified to be externally insulated shall have extended activator/handle rods with extension bracket such that adjustment of the damper handle will not disturb the insulation.

P. Submit the sheet metal shop drawings to the Balancing Contractor of the project for his review and placement of dampers with the final balancing procedures and requirements in mind.

1. Coordinate the location and areas with the Balancing Contractor, and fabricate the ductwork system accordingly.
2. Provide any and all balancing dampers required by the balancing contractor at no additional cost.

Q. In addition to SMACNA requirements, all round ductwork, if used in lieu of rectangular supply and/or return/exhaust systems shall conform to SMACNA.

1. The use of flat oval ductwork shall not be acceptable.
2. Round duct shall be manufactured of spiral lock seam. Ductwork up to 12"ø and 2" w.g. pressure class can be manufactured with longitudinal lock seams. All fittings seams shall be continuously welded.
3. All tees shall be conical.
4. All laterals shall be straight.
5. All taps through 10" diameter in size shall have a machine drawn entrance and all fittings shall have longitudinal seams, continuous-welded. Both sides of all welds shall be primed with zinc chromate.
6. All tap entrances shall be free of weld build-up.
7. Elbows in diameters 3" through 10" shall be 2-section stamped or pleated elbows. Larger elbows shall be gored construction. Elbows shall be fabricated to a centerline radius of 1.5 times the diameter. All fittings seams (including gore) shall be continuously welded. All gored longitudinal seams shall be staggered. All gored elbows shall be fabricated according to the following schedule:

Elbows	# of Gores
Up to 35°	2
36° to 71°	3
Over 71°	5

8. All field joints in diameters through 48" shall be made with a 2" long slip-fit or sleeve coupling provided assembly is not hindered. Ductwork over 48", and for all sizes where disassembly and removal is required, shall be joined with Vanstone or shop fabricated flanges.

9. All flanges and taps into spiral ducts shall be factory or shop fabricated and installed as hereinbefore specified. Shipment of loose flanges or taps for field installation shall be avoided.
10. All access doors for round duct shall be furnished by the access door manufacturer. Round duct access doors shall be of low leakage sandwich type suitable for systems up to 8” pressure, positive or negative. Round duct access doors shall be insulated and shall be equivalent to Ruskin model ARDD.
11. Unless specifically noted otherwise or required by special constraints, all elbows on ductwork changing direction from vertical to horizontal shall be 1.5 times radius.

2.04 SPECIAL EXHAUST SYSTEMS

A. Canopy hoods shall be fabricated of 18 gauge welded 304 stainless steel with No. 2B finish. Canopy hoods shall have all welds ground and polished with stainless steel wire brushes. Welds shall be free of stains, burns or discoloration. Transition to the duct connection shall be a maximum angle of 45°. Duct work shall extend down to mounting height of hood.

2.05 ACCESS DOORS

A. Provide access doors and frames in all supply, exhaust and return ductwork as required, to permit access to:

1. Automatic dampers
2. In-box heating coils
3. Fire dampers
4. In-duct coils
5. All plenums
6. In-duct humidifiers

   a. Provide sight doors

7. Other similar equipment
8. Fan Bearings enclosed in ducts.
9. Duct smoke Detectors

   a. Provide sight doors

10. For cleaning and inspection purposes
11. Where indicated on the drawings

B. Door Size

1. Ductwork

   a. Minimum 16” x 12”
   b. In ducts smaller than 12” they shall be 10” x 6” less then duct width except:

      1) Terminal Box heating coil door may be 10” x 6”

   c. Vacuum cleaning access door shall be 12” round.

2. Plenums

a. Shall be 20” x 56”

1) 18” x 45” door may be used only when 20” x 56” will not fit.

b. Larger door shall be provided if required for equipment removal. Coordinate with equipment.

C. Door Construction

1. Doors shall match material type and gauge of the duct system in which they are installed. This includes hardware such as bolts.
2. Minimum gauge shall be 20.
3. Pressure tested to ±15” wc

a. Leakage shall be zero at ±10” wg

4. Provide a neoprene gasketed around their entire perimeter.
5. Where sight doors are required, a wire reinforced safety glass shall be utilized.

a. All humidifiers

6. Insulated or lined ductwork shall have insulated door
7. Insulated plenums shall have insulated door
8. Insulated doors shall be double wall.
9. Insulation between the metal panels shall be of the same thickness as the duct or panel adjacent to the access doors.
10. Plenum access doors shall be hung on heavy hinges and shall be secured in the closed position by means of latches.
11. Ductwork access doors shall be clamp type with a retaining chain or cable.
12. Ductwork access doors shall be similar to Ductmate Sandwich access door.
13. All plenum hinge doors shall be submitted with test (provide E leakage) data before approval.

2.06 FLEXIBLE CONNECTIONS (AHUs, FANS)

A. Provide flexible connections of 4" minimum fabric width

1. Between ductwork and the inlets and outlets of all fans **<u>except</u>**:

a. Hazardous exhausts
b. Lab exhaust fans located indoors.

2. Equipment equipped with fans
3. All ductwork that crosses building expansion joints

B. The connections shall be placed as close to the equipment as practical except at fan suction connections and the clear gap at rest shall be not less than 3". At fan suction connections, locate flexible duct connection at least 3 duct diameters away from fan inlet connection.

C. There shall be no tension of the fabric under static or dynamic loads

D. All fabric for flexible duct connections to equipment shall be a minimum of 22 oz. glass fabric, double coated with neoprene, fire retardant, waterproof, airtight, and approved by UL, similar to Ventfabrics or Ventglass.

E. Exterior flexible connection shall be insulated type similar to Duro Dyne.

F. Flexible connections shall be fabricated from approved flameproofed fabric conforming to NFPA 90A. Asbestos shall not be acceptable.

G. Flexible connections shall be installed further upstream from fan powered equipment (in the main duct size) to prevent obstruction of the fan inlet due to suction of the fabric into the airstream.

H. Ductwork shall be increased in size where the flexible connections are located to prevent fully drawn in connections from blocking any duct area. Submit detail for review.

2.07 BLANK OFF PANELS FOR UNUSED LOUVER AREAS

A. Provide minimum 20 gauge sheet metal blank off panels for all unused louver areas:

1. All louver areas not enjoined or connected to an active plenum.

B. Exterior/visible face of blank off panel shall be cleaned and painted flat black, prior to installation.

C. Panels shall be screwed to louver frames and caulked to provide a weathertight seal.

D. Provide insulation of blank off panels. See specification Section 230713 - Ductwork insulation.

2.08 DAMPERS

A. General

1. The minimum damper requirements shall be as indicated in the following table:

Damper Construction Table					
Type	**Approach Velocity (FPM)**	**Pressure Rating**	**UL555S Leakage Class**	**Blade Type**	**Listing**
Fire dampers in ducts greater than +2" w.g. or less than -2" w.g. (FD)	2,000	4”w.g.	N/A	OBD 3V	UL555 Dynamic
Other fire dampers (FD)	2,000	4"w.g.	N/A	Curtain or OBD	UL555 Dynamic
Fire smoke dampers in ducts greater than +2" w.g. or less than -2" w.g. and at all shafts (FSD)	3,000	4"w.g.	I	Air Foil	UL555, UL555S Dynamic
Other fire smoke dampers (FSD or HFD)	2,000	4"w.g.	I	OBD 3V	UL555, UL555S Dynamic
Smoke dampers (SD)	3,000	4"w.g.	I	Air Foil	UL555S Dynamic
Isolation dampers (at units)	4,500	8"w.g.	I	Air Foil	
Automatic dampers (AD)	4,500	6"w.g.	I	Air Foil	N/A

Damper Construction Table					
Type	**Approach Velocity (FPM)**	**Pressure Rating**	**UL555S Leakage Class**	**Blade Type**	**Listing**
Balancing dampers in ducts wider than 48" and/or deeper than 12" (VD or as specified)	2,500	4"w.g.	N/A	OBD	N/A
Balancing damper in ducts less than 48" by 12" (VD or as specified)	2,500	2”	N/A	OBD	N/A
Smoke control damper (SCD)	3,000	4"		OBD	UL555S Dynamic

2. Dampers in stainless steel ducts shall be stainless steel.
3. Automatic dampers in aluminum duct shall be aluminum construction.
4. All curtain type fire damper assemblies shall be 100% face area type with the blade package and all frame components out of the air stream.

B. Automatic Dampers

1. See Automatic Temperature Control Specification.

C. Fire Dampers, Ceiling Radiation Dampers, Smoke Dampers, and Combination Smoke/Fire Dampers

1. Fire dampers, smoke dampers and combination smoke/fire dampers shall be provided as shown on the drawings and wherever Architectural drawings indicate fire and/or smoke rated partitions. Devices shall be of the appropriate service for the partition class into which they are installed. Exact requirements and type of partition shall be coordinated with the Architect.
2. All dampers shall meet the requirements of NFPA 90A and further shall be tested, rated and labeled in accordance with UL 555 (7th Edition), UL555S (4th Edition) and UL555C (3rd Edition).

   a. All dampers shall be field tested upon the completion of installation as required per NFPA 90 A, NFPA 80 and NFPA 105 (latest editions).
   b. All damper testing shall be documented as outlined per the above NFPA references and submitted to the Architect/Engineer for review prior to project closeout.
   c. All damper testing documentation shall be submitted as part of the project closeout for Owner record.

3. All dampers shall be tested, rated and labeled as "Dynamic Rated" for closure against airflow in the following configuration:

   a. Vertical mount (horizontal airflow):
      Ducted and unducted.
   b. Horizontal mount (airflow up):
      Ducted and unducted.
   c. Horizontal mount (airflow down):
      Ducted and unducted.

Note: Static rated dampers shall not be allowed.

4. Each damper shall be rated to close against maximum design airflow at its installed location, with 400 fpm and .5 in wg. safety factors and against 4" w.g. maximum pressure across the closed damper.
5. All dampers shall include the required oversize enclosures which shall be sealed by the damper manufacturer for the appropriate duct pressure class into which they are installed. All such dampers shall have appropriate rectangular, flat oval or round duct collars to facilitate connection of mating ductwork. The Contractor shall be responsible for any additional sealing of duct collars and connections required to maintain the duct seal class requirements but shall not jeopardize the UL breakaway connection when utilized.
6. The Contractor shall indicate the location and rating of all dampers on his shop drawings and shall provide access doors at each location of sufficient size and type to permit access to the damper components.
   A detailed list of fire dampers, smoke dampers and fire/smoke dampers shall be included as part of the shop drawing/submittal process for review. The list shall include damper size, damper type, location, material, rating, access door size, velocity, pressure drop, etc. The Contractor shall be solely responsible to coordinate all locations of duct access doors and dampers of all types. All duct access doors for all dampers shall be labeled in accordance with the herewith in NFPA references.
7. Contractor shall include damper manufacturer's installation instructions as part of the damper submittal. These instructions shall describe the applicable requirements for damper sleeve thickness; retaining angles; sealing; duct-to-sleeve connections; preparation of wall, floor or ceiling openings; and all other requirements to provide an installation equivalent to that tested by the damper manufacturer during the UL 555, UL555S and UL555C qualification procedures. Contractor shall detail any proposed installations that deviate from these manufacturer's instructions and explain the needed deviations. All fire, smoke and ceiling radiation damper installations shall comply with the manufacturer's installation instructions. Any submitted deviations must be acceptable to the appropriate authority having jurisdiction.
8. Fire Dampers

   a. Fire dampers shall be provided as shown on the drawings and wherever Architectural drawings indicate fire-rated partitions to the following schedule:

Partition Assembly Fire Rating	Penetration Type	Damper Rating
1 Hour	Continuously ducted and Sprinklered.with ducted steel sheet metal, with all portions of sheet metal not thinner than 26 ga steel, is not constructed of non-steel materials (i.e. aluminum), nor, has any portion of the entire duct system constructed of flexible ductwork.	No damper required; duct sleeved and packed with fireproofing only at the fire-rated assembly.
1 Hour	Ducted and Non-Sprinklered	1.5 Hour
1 Hour	Open (Transfer) or open-ended above the ceiling (termination not made with a register/diffuser)	1.5 Hour

Partition Assembly Fire Rating	Penetration Type	Damper Rating
1 Hour	Ducted steel sheet metal with any portion of sheet metal that is thinner than 26 ga steel; or, is constructed of non-steel materials; or, has any portion of the entire duct system constructed of flexible ductwork.	1.5 Hour
1.5 to 2 Hours	Ducted or Open	1.5 Hour
3 Hour	Ducted *	3.0 Hour
4 Hour	Ducted *	3.0 Hour
*No open transfer will be permitted through these partitions.		

b. Fire damper sleeves shall be manufactured with a metal sleeve of appropriate length and thickness for the required damper installation as shown in the table below:

Maximum Duct I.D.	Sleeve Gauge (U.S.)
Up to 84”	20 gauge
85” & Up	18 gauge

c. Heat Release temperature rating for all fire dampers shall be 212°F or 50°F above the highest system temperature, whichever is greater.
d. Dampers in stainless steel ducts shall be stainless steel.
e. Dampers located in welded systems shall be rigidly connected with welded connections (not breakaway). Damper size and metal thickness must be confirmed per the manufacturer to coordinate with the rigid welded connection requirements.
f. Large fire dampers may require motor operator to comply with code if this is required. Mechanical Contractor shall provide power and connections from electrical panel.

9. Smoke Dampers and Combination Fire/Smoke Dampers

a. Smoke dampers and combination fire/smoke dampers shall be provided as shown on the drawings and wherever architectural drawings indicate smoke/fire rated partitions. Combination fire/smoke dampers shall be dynamically rated for 1.5 or 3 hours as determined by the Architect.
b. Smoke dampers and combination fire/smoke dampers and actuators shall meet the requirements of NFPA 92A and NFPA 92B and further shall be tested, rated and labeled as a "Leakage Rated Damper for Use in Smoke Control Systems" in accordance with the 4th edition of UL 555S. All smoke dampers shall be of low leakage design qualified to UL 555S Leakage Class I (8 cfm/sq.ft. at 4" w.g.) and shall have a UL 555S elevated temperature rating of 350°F.

1) Each smoke damper/actuator combination shall be UL 555S rated to operate at maximum design airflow at its installed location with 400 fpm and .5 in wg. safety factors.
2) Each smoke damper and combination assembly shall bare an AMCA certification.

c. Each smoke damper and combination fire/smoke damper shall be supplied with an appropriate damper actuator installed by the damper manufacturer at the time of damper fabrication. Combination fire/smoke dampers shall be manufactured with a metal sleeve of appropriate length and thickness for the required damper installation, and the damper actuator shall be installed on the sleeve exterior. Smoke dampers may be installed in ductwork up to 24” from wall with no openings between the wall and the smoke damper.

   1) Damper actuators shall be electric type for 120 volt operation.
   2) Power wiring, including interlocking to smoke detectors and fire alarm system, and panels to affect the sequence of operation shall be by the Electrical Contractor.
   3) Dampers shall be fail closed as follows:

      a) Power to Damper: Open
      b) No Power to Damper: Closed

d. Damper frame shall be galvanized steel formed into a structural hat channel shape with reinforced corners. The smoke and combination fire/smoke damper blades shall be airfoil type with Class 1 leakage rating. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. Blade edge seals shall be silicone rubber designed to withstand 450ºF (232ºC) and jamb seals shall be stainless steel flexible metal compression type.

e. Each damper shall be equipped with a remote open or closed position indication switch. The switch shall be over the shaft type using two independent rotary cams and adjustable switch points indicating open and closed positions. Switch can be factory or field applied to manufacturer’s damper.

   1) These switches shall be furnished by the damper manufacturer and wired by the Electrical Contractor, in a location approved by the Architect.
   2) Spare contacts for each damper shall be provided for additional remote (fire panel) operation.

f. Each combination fire/smoke damper shall also be equipped with a temperature limited re-openable feature equivalent to Greenheck model TOR providing the following operational sequence:

   1) Temperature at damper heat release reaches 165°F or 50°F above highest system temperature, whichever is greatest, and primary heat sensing device closes damper. Remote or local override command panel can then re-open damper.
   2) If temperature at damper heat release reaches 350°F, secondary heat sensing device will close the damper. Override and re-opening above this secondary temperature is not permitted. Both primary and secondary heat responsive devices shall incorporate a manual reset feature allowing restoration of normal operation after fire emergency has been cleared.

g. If utilizing system operation for smoke control purposes during the early phase of a fire emergency, each combination fire/smoke damper shall be equipped with a 212°F primary heat release and 350°F minimum rated damper actuator.

h. Dampers in stainless steel ducts shall be stainless steel.

i. Dampers located in welded systems shall be rigidly connected with welded connections (not breakaway). Damper size and metal thickness must be confirmed per the manufacturer to coordinate with the rigid welded connection requirements.

10. Smoke Isolation Dampers at Air Handling Units

a. Provide smoke isolation dampers at air handling units as shown on drawings. Smoke isolation dampers shall comply with NFPA 90A, UL 555S and the aforementioned requirements with a minimum of (1) actuator for every 16 sq.ft. of damper or portion thereof.

Device	Furnished By	Installed By	Actuator By	Actuator Type	End Switches	Control Wires	Power	UL Assembly
Automatic Damper (AD)	Div 25	Div 23	Div 25	Electric	Div 25	N/A	Div 25	No
Automatic Damper (AD) (When noted to be electric)	Div 25	Div 23	Div 25	Electric	Div 25	Div. 25	Div 25	No
Fire Smoke Damper (FSD)	Div 23	Div 23	Damper Manufacturer	Electric	Damper Manufacturer	ATC	Div 26	Yes
Smoke Damper (SD)	Div 23	Div 23	Damper Manufacturer	Electric	Damper Manufacturer	ATC	Div 26	Yes
Smoke Isolation Damper (SD)	Div 23	Div 23	Damper Manufacturer	Electric	Damper Manufacturer	ATC	Div 26	Yes
Fire Damper (FD)	Div 23	Div 23	If Req'd Damper Manufacturer	If Req'd Electric	If Req'd Damper Manufacturer	N/A	If Req'd Div 23	Yes

11. Smoke Control Dampers shall be the same as specified for smoke dampers.
12. All fire/smoke damper access doors in all positive pressure supply ductwork of +3" w.g. or greater construction:

a. Shall be of the pressure relief (negative pressure) spring loaded type. Design shall incorporate self-closing spring latch or be complete with secure retainer chain and "D" handle.

b. These doors shall be mounted downstream (after shutoff) of fire dampers, fire/smoke dampers or smoke dampers or similar automatic shutting devices.

PART 3 EXECUTION

3.01 SHEET METAL INSTALLATION

A. All ductwork shall be installed to true alignment, generally parallel or perpendicular to adjacent building walls, floors and ceilings, so as to present a neat and workmanlike appearance. All fabricated, stored and installed ductwork shall be protected with removable caps, plastic or other means to prevent dirt, water and debris from entering duct system. The Sheet Metal Contractor shall be responsible for maintaining a clean duct system and shall clean and/or replace any ductwork identified by the Owner or Architect as being deficient or dirty. The Sheet Metal Contractor shall be responsible for all costs associated with the temporary protection cleaning and/or replacement of ductwork. <u>All fabrication labels shall be applied to the exterior of the duct</u>. The Sheet Metal Contractor shall be responsible for the removal of all internal labels if such labels were incorrectly applied.

B. Care shall be paid to the exact locations of all sheet metal work with respect to equipment, ducts, conduits, piping, slabs, beams, columns, ceiling suspension systems, lighting fixtures and electrical, plumbing and fire protection systems in the building.

Close coordination and cooperation shall be exercised with other Trades in locating the piping and equipment in the best interests of the Owner. The drawings and specifications covering other work to be done in the building shall be carefully studied and arrangements shall be made to avoid conflict.

C. The drawings shall be followed where they are definite and provided such procedures do not cause objectionable conditions for equipment provided installed under this Contract. The drawings are intended to indicate the sizes of ductwork and if certain sizes are omitted or unclear, obtain additional information before proceeding.

D. Locate and size all openings for ductwork in the building construction. Provide all sleeves as hereinbefore specified.

E. Provide access doors in ductwork at the following locations:

1. Both sides of all coils
2. Fire dampers
3. Smoke dampers
4. Fire/Smoke dampers
5. Both sides of automatic dampers
6. Humidifiers
7. Both sides of filters
8. At all exhaust and intake plenums, doors shall allow full body access in all plenums over 4'-0" tall.
9. Otherwise indicated or specified

F. Provide labels with a minimum of 1" high red letters on white background. Each access door shall be labeled as follows (or worded as required by Code):

1. Fire Damper
2. Fire/Smoke Damper
3. Smoke Damper
4. Automatic Damper
5. Humidifier
6. Filter Access
7. Coil Access

G. The installation of special items of equipment in the duct systems, including automatic dampers, thermostats, thermometers, duct airflow measuring devices and other related controls, shall be done by this Contractor under the direct supervision of the manufacturer of such controls.

H. All elbows, tees and branch takeoffs in round ductwork shall be made of the same materials as the ductwork.

I. Duct connections to equipment shall be in no case smaller than the equipment openings.

J. All openings for pitot tube traverses shall be fitted with neat removable plugs or caps. As a minimum, such openings shall be provided at every fan inlet and at such other points as may be required for airflow measuring and balancing. Coordinate the location of plugs and caps with the Balancing Contractor.

K. All internally lined duct sections and joints shall be closely inspected by the contractor before and after each piece is erected. Loose edges, open joints, damaged areas and other defects shall be sealed securely so as to insulate all metal surfaces and so as to endure without falling in the presence of moving air. All liner applications shall comply with SMACNA "Duct Liner Application Standard".

L. Provide other miscellaneous sheet metal work shown on the drawings including blanking off portions of louvers not required for the specific usage and diffusion plates or mixing air scoops to allow for air mixing where job conditions require the provision of same. All above work shall be provided as part of this Contract at no extra cost to the Owner.

M. Where applicable and as approved by the Architect, all exposed ductwork shall be installed in a workmanlike manner to result in a neat appearance with no visible penetrations, screws, or other sheet metal imperfections.

N. Install all UL classified devices in accordance with their UL approved installation sheets.

O. Counterflashing of duct penetrations through roof shall be provided under this Contract.

3.02 DUCT HANGERS AND SUPPORTS

A. Provide suitable angle iron/strap hangers and supports inside the mechanical shafts, mechanical rooms and in ceilings of the buildings, and on the roof(s) as shown on the drawings (Architectural/HVAC). This work shall be performed as required by job conditions and as instructed by the Architect in the field to support all air distribution ductwork and devices in both horizontal and vertical planes.

B. When hanging and supporting the ductwork, the following shall be complied with:

1. Except as otherwise noted, ductwork up to 42" in greatest dimension shall be hung by using sheet metal bands secured as a minimum at (2) locations to the vertical sides of the ductwork and at (1) location under the duct. All support systems shall be compatible with the building structure and roofing system as approved by the Architect.
2. Where ductwork major axis dimension is larger than 42", ductwork shall be hung by using rods of not less than 3/8" soft steel secured to angle iron/unistrut trapeze support frame around ductwork with threaded nuts for securement and adjustment. All rods used on ductwork exposed in finished spaces shall be plain smooth rods threaded only at the ends.
3. Ductwork shall be securely attached to the building construction. The hanger design and spacing shall be governed by the major duct dimension and shall be in accordance with SMACNA Duct Manual, except as modified hereinbefore. Vertical ductwork shall be supported at each floor level in an approved manner using angles or channels attached to the ducts. The installation, when complete and under operating conditions, shall be free from chatter or vibration. If necessary to achieve this, additional supports and/or bracing shall be furnished without extra cost to the Owner. Supports and bars and similar items shall be primed and painted structural steel.

Touch up with aluminum paint any surfaces where galvanizing is destroyed on indoor ductwork, zinc primer on exposed ductwork with a final coat of aluminum paint. Provide vibration isolation hangers where specified under Vibration Isolation Section of these specifications. Explosive powder studs or detonator assisted studs or anchors will not be permitted.

4. The Sheet Metal Contractor shall provide all supplemental steel required to support the ductwork in shafts, mechanical rooms or on the floor where structural steel is not properly positioned. Beam clamps shall be double sided.
5. The maximum hanger spacing shall be 10'-0" on centers and additionally on each side of an elbow or change-in-direction fitting.
6. In addition to the above, provide supports on each side of any duct mounted device, fans, coils, flow measuring stations, framed dampers, etc., to permit removal of the device without disconnecting adjacent duct sections.
7. Provide angle sway bracing to the structure wherever lateral loads would be imposed on the ductwork, including but not limited to:

    a. Elbows downstream of fan discharges.
    b. Ductwork exposed to the weather subject to wind loads.

8. Ductwork mounted on the roof or otherwise exposed to the elements shall be supported with frames constructed of galvanized steel angles and channels regardless of duct size.

    a. Coordinate all roof supports with General Contractor/Construction Manager.
    b. Provide diagonal cross bracing between supports as required to sustain maximum area wind loads as dictated by the Architect.
    c. Refer to Specification Section 230548 for vibration and seismic restraint requirements.

9. The Sheet Metal Contractor shall provide expansion compensators, anchors and guides on all high temperature ductwork (breeching, high temperature supply/exhaust) as required.

3.03 SHEETMETAL TESTING

A. General

1. All ductwork that is required to be tested shall be tested on regular intervals as the job proceeds and shall be completed prior to enclosure in shafts, above ceilings or behind walls.
2. The Sheet Metal Contractor shall keep an up-to-date log of the ductwork tested for review by the Architect. The test records shall include marked drawings showing the system/area tested. The testing system/area shall be designated with unique naming. Testing documentation shall include pressure class, system, dates, calculations, allowable leakage, tested leakage and signatures. Testing results shall be Pass or Fail. The Sheet Metal Contractor shall notify all other Contractors when the testing is completed and accepted to permit enclosure of ducts. All test documentation shall be submitted as part of the project close out documentation package.
3. The Sheet Metal Contractor shall furnish and install all blank off plates, blind flanges, safing, etc., necessary to isolate each section of duct being tested for leakage.
4. The Sheet Metal Contractor shall submit for review all proposed testing procedures, sample report, and equipment to the Engineer prior to proceeding. Additionally, the Sheet Metal Contractor shall notify the Engineer when testing is to occur so that the test can be witnessed at the Engineer's option.

5. All test equipment shall be calibrated per ANSI Standards prior to testing. Certified test reports shall be submitted to the Architect prior to commencement of the testing.
6. Testing Procedure

    a. The testing procedure shall be in accordance with SMACNA "HVAC Air Duct Leakage Test Manual".
    b. The test pressure shall be the specified construction pressure of the duct system.

7. Scope of Testing

    a. All ductwork (regardless of pressure class) that will be in inaccessible areas including, but not limited to, all ducts within shafts, above hard ceilings, and those that will be made inaccessible by the work of other Trades. (This shall include ±2" w.g. construction.)
    b. All ductwork constructed to greater than +2" w.g. or less than -2" w.g.
    c. All other sheet metal in duct systems constructed to ±2" w.g. shall be tested under normal fan pressure and shall not leak sufficiently to cause audible leaks or blowing detectable by hand. **If, in the opinion of the Architect, the ductwork does not appear to be constructed and/or sealed to the approved shop standards, the Architect may request any or all of this ductwork to be tested at the specified construction pressure.**
    d. Allowable Leakage

        1) The total allowable leakage shall be less than specified leakage class with no audible leaks.
        2) If no leakage class is listed elsewhere, the system shall meet leakage Class 4.
        3) All duct risers shall be tested with branch takeoffs, fire dampers and access doors installed. Duct leakage shall be calculated based on duct surface area per SMACNA Test Manual. The duct surface area method shall include all seams, joints and other duct surface connections for take-offs, fire dampers and access doors, etc.

3.04 DUCT CLEANING

A. Clean dust and debris from interior and exterior of all ducts using wet rags and vacuums.

B. Cover open ends of ductwork when installation does not proceed for more than one day. This requirement shall apply to each individual run of duct, such that no duct section shall remain open or unconnected for more than 8 hours.

C. Supply Ductwork Cleanliness Requirements

1. Extreme cleanliness of the supply ductwork shall be maintained from fabrication through installation so as to not compromise the integrity of the facility filtration.
2. For all ductwork, the following cleanliness requirements shall apply:

    a. Upon fabrication, each duct section shall be cleaned with alcohol wipes and made oil-free.
    b. Following cleaning, each duct section shall be shrink-wrapped for shipment.
    c. On-site storage of supply ductwork, prior to installation, shall be in an enclosed, clean, dry space.

d. Upon installation, the protection requirements as specified in Paragraph 3.04B shall apply.

END OF SECTION

SECTION 233319

SOUND ATTENUATORS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Duct Sound attenuators.

B. Unit Sound attenuators.

C. Space Sound attenuators.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

B. UL 181 - Factory-Made Air Ducts and Connectors.

C. NFPA 70 - Electric Duct Heaters.

D. ASTM A 653/A653M Steel Sheet, Zinc Coated Galvanized.

E. ASTM C 553 Mineral fiber Blanket and felt.

F. ASTM C 612 Mineral fiber Block and Board Thermal insulation.

G. ASTM E 84 Surface Burning Characteristics of Building materials.

H. NFPA 255 Surface Burning Characteristics of Building materials.

I. UL 723 Surface Burning Characteristics of Building materials.

J. ASTM E-477-99

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Submit shop drawings and product data sheets indicating configuration, general assembly, and materials used in fabrication.

C. Submit product performance data indicating design air flow, minimum static pressure drop at operating condition.

D. Submit sound power and noise criteria (NC) values for radiated and discharge paths.

E. Submit installation, operation and maintenance documentation.

F. The manufacturer shall supply certified test data for each scheduled silencer. The data shall include dynamic insertion loss, generated noise and pressure drop for forward or reverse flow, matching the project's air distribution system requirement. All ratings shall be conducted in the same facility and shall utilize the same silencer.

G. Test facilities and test reports shall be open to inspection upon request from the Engineer. Silencer performance must have been substantiated by laboratory testing according to ASTM E-477-99 and so certified when submitted for approval.

H. Acoustic laboratory must be NVLAP accredited for the ASTM E-477-99 test standard. A copy of the accreditation certificate shall be included with the submittals. **Data from non-NVLAP accredited test facilities will not be accepted**.

1.06 QUALIFICATIONS

A. Manufacturer: The company manufacturing the products specified in this section shall have a minimum of ten year' experience producing products of this type.

1.07 WARRANTY

A. Provide manufacturer's parts warranty for one year from unit start-up.

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers contingent on compliance with the specifications:

1. Vibro Acoustics
2. VAW Systems
3. Dynasonics
4. United McGill
5. Kinetics Noise Control
6. Commercial Acoustics
7. Price

B. Silencers in aluminum systems shall be aluminum with all casing gauges adjusted accordingly.

C. Silencers in stainless steel systems shall be stainless steel.

D. Silencer in galvanized systems shall be galvanized steel.

E. Silencer in welded systems shall be continuously welded. See sheet metal section.

F. All gauges are based on steel. If aluminum is required equivalent strength aluminum gauges shall be used.

2.02 RECTANGULAR SILENCERS

A. All rectangular silencers shall be constructed with a casing of a minimum gauge noted below and minimum 22 gauge perforated internal liner. All casing seams and joints shall be lock-formed and sealed except welded systems shall be continuously welded.

	Connection Dimension	Casing Gauge
1.	Less than 48"	22
2.	Over 54"	Provide Calculations

B. All welded silencers shall be a minimum of 16 gauge.

2.03 ELBOW SILENCERS

A. All elbow silencers shall be constructed with a minimum 18 gauge outer casing and minimum 22 gauge perforated internal liner. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 48” shall have at least two half splitters and one full splitter.

B. All welded silencers shall be a minimum of 16 gauge.

2.04 TRANSITIONAL SILENCERS

A. All transitional rectangular silencers shall be constructed with a minimum of 22 gauge outer casing and minimum 22 gauge perforated internal liner. Transitioning shall occur internal to the silencer such that the height of the gap or air passage is uniformly changing with the length of the splitters.

B. All welded silencers shall be a minimum of 16 gauge.

2.05 ACOUSTIC MEDIA:

A. Dissipative and Film Lined silencers:

1. Media shall be of acoustic quality, shot-free glass fiber insulation with long, resilient fibers bonded with a thermosetting resin. Glass fiber density and compression shall be as required to insure conformance with laboratory test data. Glass fiber shall be packed with a minimum of 15% compression during silencer assembly. Media shall be bacteria and fungus resistant, resilient such that it will not crumble or break, and conforming to irregular surfaces. Media shall not cause or accelerate corrosion of aluminum or steel. Mineral wool will not be permitted as a substitute for glass fiber.

2.06 MEDIA PROTECTION

A. Dissipative silencers:

1. Where indicated on the silencer schedule, media shall be encapsulated in glass fiber cloth to help prevent shedding, erosion and impregnation of the glass fiber. Axial Cone silencers shall have a glass fiber cloth liner.

B. Film Lined silencers:

1. The acoustic media shall be completely wrapped with Tedlar film to help prevent shedding, erosion and impregnation of the glass fiber.
2. The wrapped acoustic media shall be separated from the perforated metal by a factory installed ½" thick acoustically transparent spacer.

   a. The spacer shall be flame retardant and erosion resistant.
   b. A mesh, screen or corrugated perforated liner will not be acceptable as a substitute for the specified spacer.

2.07 COMBUSTION RATINGS

A. Dissipative silencers:

1. Silencer materials, including glass fiber shall have maximum combustion ratings as noted below when tested in accordance with ASTM E84, NFPA 255 or UL 723.

   a. Flamespread Classification: 15
   b. Smoke Development Rating: 5

2.08 FILM LINED SILENCERS

A. Silencer materials, including glass fiber, Tedlar film and acoustical spacer shall have maximum combustion ratings as noted below when tested in accordance with ASTM E84, NFPA 255 or UL 723.

1. Flamespread Classification: 20
2. Smoke Development Rating: 45

2.09 HTL CASINGS(HIGH TRANSMISSION LOSS)

A. Where indicated on the silencer schedule, silencers shall have high transmission loss (HTL) walls externally applied and completely sealed to the silencer casing by the silencer manufacturer to assure quality controlled transmission loss. The HTL walls shall consist of media, airspace, mass and outer protective metal skin, as required, to obtain the specified room noise criteria. Standard acoustical panels will not be accepted as HTL walls. If requested by the Engineer, breakout noise calculations for each air handling and fan system shall be provided with the silencer submittal to insure compliance with the room noise criteria. Breakout noise calculations shall be based on the sound power levels of the specified equipment.

PART 3 EXECUTION

3.01 CONSTRUCTION

A. Silencers shall be constructed in accordance with ASHRAE and SMACNA standards for the pressure and velocity classification specified for the air distribution system in which it is installed. Material gauges noted in "Section B Materials", are minimums.

1. Material gauges shall be increased as required for the system pressure and velocity classification.

2. The silencers shall not fail structurally when subjected to a differential air pressure of 12 inches water gauge.

B. Casings shall be lock-formed and sealed, except as noted in Section B Materials, to provide leakage-resistant construction. Airtight construction shall be achieved by use of a duct-sealing compound supplied and installed by the contractor at the jobsite.

C. All perforated metal shall be adequately stiffened to insure flatness and form. All spot welds shall be painted.

PART 4 SCHEDULES

4.01 SEE DRAWINGS FOR SCHEDULES

4.02 ACOUSTIC PERFORMANCE

A. Silencer dynamic insertion loss shall not be less than that listed in the silencer schedule.

B. Silencer generated noise shall not be greater than that listed in the silencer schedule.

C. Acoustic performance shall include dynamic insertion loss and generated noise for forward flow (air and noise in same direction) or reverse flow (air and noise in opposite direction) in accordance with the project's air distribution system requirements.

D. All silencer ratings shall be determined in a duct-to-reverberant room test facility which provides for airflow in both directions through the test silencer in accordance with the ASTM E-477-99 test standard. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption.

4.03 AERODYNAMIC PERFORMANCE

A. Silencer pressure drops shall not exceed those listed in the silencer schedule. Silencer pressure drop measurements shall be made in accordance with the ASTM E-477-99 test standard. Tests shall be conducted and reported on the identical units for which acoustical data is presented.

END OF SECTION

SECTION 233363

AIR FLOW MEASURING STATIONS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install a complete system all Air flow Measuring stations

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.
2. NFPA 90B – Installation of Warm Air Heating and Air Conditioning Systems.
3. NFPA 96 – Installation of Equipment for the Removal of Smoke and Grease-laden Vapors from Commercial Cooking Equipment.
4. SMACNA (DCS) – HVAC Duct Construction Standards – Metal and Flexible.
5. UL 181 – Factory-Made Air Ducts and Connectors.

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: Provide data for duct materials.

C. Prepare and submit scaled coordination drawings.

D. Manufacturer's Installation Instructions.

1.06 QUALITY ASSURANCE

A. Manufacturer shall have adequate experience of building ductwork of the types required for this project as well as successful experience with projects of similar scope.

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable Manufacturers (Provided they are in compliance with these specifications)

1. Space Pressure Monitor & Controller

a. Air Monitor Corporation
b. Paragon Controls Inc
c. TSI
d. Setra Sensing Solutions

2. Airflow/Temperature Measurement Device

a. EBTRON, Inc. (basis of design)
b. Fluid Components International
c. KURZ Instruments
d. Sierra Instruments

2.02 SPACE PRESSURE MONITOR & CONTROLLER

A. Space pressure monitor/controller located as follows:

1. Isolation rooms
2. As indicated on drawings

B. The space pressure monitor shall measure the differential pressure between two individual spaces utilizing industrial quality differential pressure transducer technology and shall issue a 0-10VDC or 4-20mA control output signal utilizing a 3-mode (P, I, 1/D) controller circuitry to maintain the desired differential pressure between these two areas.

C. The space pressure monitor shall provide an analog output linear to the space pressure being monitored and a digital output to indicate the alarm status of the space for remote monitoring purposes.

1. Remote alarm status shall be via a Form C dry contact.
2. Local, high visibility, LED space pressure status lights
3. Audible alarm with alarm acknowledge (silence) button
4. Local indication shall display the measure differential pressure to the ten thousandth of an inch of water column.

D. The space pressure monitor shall be factory configured for either positive or negative space pressure monitoring based on the room's scheduled usage.

E. The positive/negative pressure alarm activation value, control setpoint value, and alarm activation delay value are to be field adjustable.

F. Switch selectable control mode values shall allow for an in operation @ adjustment of proportional band, reset (integral), and inverse derivative to match system dynamics. The controller shall also be provided with the following:

1. Auto/ Manual selection of controller output.

2. Local or remote controller setpoint for control of the space pressure.
3. Controller output/setpoint display selection switch.
4. Door interrupt feature to freeze or ramp the controller output to a pre-determined value when the room door is opened.

G. Differential pressure transducer performance shall be as follows:

1.	Accuracy:	±0.5% F.S. Terminal Point / ±0.35% F.S. BFSL
2.	Hysteresis:	±0.05%
3.	Linearity:	±0.4%
4.	Repeatability:	±0.1%
5.	Temperature Effects:	< ±0.03% F.S./EF
6.	Over-pressure:	5 PSIG Proof
7.	Response:	< 0.25 seconds for full span input
8.	Noise Filtration:	Low Pass Filter, factory set @ 3.2Hz

H. Three mode differential pressure controller performance shall be as follows:

1.	Proportional Band:	Adjustable from 1% to 100%
2.	Reset:	Adjustable from 0.6 to 6 repeats per minute
3.	Inverse derivative:	Adjustable from 0.5 to 7 minutes per repeat
4.	Hysteresis and dead band:	Within .01% of span
5.	Repeatability:	Within .01% of span.
6.	Control accuracy:	±0.1% of span.
7.	Output Signals:	0-10 VDC or 4-20 mA

I. The space pressure monitor & controller similar to the Guardian Plus as manufactured by Paragon Controls Incorporated.

2.03 AIRFLOW/TEMPERATURE MEASUREMENT DEVICES

A. General

1. Each element designed and built to comply with, and provide results in accordance with, accepted practice for duct system traversing as defined in the ASHRAE Handbook of Fundamentals, AMCA publication #203, as well as the Industrial Ventilation Handbook.
2. The number of sensing element, and the quantity of elements utilized at each installation, shall comply with ASHRAE Standard #111 for equal area duct traversing.
3. The airflow traverse elements shall produce steady, non-pulsating signals of true flow, with an accuracy of 2% of actual flow for operating velocities as low as 50 feet per minute.
4. The operating temperature range for the measuring probes shall be -20° F to 140° F. The operating humidity range for the measuring probe shall be 0-99% RH (non-condensing).
5. The airflow traverse elements shall not induce a pressure drop greater than 0.2 inches of water column at 4000 feet per minute.
6. The units shall have a self-generated sound rating of less than NC35 and the sound level within the duct shall not be amplified, nor shall additional sound be generated.

B. Products Included in this Section:

1. Duct and plenum mounted airflow measurement devices
2. Fan inlet mounted airflow measurement devices

C. Provide airflow/temperature measurement devices where indicated on the plans. Fan inlet sensors shall not be substituted for duct or plenum sensor probes indicated on the plans.

1. Duct and plenum mounted sensors shall be fabricated of anodized aluminum alloy tube with 303/304 stainless steel mounting brackets.
2. Fan inlet probes shall be field adjustable to fit the fan inlet and have 303/304 stainless steel mounting feet.

D. Each measuring device shall consist of one or more multi-point measuring probes and a single microprocessor-based transmitter. Each transmitter shall have an LCD display capable of displaying airflow and temperature. Airflow shall be field configurable to be displayed as a velocity or volumetric rate. Each transmitter shall operate on 24 VAC.

E. Each sensing point shall independently determine the airflow rate and temperature, which shall be equally weighted and averaged by the transmitter prior to output. Devices, which average multiple non-linear sensing point signals, are not acceptable. Pitot tube arrays are not acceptable.

F. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter at a given measurement location. Probes and transmitters shall not require field matching for proper operation.

G. The operating airflow range shall be 50-5,000 FPM unless otherwise indicated on the plans.

H. The operating temperature range for the measuring probes shall be -20° F to 140° F. The operating humidity range for the measuring probe shall be 0-99% RH (non-condensing).

I. The operating temperature range for the transmitter shall be -20° F to 120° F. The transmitter shall be protected from weather and water.

J. Each independent airflow sensor shall have a laboratory accuracy of +/-2% of reading over the entire operating airflow range and be wind tunnel calibrated or verified against standards that are traceable to NIST.

1. Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.

K. Each independent temperature sensor shall have a laboratory accuracy of +/-0.15° F over the entire operating temperature range and be calibrated or verified against standards that are traceable to NIST.

L. The number of sensors for each location shall be as follows:

1. Ducts and plenums:

Area (sq.ft.)	Sensors
<=1	2
>1 to <4	4
4 to <8	6
8 to <12	8
12 to <16	12
>=16	16

2. Fan inlets: 2 per inlet

M. The airflow/temperature measuring device shall be capable of displaying the airflow and temperature readings of each sensor on the transmitter's LCD display.

N. The transmitter shall fully communicate with the host controls and the ATC:

O. Airflow/Temperature measuring devices shall be UL listed as an entire assembly.

P. The manufacturer's and or there authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans. A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer's placement requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. The drawings shall be followed where they are definite and provided such procedures do not cause objectionable conditions for equipment provided installed under this Contract. The drawings are intended to indicate the sizes of ductwork and if certain sizes are omitted or unclear, obtain additional information before proceeding.

B. The installation shall be done under the direct supervision of the manufacturer.

C. Duct connections to equipment shall be in no case smaller than the equipment openings.

D. Primary Elements shall be installed in strict accordance with the manufacturers published requirements, and with ASME guidelines effecting non-standard approach condition. These elements serve as the primary signals for the airflow systems; therefore, it shall be the responsibility of the contractor to verify and installation, to assure that accurate primary signals are obtained.

E. Install all UL classified devices in accordance with their UL approved installation sheets.

F. An identification label shall be place on each primary flow element showing airflow direction and listing the Model No.; System Served, Size and Identifying Tag No.

G. An identification label shall be placed on each airflow indicating transducer listing the Model No., Flow Elements Served, Full Scale Value, and Identifying Tag No.

3.02 AIRFLOW/TEMPERATURE MEASUREMENT DEVICES

A. Installation

1. Install in accordance with manufacturer's instructions at the locations indicated on the plans. A written report shall be submitted to the consulting mechanical engineer if any discrepancies are found.

B. Adjusting

1. Duct and plenum devices shall not be adjusted without approval from the consulting Mechanical Engineer.

END OF SECTION

SECTION 233600

AIR TERMINAL BOXES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Terminal unit assembly.

B. Heating coils.

1. Electric resistance.
2. Hot water.

C. Sound attenuator.

D. Terminal Unit Controls

1. Direct digital.

a. By ATC

E. Single Duct Terminal Units

1. Exhaust and return terminal units.
2. Variable volume.
3. Constant volume.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections and divisions of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

B. UL 181 - Factory-Made Air Ducts and Connectors.

C. NFPA 70 - Electric Duct Heaters.

D. UL 1995, Heating and Cooling Equipment.

E. CUL C22.2 No. 236, Heating and Cooling Equipment.

F. ARI 880 - Air-Conditioning and Refrigeration Institute Standard Rating Conditions for Air Terminals

G. ASTM A 653/A653M (Steel Sheet, Zinc Coated Galvanized).

H. A-A-1419 or F-F-310 Federal specification (filter element, Air conditioning, Viscous-impingement or Dry type, replaceable), Tested per UL 900.

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Submit shop drawings and product data sheets indicating configuration, general assembly, and materials used in fabrication.

C. Submit product performance data indicating design air flow, minimum static pressure drop, fan operating condition.

D. Submit sound power and noise criteria (NC) values for radiated and discharge paths.

E. Submit installation, operation and maintenance documentation.

1.06 QUALIFICATIONS

A. Manufacturer: The company manufacturing the products specified in this section shall have a minimum of ten years' experience producing products of this type.

1.07 SYSTEM RESPONSIBILITY

A. The Contractor shall be responsible for any and all costs associated with any and all changes resulting from the use of a supplier other than the listed acceptable manufacturers.

1.08 WARRANTY

A. Provide manufacturer's parts warranty for one year from unit start-up.

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers contingent on compliance with the specifications:

1. Enviro-Tec
2. Price
3. Nailor
4. Anemostat

B. Provide Terminal unit assemblies with:

1. Operating characteristics and other requirements so as to comply with schedules and details on the drawings and as hereinafter specified.
2. The physical sizes of units shall not be larger than the scheduled units.
3. Terminal units shall be UL listed as an entire assembly.

4. Terminal units shall be UL Labeled as an entire assembly.
5. Shall be lined with thermal and acoustic insulation meeting "Hospital Grade".
6. Access doors securely attached to the box upstream of the heating coil.
7. Access doors securely attached to the box downstream of the heating coil.
8. Identification label

    a. Identify each terminal unit with clearly marked with:

        1) Box Identification number matching the drawings
        2) Air flow.
        3) Maximum factory-set air flow.
        4) Minimum factory-set air flow.
        5) Coil type.

    b. Direction of air flow

C. Primary Air Valve

1. Minimum 22 gauge cylindrical body
2. Damper Blade

    a. Connected to a solid shaft by means of an integral molded sleeve which does not require screw or bolt fasteners.
    b. Minimum of 20 gauge.

3. The shaft shall include a damper position indicator visible from the exterior of the unit.
4. The damper shall pivot in self-lubricating bearings.
5. The damper actuator shall be mounted on the exterior of the terminal for ease of service.
6. The valve assembly shall include internal mechanical stops for both full open and closed positions.
7. The damper blade seal shall be secured without use of adhesives.
8. The air valve leakage shall not exceed 1% of maximum inlet rated airflow at 3" w.g. inlet pressure.
9. Damper shall pivot in nylon self-lubricating bearings
10. Damper shall remain unaffected by temperature and humidity.

D. Primary Air Pressure Sensor

1. The primary air valve shall include a differential pressure type sensor upstream of the damper blade.
2. The sensor shall traverse the inlet collar (for total pressure) along (2) axis. A minimum of (12) sensing points shall be utilized.
3. The sensor shall be accessible and removable for easy cleaning.
4. Each sensing point shall be located for accuracy.
5. The sensor shall be designed to average the pressure signals.
6. The average signal of these pressures shall pass to the control device signal through a single port.
7. Brass balancing taps and airflow calibration charts shall be provided for field measurements.
8. The sensor shall be designed to provide an amplified differential pressure signal.
9. Signal shall provide accurate control of the air flow to or below the minimum flows scheduled and to one half the minimum for variable volume units.
10. Documentation shall be submitted which substantiates this requirement.

E. Manufacturer shall participate in the ARI Certification program.

F. Unit performance data shall be rated in accordance with ARI Standard 880.

G. The manufacturer shall display the ARI Symbol on all units.

1. Insulation

a. Minimum thickness of 1.0”
b. Comply with:

1) NFPA-90A.
2) UL 181
3) UL 723
4) ASTM 84
5) Bacteriological standard ASTM C 665.

c. Minimum R-Value shall be 4.6.
d. Hospital Grade
e. All insulation edges shall be metal encased.
f. Adhesive shall comply with NFPA 90A
g. Secured to the terminal casing using mechanical fasteners in addition to adhesive.

2. Type

a. Closed Cell Foam

1) Minimum Density 2.5 lb./cu. ft.
2) The insulation R-Value shall be a minimum of 1.4.

H. Testing

1. General

a. All tests shall be performed in a certified laboratory.

2. Unit leakage

a. Assemble leakage including all devices, box, coil, attenuator, access doors, and fittings:

1) Shall be less then leakage class 6 at ±3 “w.g.

3. Unit performance

a. A assembly shall consist of valve, coil attenuator and transitions as called for on the documents
b. The performance of the assembly shall be tested and certified.

1) Each box size shall be tested with:

a) Coils
b) Sound attenuators

c) Box
d) Each Flow configuration.

2) With an inlet static of 1 ½"w.g. at the system side of the supply box.
3) With an inlet static of -1 ½"w.g. at the system side of the exhaust box.

c. These tests shall include the pressure loss of each component and the sound power levels in each octave band leaving the assembly.

I. Heating Coils

1. All supply terminals scheduled with a heating coils shall be equipped hot water heating:

a. Coils shall be enclosed in a sheet metal casing.
b. Coils casing shall be insulated.

1) Minimum R 6.0

c. The maximum coil air velocity shall be as scheduled.
d. The minimum coil performance shall be as scheduled.
e. The maximum pressure drop scheduled shall not be exceeded at the box maximum CFM.
f. Coils shall be removable.
g. Coils shall have access doors upstream and downstream of coil.
h. Coils shall have left- or right-hand connections to suit job conditions
i. Two (2) rows to meet heating requirements.
j. Coils shall have aluminum plate fins maximum of 6 fins per inch.
k. Tested with 400 psig hydrostatic pressure (underwater).
l. The minimum fin thickness shall be 0.095 inches.
m. All coils shall be performance certified in accordance with ARI 410 (latest Edition).

J. Sound Attenuators

1. Minimum sheet metal gauge 20.
2. Hospital grade lining.
3. Minimum performance to meet scheduled data.
4. Pressure drop of the assembled package as tested shall not exceed the scheduled performance.

K. Unit Controls

1. DDC Controls with:

a. Terminal unit controls.
b. Transformers
c. Actuators shall be DDC.
d. Furnished and shipped to the box manufacturer by the ATC Contractor.
e. The ATC Contractor shall be responsible for all costs associated with shipping the controls to the terminal box manufacturing facility.
f. Box damper actuators, transformers and controller shall be installed by the box manufacturer.
g. The box manufacturer shall factory mount and wire the controller and actuator in accordance with the ATC Contractor's instructions.

h. Controller installation costs shall be borne by the airflow terminal box manufacturer.
i. Box manufacturer shall provide velocity inlet probe and NEMA control cover.

Note: Controller and actuator specified in ATC.

2.02 SINGLE-DUCT TERMINAL UNITS

A. Provide air terminal units (boxes) of the single duct type, with:

1. Heating coils:
2. Sound attenuators, meeting the performance scheduled.

3. Units shall be similar to Enviro-Tec Model SDR -SA-WC or Model SDL -SA-WC

B. Terminal casings shall be :

1. Minimum 22 gauge sheet metal casing and insulation
2. Primary valve: See Products – General
3. Primary Air Pressure Sensor: See Products – General
4. Terminal shall be assembled and sealed for an airtight casing:

a. Meet SMACNA leakage class 3 at 3” w.g.

5. Attenuators See Products – General.

2.03 SINGLE DUCT RETURN OR EXHAUST BOX

A. Similar to single duct terminal units except.

1. Boxes shall be provided with an inlet of the VAV sensing neck to minimize pressure drop.
2. Designed with the sound attenuator on the room side.

B. Single Duct Terminal Unit Controls

1. DDC Controls See Products – General

2.04 AIR VOLUME CONTROL AND MEASURING STATION (AVCMS) / HVAC CUSTOM VAV BOXES

A. Manufacturers: Price Industries

B. Sleeve:

1. Damper sleeve supplied as a single assembly with a minimum length of 36”. The assembly casing shall be constructed of 20 gauge zinc coated steel.

2. The casing shall be constructed to maintain leakage rates not exceeding the maximum values listed in Table A.

Standard Unit Leakage, CFM

Size	.25"Ps	0.5"Ps	1.0"Ps
4, 5, 6	1	2	3
7, 8	1	2	3
9, 10	1	2	3
12	1	2	3
14	2	2	3
16	2	3	4

C. Damper

1. Dampers shall have a maximum leakage of 6 cfm/ sq. ft. @ 4 in. wg or 3 cfm/sq. ft. @ 1 in. wg.

   a. Damper shall meet or exceed the IECC (International Energy Conservation Code) requirements for damper leakage ratings of 3 cfm/ sq. ft @ 1 in. wg or 8 cfm/sq. ft. @ 4in. wg or less when integral to the building envelope.
   b. Dampers shall bear the AMCA Certified Ratings Seal for Air Performance in accordance with AMCA 511.

2. Differential Pressure:

   a. Dampers shall have a maximum differential pressure rating of 5 in. wg.

3. Velocity:

   a. Dampers shall have a maximum velocity rating of 3000 fpm (15.2m/s).

D. Damper Construction

1. Frame:
   Damper frame shall be 16 ga. galvanized steel formed into a 5” x 1” structural hat channel. Top and bottom frame members on dampers less than 17” high shall be low profile design to maximize the free area of these smaller dampers. Frame shall be 4-piece construction with 1 ½” (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking.

2. Blades:
   Blades: Damper blades shall be 16 ga. galvanized steel strengthened by three longitudinal 1” deep Vee grooves running the entire length of each blade. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening. Blade orientation is horizontal. Blade operation is opposed.

3. Blade Stops:
   Each blade stop (at top and bottom of damper frame) shall occupy no more than ½” of the damper opening area to allow for maximum free area and to minimize pressure loss across the damper.

4. Seals:

   a. Blade Edge: Blade seals shall be TPE comes standard which are mechanically fastened to each blade. Silicone blade seal is optional.
   b. Jamb: Flexible stainless steel compression type

5. Linkage: Concealed in jamb, plated steel material. Stainless steel is available as an option.
6. Axles: Minimum ½ inch dia. plated steel. Stainless steel axle is optional.
7. Bearings: Axle bearings shall be synthetic (acetal) sleeve rotating in polished extruded holes in the damper frame.
8. Finish: Mill Galvanized finish is standard.

E. Air Flow Measuring Station

1. Acceptable Manufacturers

   a. Subject to compliance with performance and design requirements of this Section, provide products that comply with this specification by one of the following vendors:

      1) EBTRON, Inc. Models GTC116-PC (basis of design)

      2) Alternatives requesting acceptance as “equals” less than 60 days prior to bid date or products submitted in non-conformance with the requirements of this specification will not be considered.

         a) For any product to be considered for substitution a written section-by-section detailed exceptions/compliance document shall be submitted to the Engineer before any approval will be considered.
         b) Any firm submitting a product as an equal shall make available a functioning non-fan powered demonstration sample for review in the specifying engineer’s office.

2. Airflow/Temperature Measurement Devices
   a. Provide airflow/temperature measurement devices (ATMD) where indicated on the plans.
   b. Each ATMD shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor nodes contained in one or more probe assemblies per measurement location.
      1) The airflow rate at each sensor node shall be equally weighted and arithmetically averaged by the transmitter prior to output. All integrated circuitry shall be temperature rated as ‘industrial-grade’. Submissions containing ‘commercial-grade’ integrated circuitry are not acceptable.
      2) The temperature at each sensor node shall be arithmetically averaged or velocity weighted and averaged by the transmitter prior to output, either as field-selected by the contractor or user.
      3) Each transmitter shall have a 16-character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics.

4) Devices using chip-in-glass, epoxy-coated or diode-case chip thermistors are not acceptable.
5) Devices with RJ-45 connections exposed to the environment or having electronic circuitry mounted in or at the sensor node are not acceptable.
6) Pitot tubes and arrays are not acceptable.
7) Vortex shedding devices are not acceptable.

c. All Sensor Probes

1) Each sensor node, shall independently determine the airflow rate and temperature at each measurement point.
2) Each sensor node shall be factory calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST).

a) Thermistor sensor calibrations traceable only to temperature standards are not acceptable.

3) Airflow accuracy shall be +/-2% of Reading over the entire operating airflow range of not less than 0 to 5,000 fpm (25.4 m/s).

a) Devices whose overall performance at the host controller input terminals is the combined accuracy of the transmitter and sensor probes shall demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.

4) Temperature accuracy shall be +/-0.14° F (0.08° C) over the entire operating temperature range of -20° F to 160° F (-28.9° C to 71° C).
5) The operating humidity range for each sensor probe shall be 0-99% RH (non-condensing). Product design shall consider direct exposure to or emersion in liquid water and temporary exposure shall not damage the sensing elements.

d. Duct and Plenum Probes

1) The number of individual sensor nodes provided for each location shall be as follows:

Duct or Plenum Area (ft^2)	**Total # Nodes / Location**	Duct or Plenum Area (m^2)
<= 1	**1 or 2**	<= 0.093
>1 to <4	**4**	>0.093 to < 0.372
4 to < 8	**6**	0.372 to < 0.743
8 to < 12	**8**	0.743 to < 1.115
12 to <16	**12**	1.115 to < 1.486
>=16	**16**	>= 1.486

2) The minimum operating airflow range shall be 0 to 5,000 FPM (25.4 m/s).

e. Transmitters

1) The transmitter shall have an integral LCD display capable of simultaneously displaying airflow and temperature. The LCD display shall be capable of displaying individual airflow and temperature readings of each independent sensor node.
2) The transmitter shall be capable of field configuration and diagnostics using an on-board pushbutton interface and LCD display.
3) The transmitter shall have an on-off power switch and operate on 24 VAC. Isolation transformers shall not be required.

a) The transmitter shall use a switching power supply, fused and protected from transients and power surges.
b) The transmitter shall use “watch-dog” circuitry to assure automatic reset after power disruption, transients and brown-outs.

4) The operating temperature range for the transmitter shall be -20° F to 120° F (-28.9° C to 48.9° C). The transmitter shall be installed at a location that is protected from weather and water.
5) The transmitter shall be capable of communicating with other devices using one of the following interface options.

a) Linear analog output signals for airflow and temperature: Field selectable, fuse protected and electrically isolated from all other circuitry, 0-5VDC / 0-10VDC / 4-20mA (4-wire)

6) The transmitter shall be capable of identifying a ‘damaged’ sensor node, ignore it and continue to operate by correctly averaging the remaining sensor nodes.

f. Quality Assurance

1) Manufacturer Qualifications: The successful firm shall have a minimum of ten years experience producing microprocessor-based, multi-point thermal dispersion velocity meters and shall have a record of successful in-service performance verified by the consulting mechanical engineer.
2) Instruments, Devices, and Accessories: Products described in this Section shall be Listed and labeled in accordance with the UL Listing and Follow-up Service having been tested in accordance with standard UL 873 – Temperature (and Airflow) Indicating Equipment as a complete and functional assembly by a testing agency acceptable to authorities having jurisdiction.

F. Integral Silencer

1. Boxes shall be provided with discharge silencer assemblies. Units certified shall be tested as a complete assembly per ASHRAE 130 Methods of testing for rating ducted air terminals. Separate testing of unassembled silencer and terminal unit will not be acceptable due to possible noise regeneration or system effects. Silencer section shall be fabricated of 22ga solid galvanized metal casing, 22ga perforated liners, and absorptive acoustic fiberglass liner.

The silencer noses and perforated liners shall be rigidly fastened to the casing on both the top and bottom.

a. The silencer section acoustic media shall be shot free inorganic glass fiber with long, resilient fibers, bonded with thermosetting resin, and contain 50% recycled media. Glass fiber shall be packed with a minimum 10% compression to eliminate voids and settling; density shall be consistent with that used to generate catalog test data. Combustion ratings for acoustical media shall meet ASTM E84, UL 713, and NFPA 255.
b. Acoustic media shall be completely encapsulated in a Mylar pillow. An acoustic stand-off shall be provided between the encapsulated acoustic media and the perforated liner to prevent media fibers from entering the air stream.

G. Accessories

1. Actuators:

a. Type:

1) Electric, 24V AC, 2-position / modulating

2. Mounting:

a. External

3. Electrical Compartment and Controls.

a. 24Volts AC transformer.
b. Sheet metal enclosure.

H. Source Quality Control

1. Factory Tests: Factory cycle damper and actuator assemblies to assure proper operation.

PART 3 EXECUTION

3.01 INSTALLATION

A. The air terminal boxes shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

B. The inlet duct size shall be as noted on the plans and/or the schedule. Air terminal boxes shall be connected to the sheet metal per requirements found herein under "Sheet Metal Work" Section.

C. Terminal boxes shall be installed with adequate service space to access the controller side of the unit and the reheat coil control valve.

D. Provide an access door in ductwork downstream of heating coil in addition to access door on unit upstream of coil. Label all access doors in accordance with labels specified under "Sheet Metal Installation" Section.

E. Support each box adequately and independently without blocking access doors, control instrument access, or any other required access.

3.02 CUSTOM VAV BOX/AIR VOLUME AND MEASURING STATION (AVCMS)

A. Install custom VAV / AVCMS boxes in accordance with manufacturer's Installation Instructions.

B. The inlet duct size as noted on the plans and/or the schedule are for reference only and final sizes are to be coordinated and verified in the field (when connecting to existing ductwork distribution systems.) AVCMS shall be connected to the sheet metal per requirements found herein under "Sheet Metal Work" Section.

C. Terminal boxes shall be installed with adequate service space to access the controller side of the unit (and the reheat coil control valve when applicable.)

D. Provide an access door in ductwork downstream of heating coil in addition to access door on unit upstream of coil. Label all access doors in accordance with labels specified under "Sheet Metal Installation" Section.

E. Support each box adequately and independently without blocking access doors, control instrument access, or any other required access.

END OF SECTION

SECTION 233700

REGISTERS, GRILLES AND DIFFUSERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all registers, grilles and diffusers including opposed blade dampers, frames and other accessories to make a complete system of air distribution.

B. All materials shall be new and manufactured for the specific purpose of distributing and controlling air flow.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as following:

1. ADC 1062: GRD – Test Code for Grilles, Registers and Diffusers; 1984.
2. AMCA 500 – Test Method for Louvers, Dampers and Shutters; 1989.
3. ASHRAE 70 – Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.
4. NFPA 90A – Installation of Air Conditioning and Ventilating Systems; 1993.
5. SMACNA (DCS) – HVAC Duct Construction Standard – metal and Flexible; 1995.

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application and noise level.

C. Project Record Documents: Record actual locations of air outlets and inlets.

D. Submit air terminal performance data including static pressure, throw, velocity, airflow and acoustical performance. Data must indicate compliance with referenced Codes and Standards specified herein.

E. Manufacturer shall review requirements of outlets as to size, finish and type of mounting before submitting shop drawings and schedule of outlets.

F. Manufacturer shall check location of outlets and make necessary adjustments in position to conform with architectural features, symmetry and lighting arrangement before submitting shop drawings.

1.06 QUALITY ASSURANCE

A. Manufacturer shall certify cataloged performance and ensure correct application of air outlet types.

B. Manufacturer shall be responsible for examining application of each outlet and shall guarantee that each will provide comfortable space conditions without drafts at noted capacity.

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers contingent on compliance with specifications.

1. Anemostat
2. Krueger
3. Tuttle & Bailey
4. MetalAire
5. Price
6. Nailor
7. Titus

B. All air distribution devices shall be of steel or aluminum construction unless otherwise specified herein or scheduled on the drawings.

C. Distribution devices, except where such devices are specified or scheduled to be steel extruded aluminum, shall be factory primed and finish painted by the manufacturer in a color as approved by the Architect during shop drawing review, unless otherwise noted.

D. **All diffusers, grilles and registers must be compatible with the designed ceiling/wall type. Refer to architectural drawings for exact details of ceiling/wall construction.**

2.02 DIFFUSERS, REGISTERS AND GRILLES SHALL BE OF TYPE AS HEREIN SPECIFIED

Designation	Service	Air Pattern
A	Supply	1-way
B	Supply	2-way (90°)
C	Supply	2-way (180°)
D	Supply	3-way
E	Supply	4-way
F	Return/Exhaust	45° Deflection

Designation	Service	Air Pattern
G	Sidewall Supply (Adjustable)	45° Deflection (Double Deflection)
H	Low Wall Return/Exhaust	---
I	Vertical Heat Pump Return	Acoustical Panel
J	Linear Supply/Return	
K	Exhaust (Filter Grilles)	---
L	Linear Supply	1-way (adj. slot)

A. Types A, B, C, D and E (Ceiling Supply)

1. Ceiling or sidewall supply air diffusers of the above types shall be of the restricted multi-orifice jet induction and air mixing type, consisting of louvered sections with built-in diffusing vanes, similar to Tuttle & Bailey Type RCLT.
2. The vanes shall be arranged to discharge air from adjacent channels at a 45° angle in opposite directions to the plane of discharge to ensure rapid mixing of primary and room air. Each individual diffusing vane shall be welded in (2) places to the adjacent louver sections to make a rigid integral unit. The vanes shall extend to the discharge edges of the louvers.
3. Where louver sections abut core frame, the louver ends shall be welded to core frame. The louver ends shall be rounded and hemmed before welding to core frames.
4. Diffusers shall be square or rectangular, as shown on the drawings. Diffusers shall be assembled in patterns which provide 1-way, 2-way, 3-way or 4-way air discharge with each side delivering a quantity of air proportional to the area served. Diffusers shall be fabricated of steel welded or aluminum construction. The diffusers shall be provided with a removable core permitting easy access to the neck connection.
5. The diffusers shall be constructed with an integral collar extending at least 1" above the core **to accommodate an internal duct connection**. Collar corners shall have welded angles on the outside to prevent leakage and ensure that internal duct connection can be made secure.

B. Type F (Return and Exhaust)

1. General return/exhaust registers shall be similar to Tuttle & Bailey Model T77D and shall be made of steel or aluminum with (1) set of fixed blades, 42° deflection. Provide with countersunk holes and suitable frame to match ceiling or wall construction.
2. All return and exhaust registers installed in all toilet rooms, laundry rooms, showers and other areas subject to moisture shall be similar to above except constructed of all aluminum, equal to Tuttle & Bailey Model A77D.

C. Type G (Sidewall Adjustable Supply)

1. Sidewall supply registers shall be similar to Tuttle & Bailey Model T547 and shall be made of steel or aluminum, with mitered corners, double adjustable deflection core, and horizontal front louvers. Frames shall be suitable for construction adjacent to where registers are to be installed. Registers shall have countersunk screw holes.

D. Type H (Low Wall Return/Exhaust)

1. Low wall return/exhaust registers shall be similar to above except frame and blade shall be manufactured of heavy gauge steel or extruded aluminum (minimum thickness 12 gauge) for rugged use similar to Tuttle & Bailey Model 117DG.

E. Type I (Vertical Heat Pump Return)

1. Panels shall be similar to Climate Master G Style Return Air Panel, Model 816. The panel shall be a solid acoustical front panel mounted slightly away from the wall to allow return air to enter the front of the unit.
2. It shall be the responsibility of the Mechanical Contractor to mount the acoustical panel on the unit in such a way as to insure proper return air flow to the unit.

F. Type J (Linear Supply and Return)

1. Stripline supply and return diffusers shall be similar to Tuttle & Bailey Model EH.
2. Linear diffusers shall be of the multi-orifice, quick diffusing type. Diffusers shall be so designed that the air will be discharged at a uniform velocity through all orifices. Airstreams shall be discharged at counter angles to create turbulence within the primary airstream and thus achieve rapid mixing of primary and room air. The diffuser efficiency must be such that the initial temperature differential shall be reduced by 50% at a distance 1'-0" from the point of discharge. Slotted elements of the grilled type lacking diffusing elements and mixing characteristics will not be acceptable.
3. Stripline borders and frames shall be of extruded aluminum. Diffusing vane sections shall be of drawn and stamped aluminum shapes.
4. Diffuser shall be equipped with matching extruded frame to suit the adjacent construction where applicable. Means shall be provided for attaching diffuser to plaster frame with safety spring locks. No screwholes shall be visible on plaster frames or stripline.
5. Finish shall be electro-plated off-white enamel or as indicated on the drawings.

G. Type K (Filter Grilles)

1. Filter grilles shall be similar to Tuttle & Bailey Model A70DFB or MetalAire Model RHF aluminum grilles. Grilles shall have concealed hinge for access to filter and filter rack to accommodate 1" filter. Hinge location shall be on bottom. Grilles shall have a minimum free area of 85%. Finish shall be electro-plated off-white enamel or as indicated on the drawings.
2. A 1" fiberglass filter shall be factory provided with filter grille.

H. Type L (Supply Slot Diffuser)

1. Furnish and install supply slot diffusers of the sizes, configurations and mounting types indicated on the plans and outlet schedule. Diffusers shall have (2) discharge slots (1 in.) wide with aerodynamically curved “ice tong” shaped pattern controllers for 180 degree air pattern control and air flow dampering if required. The diffuser border shall be heavy extruded aluminum construction with extruded aluminum spacers and mitered end flanges, open ends, flush end caps or angle end caps as required to suit the architectural reflected ceiling plan. Continuous length units shall be provided with factory assembled corner modules to suit drawings and on site conditions. Joiner strips shall be provided to align continuous slot assemblies. The diffuser border shall be finished in B12 White Powder Coat. Paint finish shall pass 500 hours of salt spray exposure with no measurable creep in accordance with ASTM D1654 and 1000 hours with no rusting or blistering as per ASTM D610 and ASTM D714.
2. Linear slot diffusers and grilles to be similar to:

    a. Price model SDS (100)
    b. Anemostat SLAD-100

3. ACCESSORY ITEM; PLENUMS to be provided.

   a. Supply linear slot diffuser shall be provided with plenum assembly of the sizes, configurations and mounting types indicated on the plans and outlet schedule. Plenums shall be constructed of zinc coated steel and have $^{1}/_{4}$ in. internal insulation. Plenum assembly shall have sloped shoulders for enhanced spread characteristics. Plenum assemblies shall be of a side inlet configuration with sizing to properly fit the width of the active diffuser lengths.

4. ACCESSORY ITEM; BLANK-OFFs to be provided.

   a. In-active linear slotted sections, where the diffuser or grille is not being used for air flow shall be provided with a mat black blank-off plate. (The appearance shall reflect a continuous “slot” appearance between “active” and “in-active” slotted sections with a continuous appearance allowing for only hairline seams.)

5. ACCESSORY Options to be provided as required to accommodate a continuous appearance (to match the Architectural Reflected Ceiling Plans.)

   a. Welded corner with standard 45° or 90° face miter, or 90° stack miter
   b. Mitered Corner custom angles (as required.)
   c. Alignment strips and keyways for precise alignment with mating linear units

6. Custom colors (provide paint chip or formulation number).

I. Air Screens/Wire Mesh

1. Mesh shall be 3/4" square pattern, 1/16" galvanized wire, interwoven, welded or secured to frame.
2. Frames shall be 1" by 1" by 1/8" galvanized steel angles for duct sizes through 24"; 1 1/2" x 3/16" for duct sizes between 25" and 48"; and, 2" by 2" by 3/16" for ducts larger than 48", continuous around perimeter of screen.

PART 3 INSTALLATION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s instruction.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry and lighting arrangement.

C. Install diffusers to ductwork with air tight connections.

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

E. Paint ductwork visible behind air outlets and inlets matte black.

END OF SECTION

SECTION 233723

ROOF ACCESSORIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install a complete system of roof curbs, air intake/exhaust houses, including accessories, at all areas indicated on the contract drawings.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel; 1994.
2. ASTM A 366/A 366M – Standard Specification for Steel, Sheet, Carbon, Cold Rolled, Commercial Quality; 1991.
3. ASTM A 569/A 569M – Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality.
4. ASTM A 653/A 653M – Standard Specification for Steel Sheets, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.
5. ASTM A 666 – Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
6. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
7. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
8. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.
9. NFPA 90B – Installation of Warm Air Heating and Air Conditioning Systems.
10. NFPA 96 – Installation of Equipment for the Removal of Smoke and Grease-laden Vapors from Commercial Cooking Equipment.
11. SMACNA (DCS) – HVAC Duct Construction Standards – Metal and Flexible.
12. UL 181 – Factory-Made Air Ducts and Connectors.

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: Provide data for materials and products.

C. Prepare and submit scaled manufacturer's drawings.

D. Manufacturer's Installation Instructions.

1.06 QUALITY ASSURANCE

A. Manufacturer shall have adequate experience of building products of the types required for this project.

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable Manufacturers subject to compliance with the specification:

1. Roof Curbs:

a. Loren Cook Co.
b. Construction Specialties
c. Greenheck

2. Louvered exhaust and supply Houses:

a. Loren Cook Co.
b. Construction Specialties
c. Greenheck

2.02 ROOF CURBS

A. General

1. Provide roof curbs for sheet metal duct penetration roof mounted fans, gravity intake, exhaust and relief hoods of types and sizes as shown on the drawings and as hereinafter specified. Roof curbs shall be as manufactured by the approved fan or hood manufacturer.
2. Refer to other Sections of this specification and Section 230500 for General Requirements and Conditions.
3. Roof curbs shall be suitable for field flashing by the Contractor.

B. Materials

1. Roof Curbs (Other than kitchen cooking hood exhaust)

a. Roof curbs shall be prefabricated, acoustical type, constructed of 16-gauge aluminum, pre-insulated with insulation protected from erosion.

PART 3 EXECUTION

3.01 INSTALLATION

A. The drawings shall be followed where they are definite and provided such procedures do not cause objectionable conditions for equipment provided installed under this Contract. The drawings are intended to indicate the sizes of curbs, intake/exhaust houses and if certain sizes are omitted or unclear, obtain additional information before proceeding.

B. Locate and size all openings for ductwork in the building construction. Provide all sleeves as hereinbefore specified.

C. The installation shall be done under the direct supervision of the manufacturer.

D. Duct connections to equipment shall be in no case smaller than the equipment openings.

E. Install all UL classified devices in accordance with their UL approved installation sheets.

3.02 ROOF CURB INSTALLATION

A. The roof curbs shall be installed in accordance with the manufacturer recommendations, Contract Drawings, and reviewed submittals.

END OF SECTION

SECTION 233900

FANS AND ACCESSORIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all fans of the various types, arrangement and sizes specified herein and as scheduled on the drawings.

B. Fans shall include all motors, drives, curbs, flashing, special coatings and accessories.

C. Furnish and install backdraft dampers with all fans.

D. Furnish and install all roof curbs and automatic dampers.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as following:

1. AMCA 99 – Standards Handbook;.
2. AMCA 210 – Laboratory Methods of Testing Fans for Rating Purposes.
3. AMCA 261 – Directory of Products Licensed to Bear the AMCA Certified Ratings Seal;.
4. AMCA 260 – Laboratory Certified ratings for induced flow fans.
5. AMCA 300 – Test Code for Sound Rating Air Moving Devices;.
6. AMCA 301 – Method of Publishing Sound Rating Air Moving Devices;.
7. NEMA MG 1 – Motors and Generators; 1993 (and Revision 1).
8. NFPA 96 – Installation of Equipment for the Removal of Smoke and Grease Vapors from Commercial Cooking Equipment;.
9. UL 705 – Power Ventilators;.

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Submit certified curves showing fan performance with system operating points plotted on curves.

C. Submit motor data sheets including motor efficiency and power factor at various loadings of nameplate horsepower. Motor efficiency and power factor shall be shown for 100%, 75% and 50% of nameplate horsepower. Submit data on efficiency and power factor required for motors 1 HP and above only. Motors shall have premium efficiency motors with minimum efficiency on motors listed in specification.

D. Submit bearing sizing calculations for each similar size and type of fan. Fan bearing calculations shall be based on fan at maximum operating conditions including belt pull. Calculations shall be done for both fan bearings and motor bearings. Calculations required on centrifugal fans, vent sets in-line fans, wall mounted propeller fans and vane axial fans only.

E. Submit sound power levels for each size and type of fan. Sound levels shall be in all (8) octave bands for discharge of fan, inlet to fan, and radiated noise through casing.

F. Submit certified shop drawings indicating all dimensional data, and operating and maintenance clearances.

1.06 QUALITY ASSURANCE

A. Fans shall conform to most recent AMCA Bulletins regarding construction and testing. Fans shall be tested and rated per AMCA and shall be selected in proper operating range without motor overloading and fan surge.

B. Manufacturers must prove experience in the production of similar products of this type for at least ten (10) years prior.

C. Fans shall be air and sound certified in accordance with AMCA 210 and 300 and shall bear the AMCA seal.

D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. and other testing firm acceptable to the authority having jurisdiction and all suitable for the purpose specified and indicated.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Do not operate fans for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings have been lubricated and fan has been test run under observation.

PART 2 PRODUCTS

2.01 GENERAL

A. Manufacturers acceptable contingent upon product's compliance with the specifications are as follows:

1. Centrifugal Fans

a. Loren Cook Co.
b. Buffalo Forge Co.
c. Greenheck Fan Corp.
d. Twin City Fan

2. Plenum Fans

   a. Greenheck Fan Corp.
   b. Loren Cook Co.
   c. Twin City Fan

3. In-Line Tubular Centrifugal Fans

   a. Greenheck Fan Corp.
   b. Loren Cook Co.
   c. Buffalo Forge Co.
   d. New York Blower
   e. Twin City Fan

B. Selection and Balancing

1. Provide and install items as listed in equipment schedules, as shown on drawings, and as specified, complete in all respects to the functions intended.
2. Provide fans capable of accommodating static pressure variations of ±10%.
3. Provide balanced variable sheaves for motors 15 HP and under, and fixed sheaves for 20 HP and over.
4. Statically and dynamically balance fans in the field to eliminate vibration or noise transmission to occupied areas of the building. Provide certificate of compliance from manufacturer.
5. Provide OSHA and ANSI approved belt guards on interior mounted belt driven fans. Provide weatherproof ventilated housing for exterior mounted fans.
6. Provide special construction fans such as sparkproof, explosionproof, or coated fans as required by the schedule.
7. Provide safety, bird or insect screen where inlet or outlet is exposed.
8. All fans shall be manufactured in accordance with this specification even where techniques are required which are not considered standard by that manufacturer.
9. Verify fan arrangement with the Contractor including motor location for servicing and discharge arrangements for proper airflow.
10. Where fixed speed sheaves are specified for a particular fan, provide (2) additional sheaves (one motor and one drive) as necessary for final air balancing.

C. Painting

1. Each fan component shall be thoroughly cleaned, degreased and deburred before the application of a rust preventive primer.
2. Two (2) coats of a rust preventive primer shall be applied under a topcoat of air-dried epoxy or enamel. Minimum coating thickness shall be 5 to 6 mils. The final coat shall be applied after final assembly to all surfaces.

2.02 CENTRIFUGAL FANS

A. General

1. Fan selection and ratings shall be based on tests made in accordance with ASHRAE 51 and AMCA 210 and shall be licensed to bear the AMCA seal.
2. Fans shall be Class I construction and labeled UL 705.

3. Fans shall be backwardly inclined, airfoil, or flat blade type with a minimum of (10) blades.
4. Fans shall have sharply rising pressure characteristics at the operating point specified and shall be quiet and stable in operation. Horsepower characteristics shall be self-limiting and at peak value at the specified operating point.
5. The specified fan RPM, outlet velocity, and tip speed are the maximum acceptable. The motor horsepower, CFM, and static pressure are the minimum acceptable.
6. Fan arrangements shall be minimum AMCA pressure class, single-width, single-inlet or double-width, double-inlet, clockwise or counter-clockwise rotation, shall be as scheduled on the drawings and as coordinated by the Contractors in the field.
7. Each fan shall be fully assembled with motor and drive on a structural steel base and run tested at the factory prior to shipment of the unit. Testing shall be conducted at the operating speed or maximum fan class speed. The total fan assembly shall be checked for balance and compared against the acceptable levels on the Rathbone Chart. The amplitude of vibration (displacement in mils) at operating speed measured at each unit fan bearing shall not exceed the values given in the following table:

Fan RPM	Displacement Mils
500	4.2
800	3.0
1100	2.3
1400	1.9
1700	1.6

Note: Displacement shall be peak-to-peak in X, Y and Z directions.

B. Fan Base

1. Fan with motor and drive shall be mounted on a structural steel base having a minimum 6" depth.
2. The base shall be electrically welded, and after welding, the base shall be cleaned, primed and painted to match fan coating.
3. Base steel sizing and construction shall be sufficient to allow the entire assembly to withstand the rigors of shipping and rigging.
4. Base shall be provided with lifting lugs and motor slide rails.
5. Fans with inertia bases as indicated in equipment schedules on mechanical drawings shall have structural bases constructed to accommodate concrete after installation. Bases shall be in accordance with Vibration Isolation Section.
6. All bases shall be constructed with gussetted brackets to accommodate field installed spring isolators as specified under Vibration Isolation Section.

C. Fan Housing

1. Fan housing shall be heavy gauge continuous welded steel construction with fan scroll and bearings supported from a structural steel framework. Minimum gauge construction shall be as indicated in the material construction schedule.
2. Fan housing shall be suitably braced to prevent vibration and pulsation.
3. Fans having wheel diameters 36" and larger shall have horizontally flanged split housings as required for installation.
4. Fan housing and inlet shall be constructed to allow the fan wheel(s) to be removed through the inlet opening when the inlet cone is removed.
5. A quick opening clean out door, shaped to conform with the scroll contour shall be provided with heavy-duty latches.

6. A 1/2" tapped 3/4" diameter pipe coupling drain connection shall be welded to the fan scroll at the lowest point.
7. Fans shall be convertible to a minimum of (8) standard discharge arrangements.
8. All fans shall be provided with a flanged discharge. The Sheet Metal Contractor shall provide the matching companion flange.
9. Fan cut-off shall be provided to deliver good pressure distribution.
10. A weatherproof housing shall be provided with ventilation grilles to cover motor and drive assembly for exterior mounted fans.
11. Exhaust fans serving kitchen hoods shall be so designed to satisfy NFPA 96, UL 762 and any other local codes required for kitchen hood exhaust system with cleanout door and grease drain with grease containment container.

D. Fan Inlet and Wheel Cone

1. Precision die spun or formed, and matched inlet and wheel cones shall be provided for streamlined airflow into the wheel to ensure full loading of the blades.
2. Inlet and wheel cones shall be hyperbolic. Radial side sheets are not acceptable.
3. Inlet cone shall be heavy gauge steel bolted to fan housing to allow for removal.
4. Fans having duct-connected inlets shall be provided with a flanged inlet collar with matching companion flange.
5. Fans which are not duct connected shall be provided with inlet screen(s). Inlet screen(s) shall be a nominal 1" by 1" mesh fabricated 10-gauge steel.
6. Hubs shall be straight bored, keyed and set screwed to shaft for positive attachment. Hubs shall be securely riveted to the backplate or center plate.
7. Bushed hubs are not acceptable.
8. Double width double inlet fans shall be a single wheel of the common center plate design or (2) single-width single-inlet wheels back to back, each keyed and set screwed to a common shaft.
9. Fan blades shall be continuously welded to the inlet hub and the backplate.
10. Wheel center plate or backplate shall be heavy gauge steel construction with a minimum gauge as indicated in material construction schedule.
11. The fan shaft shall be solid AISI C-1018, 1040 or 1045 hot rolled steel, accurately turned, ground and polished, and ring gauged for accuracy.
12. Recommended bearing manufacturer tolerances must be met in the contact area for bearings.
13. All shafts must be dial indicator inspected for straightness after the keyways are cut.
14. Fan shaft shall be coated with a rust inhibitive coating.
15. Fan wheel shall be statically and dynamically balanced prior to fan assembly.
16. The entire rotating assembly shall be designed so the first critical speed is a minimum of 25% greater than the fan design speed.

E. Fan Shaft Bearings

1. Fan bearings shall be foot-mounted type, bolted on a rigid welded steel framework integral with the housing.
2. Bearings shall be sized for a minimum L-10 life of 200,000 hours at maximum fan class operating conditions including belt pull. Bearings shall be selected in accordance with standards set forth by the Anti-Friction Bearing Mfrs. Assn.
3. The bearings shall be double-row spherical, self-aligning, grease lubricated, roller bearings housed in a horizontally split pillow block housing.
4. Bearings shall be SKF-SAF Series 22500 or Linkbelt P-B22400H or approved equal.
5. Extruded copper grease leads shall be provided to an easily accessible location.

F. Fan Drive

1. Fans shall be belt driven unless otherwise specified. The drive shall be a multiple V-belt type sized for 1.65 times the fan motor horsepower. Sheaves shall be fixed or adjustable based on fan motor horsepower as specified hereinbefore. The fan sheave shall have a tapered lock, split and keyed hub.
2. Motors shall meet requirements specified in Special Conditions Section.
3. Motors shall be 1800 rpm for all belt driven fans and 1200 RPM or 900 rpm for all direct driven fans.
4. An OSHA approved type fan drive guard shall be provided with provision for RPM measurement, without removing the guard. The guard shall be made of 1/2" 16 gauge flattened expanded steel, wrapped around a 16 gauge channel frame suitably braced to prevent vibration. Paint guard with coating similar to fan.
5. Fan belts shall be oil resistant 24,000-hour non-static belts.

G. Fan Material Construction Schedule

1. The following schedule indicates minimum allowable steel gauge thicknesses for construction:

Housing				Wheel			
Wheel Size	**AMCA Pressure Class**	**Side Sheet**	**Scroll**	**Blades**	**Wheel Cone**	**Back-Plate**	**Center-Plate (DWDI)**
12	1	12	14	16	10	8	8
thru	2	10	12	16	10	8	8
22	3	10	10	16	10	8	8
24	1	12	14	16	10	8	8
thru	2	12	14	16	10	8	8
33	3	8	10	16	10	8	1/4
36	1	12	14	16	10	8	8
	2	12	14	16	10	8	8
	3	8	10	16	10	8	1/4
40¼	1	12	12	14	10	8	8
thru	2	12	12	14	10	1/4	1/4
44½	3	8	10	14	10	1/4	1/4
49	1	12	12	12	10	8	8
	2	12	12	12	10	1/4	1/4
	3	8	10	12	10	1/4	1/4
54¼	1	12	12	12	8	8	1/4
	2	12	12	12	8	1/4	5/16
	3	8	10	12	8	1/4	3/8
60	1	12	12	12	8	3/16	1/4
	2	12	12	12	8	3/8	3/8
	3	8	10	12	8	3/8	3/8
66	1	8	8	10	1/4	3/16	5/16
	2	8	8	10	1/4	3/8	3/8
	3	8	8	10	1/4	3/8	3/8
73	1	8	8	8	1/4	1/4	5/16
	2	8	8	8	1/4	3/8	3/8
	3	8	8	8	1/4	3/8	3/8

2. Manufacturers shall use their standard gauges if heavier than those indicated above. Information on standard construction shall be made known if requested by the Architect/Engineer.

2.03 PLENUM FAN ASSEMBLIES

A. General

1. All fans shall meet the airflow performance specified and shall not exceed the break horsepower or sound power levels specified on the mechanical equipment schedule.
2. Fan performance shall be based on testing and be in accordance with AMCA Standards 210 and 300. All fans shall have a steep pressure/volume curve.
3. Fans shall be AMCA certified for air and sound performance.
4. Fan(s) shall be plenum type, designed for horizontal airflow
5. Fans shall be AMCA arrangement 3 with airfoil backward-inclined blades, AISI C-1045 hot rolled steel turned/ground and polished shaft. Wheel and frame shall be of welded construction
6. Completed isolated assemblies shall be dynamically balanced in all 3 planes to category BV-2 for fan 5 hp or less and category BV-3 for fans greater than 5 hp as required by ANSI/AMCA Standard 204 in the horizontal, vertical and axial planes meeting “Factory Filter In” and “Startup Filter Out” requirements.
7. Fans shall be single width airfoil centrifugal plenum type, designed for rugged industrial duty and suitable for continuous operation. All fans larger than 18” diameter shall have a minimum of 12 blades. Fans shall be selected to operate at a point no higher than 90% of the peak static pressure rating as defined by the fan performance curve at the selected operating speed.
8. Fan shafts shall be solid AISI 1040 or 1045 steel. Shafts shall be turned, ground and polished to a minimum 16-micro-inch finish. Shafts shall be sized to run at a minimum of 20% greater than the maximum AMCA class speed.
9. Inlet cones shall be precision spun or die formed. Inlet cones shall be aerodynamically matched to the wheel side plate to provide streamlined airflow in the wheel and ensure full loading of the blades.
10. All fan section access doors shall have one (1) latch, which requires a tool to open.
11. Fans shall be isolated from bulkhead walls by means a neoprene coated flexible fabric connector.

B. Motor

1. Motor shall be TEFC see Motor specification section.
2. Motors shall have a 1.15 service factor. [Motors shall be suitable for use with variable frequency drives].

C. Drive

1. Provide belt or direct drive as indicated.
2. Belt drive

   a. Belt drive shall have fixed pitch sheaves. Drive belts shall have a 1.50 service factor.
   b. Drive assembly shall be furnished with a totally enclosed beltguard.

c. Sheaves and Belts: All sheaves shall be selected with a 1.5 service factor. Sheaves shall be machined from a close grain cast iron and statically balanced by the manufacturer. Drive belts shall be a V type. One variable pitched sheave shall be provided on motors from 1 to 15 horsepower. Fixed pitch sheaves shall be provided on motors larger than 15 horsepower. Where fixed sheaves are provided one sheave exchange shall be provided as required FOB the factory. Belts shall be oil and heat resistant.

3. Direct drive

a. Motor shall be 1200 rpm or less.

D. Bearings

1. Fan bearings shall be heavy-duty, pillow block, self-aligning ball or roller type, and grease lubricated. Using AFBMA ratings, bearings shall be selected for a minimum L-10 life of 100,000 hours. Both bearings shall have the same bore, type and manufacturer. At least one bearing shall be fixed. Both bearings being the floating type is not acceptable. Extended flexible lube lines shall be provided and extended to the drive side of the fan.

E. Base

1. Fans shall be supplied with following features: 2” nominal deflection isolators, fan manufacturer's standard paint finish, inlet
2. Fan assemblies shall be designed for heavy-duty industrial applications with no structural resonance occurring within the fan operating speed range when isolated. Fan framing assemblies shall be fabricated from structural steel. Formed members are not acceptable. This structural steel shall be welded together to form a rigid integral base. Fan assemblies shall be independently isolated with spring-type vibration isolators.

F. Fan unloading devices

1. Each variable air volume supply and return fan shall be provided with separate variable frequency drives.

2.04 IN-LINE TUBULAR CENTRIFUGAL FANS

A. Provide belt driven centrifugal type in-line fans with capacities as indicated in the equipment schedules on the mechanical drawings.

B. AMCA pressure Class I or Class II as indicated in the equipment schedule.

C. Fan housing shall be heavy gauge galvanized steel welded to a rigid galvanized structural steel framework or steel coated with an epoxy finish. Minimum thickness of epoxy finish shall be 5 mils. Fan housing shall be provided with mounting brackets at both inlet and discharge suitable for hanger rods or bolting directly to structure.

D. Fan housing shall have inlet and outlet connections flanged.

E. Fan inlet cone shall have a die spun hyperbolic shape and be matched to the wheel cone to ensure full loading of fan blades and to maximize efficiency.

F. Fan wheel shall have single thickness backward inclined blades or true hollow airfoil shaped blades. Wheel characteristics shall be non-overloading.

G. Fan inlet cone, wheel cone, blades and backplate shall be constructed of heavy gauge aluminum or steel. Steel construction shall be coated with an epoxy coating having a minimum thickness of 5 mils.

H. Blades shall be welded to wheel cone and backplate.

I. Wheel shall be statically and dynamically balanced.

J. Drive shaft shall be ground and polished high grade steel supported by permanently lubricated sealed ball bearings housed in a cast iron pillow block housing.

K. Bearings shall be sized for a minimum of L-10 life of 200,000 hours at maximum fan operating conditions including belt pull. Bearings shall be selected in accordance with standards set forth by the Anti-Friction Bearing Mfrs. Assn.

L. Drives shall be sized for a minimum of 1.65 times the fan motor horsepower. Sheaves shall be adjustable and have a tapered lock, split and keyed hub. Belts shall be oil resistant, 24,000-hour non-static type.

M. Fan shall be suitable for horizontal or vertical mounting.

N. Motor, drive, and bearings shall be out of the exhaust airstream and housed to facilitate ease of maintenance. Motor cooling shall be through the fan drive and motor housing. Housing for motor drive and bearings shall be of the same construction as the fan housing.

O. Motors shall be in accordance with Motors Section of the Special Conditions.

P. Fans shall be constructed in accordance with AMCA 99-0401 Type A, B or C.

Q. Provide with 1/2" by 1/2" galvanized wire mesh attached to a galvanized structural steel frame. Frame shall be bolted to the flanged housing construction.

R. Provide thrust arrestors as required to limit movement of the fan upon start-up.

PART 3 FAN INSTALLATION REQUIREMENTS

3.01 INSTALLATION

A. Fans shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

B. Fans shall be installed so as to ensure easy accessibility for service or removal or replacement of all components such as, but not limited to, fans, motors, belts, drives, bearings, dampers, actuators, isolators, and field connections.

C. The HVAC Contractor shall install all motors and drives shipped loose. Fans shall be installed and tested, and shall be made fully operational by the HVAC Contractor.

D. Provide fixed sheaves as necessary for final air balancing. The Contractor shall install the fixed sheave after balancing with the Contractor to adjust the fans.

E. Manufacturer shall include the adjustment of pitch for adjustable pitch fans as required by balancing.

F. Set roof mounted fans on sound absorbing insulated curbs. Coordinate installation with Roofing Contractor. Curbs shall be provided by the HVAC Contractor. The HVAC Contractor shall provide all counter flashing.

G. Mount vent sets and vane axial fans located on roof to inertia bases as required under Vibration Isolation Section.

H. Make all penetrations through roof or vertical walls watertight. Submit methods of sealing to Architect/Engineer for review and approval.

I. All fans shall have flexible inlet and outlet couplings to prevent vibration transmission to ductwork.

J. The Contractor shall assemble all loose parts including motors and drive assemblies on site and shall vibration balance the fans in the field. Field adjustment including belt alignment, wheel balancing, belt tension, greasing of bearings, installation of belt guards, and other loose parts shall be provided by the HVAC Contractor.

3.02 COORDINATION

A. The Contractor shall coordinate the fan arrangement with the coordinated ductwork layout prior to ordering the fan. The Contractor shall provide all labor and materials necessary to change fan arrangement in the field when fan arrangement does not match ductwork.

B. The inlet and discharge ductwork shall have a minimum straight run of (2) fan diameters upstream and downstream of the fan. The Contractor shall notify the Engineer in writing if these conditions cannot be achieved. Installation of improper inlet/discharge conditions without the review of the Engineer shall be corrected in the field at no cost to the Owner.

C. The discharge duct arrangement shall comply with AMCA recommended layouts for elbows after fans.

D. The Contractor shall provide all supplemental steel, supports, rods and hangers necessary to hang or mount fans. Supports shall include thrust restraint as required by the fan manufacturer.

E. The fan manufacturer and Contractor shall coordinate the fan orientation for tubular centrifugal fans and shall verify that the fan support and bearings are supplied for the coordinated fan orientation (horizontal or vertical). The Contractor shall revise the fan in the field if job conditions require changing of orientation, at no cost to the Owner.

F. The Contractor shall receive and inspect all fans and motors to make sure that all fans are received without defect. All defective or damaged fans shall be returned to the manufacturer by the Contractor for replacement.

G. The Contractor shall properly protect all equipment to prevent damage from water, dirt, etc. Protection shall include temporary plastic wrap to keep equipment in original factory condition. Fans used for temporary ventilation during construction shall be totally cleaned and refurbished prior to turnover to the Owner.

H. The HVAC Contractor shall mount and vibration balance all fans. The Electrical Contractor shall furnish and install power wiring to the fan motor and verify proper fan rotation. The HVAC and Electrical Contractors shall coordinate the starter requirements to ensure that the proper starter is installed for non-standard motors. The ATC Contractor shall wire all interlocking wiring to the fan including smoke detector wiring for fan shutdown.

I. The HVAC Contractor shall mount all automatic control dampers on the fan either shipped loose or provided by the ATC Contractor.

J. The HVAC Contractor shall mount all field mounted flow measuring devices on the inlet or discharge of the fan prior to fan installation.

END OF SECTION

SECTION 234100

FILTERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Provide filters, filter frames, filter housings, and filter gauges of size, capacity, location and types shown and scheduled on the drawings and hereinafter specified.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements, which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as following:

1. ARI 850 – Commercial and Industrial Air Filter Equipment.
2. ASHRAE 52.1 – Gravimetric and dust-Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
3. ASHRAE 52.2, Method of Testing General Ventilation Air-cleaning Devices For Removal Efficiency by Particle Size. (Minimum efficiency Reporting Value.)
4. MIL-STD-282 – Filter Units, Protective Clothing, Gas-Mask Components, and Related Products; Performance – Test Methods; current edition.
5. UL 586 – Test Performance of High Efficiency Particulate, Air Filter Units.
6. UL 867 – Electrostatic Air Cleaners.
7. UL 900 – Test Performance of Air Filter Units.

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: Provide typical catalog of information including arrangements.

C. Manufacturer’s Instructions; Indicate installation instructions and recommendations.

D. Warranty: Submit manufacturer’s warranty and ensure forms have been completed in Owner’s name and registered with manufacturer.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: company specializing in manufacturing the Products specified in this section with minimum five (5) years of documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriter's Laboratories Inc. testing firm acceptable to the authority having jurisdiction and suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 PREFILTERS TYPE "A"

A. Acceptable manufacturers subject to compliance with the specifications:

1. Flanders (Type 62R)
2. Camfil/Farr
3. Purolator Air Filter (MK80D)
4. American Air Filters

B. Prefilter shall be 4" thick: throwaway, medium efficiency, pleated, disposable type as shown on the drawings. Each filter shall consist of a non-woven fabric media, support grid and enclosing frame. The filter shall be UL listed as Class I.

C. Filter media shall be of the non-woven fabric. The filter media shall have an average efficiency of 30% to 35% and an average arrestance of 90% to 92% in accordance with ASHRAE 52-1, and MERV 8 Rating per ASHRAE 52.2.

D. The effective filter media shall be at least 7.0 sq.ft. of media per 1.0 sq.ft. of filter face area

E. Initial resistance at 500 fpm approach velocity shall not exceed 0.35"w.g (7.0 sq ft per 1.0 sq ft face area, 11 pleats per linear ft. Filter thickness – 4".

F. The media support shall be a welded wire grid or expanded metal with an effective open area of at least 96%. The welded wire grid shall be bonded to the filter media to eliminate the possibility of media oscillation and media pull-away. The media support grid shall be formed in such a manner that it affects radial pleat design, allowing total use of filter media.

G. The enclosing frame shall be constructed of a rigid, heavy duty, high wet strength beverage board, with diagonal support members bonded to the air entering and exiting side of each pleat to ensure plate stability. The inside periphery of the enclosing frame shall be bonded to the filter pack, thus, eliminating the possibility of air bypass.

H. Provide holding frames, factory fabricated of a minimum of 16 gauge stainless steel and equipped with gaskets and (4) spring type positive sealing fasteners. Fasteners shall be capable of being attached or removed without deforming the gaskets and without the use of tools. Frames shall be dimpled for proper centering and shall be designed so that filters of other efficiencies and depths can be used, at the owner's discretion, merely by change of fasteners.

2.02 BAG FILTER TYPE “B”

A. Acceptable manufacturers subject to compliance with the specifications shall be as follows:

1. Flanders – PRECISION PAK
2. Camfil/Farr – HI FLO
3. Purolator – SERVA-PAK
4. American Air Filter – DRI PAK

B. Filters shall be of the size and quantity noted on the plans.

C. Construction

1. Each filter shall consist of a (synthetic) or (glass fiber) media (select one), with a bonded backer, individual pockets, and a corrosion resistant galvanized steel header. The filter shall be completely factory assembled and classified by Underwriters Laboratories as (Class I).
2. The stitched pockets shall be sealed with a leak free sealant with pockets and media area of 108 ft^2.
3. Efficient shall be 90-95% per ASHRAE 52.1 Test Method and initial resistance of 500 fpm shall not exceed .65" w.g.

D. Framing

1. Filters shall be installed in 16 GA galvanized frames, or side access filter housings, as noted on plans, furnished by air filter manufacturer.

E. Final Filter Type B1

1. Same as B except efficiency shall be 80-85%
2. Initial resistance at 500 fpm shall not exceed .46" w.g.

F. Final Filter Type B2

1. Same as B except efficiency shall be 60-65%.
2. Initial resistance of 500 fpm shall not exceed .30" w.g.

2.03 FILTER TYPE “D” V CELL HIGH PERFORMANCE RIGID FILTER

A. Acceptable manufacturers subject to compliance with the specifications shall be as follows:

1. Flanders (Superflow V)
2. Camfil/Farr
3. Purolator Air Filter (Servacell V)
4. American Air Filter

B. Filter shall be 24” x 24” x 12”.

C. The filter unit shall be similar to Flanders Superflow V-95 mini-pleated microglass fiber filter media packs with fiberglass thread separators. The filter packs shall be assembled in a V-bank configuration for low-pressure drop and extended service life. The filter framing system shall include molded plastic flanges, galvanized steel channels, and extruded aluminum supports. All materials used will be fire-retardant and self-extinguishing in accordance with Underwriters Laboratories UL 900 Classification. Filter shall have 200 sq.ft. of media and 90-95% 52-1 MERV 14 per test method 52.2.

1. The filter shall be Class I.

D. Initial resistance at 500 fpm approach velocity shall not exceed 0.37”w.g.

2.04 FILTER GAUGES

A. Provide filter gauges as hereinafter specified at all filter locations, in-duct and air handling unit installations. The HVAC Contractor shall also coordinate the filter frames with the air-handling units provided to ensure compatibility of systems and equipment.

B. Acceptable manufacturers subject to compliance with the specifications shall be as follows:

1. F.W. Dwyer Model 2000
2. Deiterich Standard Corp.
3. Bacharach Instrument Co.

C. Provide (1) filter gauge for each filter bank. The scale shall be selected so that it allows for 1" w.c. greater than the final filter resistance.

D. Provide suitable decal at the gauge for each filter system containing servicing information.

E. Static pressure taps shall be located in the airstreams as recommended by the manufacturer and connected to gauges located on air handling unit casings or on walls for in-duct HEPA filter locations as directed, with 1/4" o.d. aluminum tubing.

F. Provide gauges similar to Dwyer photohelic pressure switch/gauges 3 in 1 indicating gauge with 2 phototransistor actuated DPDT relays. Similar to Dwyer Series A3000

2.05 FILTER HOLDING RACK – SIDE ACCESS

A. General

1. Provide front-loading access, one or two-stage filter system similar to Flanders Sureseal, consisting of spring-loaded filter, tracks. Housing shall accommodate any 4" prefilter and various final filters with efficiencies of 45%-95%, per ASHRAE 52-76.

B. Leakage

1. Leakage at rate airflow, upstream to downstream of filter, holding frame, and slide mechanism shall be less than 1% at 3" w.g. differential. Leakage into housing from ambient atmosphere at rated airflow shall be less than 0.5% at 3" w.g. negative. Manufacturer shall submit substantiating test reports.

C. Housing

1. Housing shall be factory fabricated and assembled of 12-gauge stainless steel with corner posts of Z-channel bracing to eliminate racking. Each housing shall be equipped with two (2) access doors and 1.5" standing flanges with prepunched holes to facilitate field installation Flanges shall be notched to provide water runoff. Housings must be weatherproof and suitable for rooftop/outdoor installation.

D. Tracks

1. Tracks shall be field adjustable and replaceable, heavy gauge, 316 S/S extrusion designed to accommodate Camfil/Farr Universal Holding Frames. Each extrusion shall be equipped with a replaceable, non-woven pile encased, aluminum backed, polypropylene finned seal providing an air barrier between the extrusion and Universal Holding Frame.

PART 3 EXECUTION

3.01 FILTER, FILTER FRAMES, FILTER HOUSING AND FILTER GAUGES

A. Filters, filter frames, filter housings, and filter gauges shall be installed in accordance with manufacturer recommendations, Contract Drawings, and reviewed submittals.

B. Filters shall be installed so as to ensure easy accessibility for service, removal and replacement of filters.

C. No system shall be operated without filters.

D. During temporary ventilation:

1. The units shall not be operated without filters. Provide the following temporary filters during initial start-up and temporary operation.

	Specified filter	Temporary Filter
a.	TYPE A	TYPE A
b.	TYPE D	TYPE B

2. Prior to Owner occupancy, of each phase, filters shall be replaced with the specified filter.

E. Prior to air balance, of each phase, before Owner occupies the finished space, install design set of pre-filter and final filters in air handling units.

F. Leave (1) new separate (attic stock) set of filters with the Owner at the completion of the entire project.

END OF SECTION

SECTION 235700

HEAT EXCHANGERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all heat exchangers to make a complete and operations system.

B. All system components shall be installed in accordance with local code including supports and bases.

C. Secure all permits and local/State approval for the installation of all components included under this Section.

D. Provide factory assembled and tested shell and tube or plate-and-frame heat exchangers with plate quantity, capacity, temperature range, physical dimensions and other characteristics, as scheduled on the drawings and as hereinafter specified.

E. Provide piping, valves, controls, fittings and accessories as required and shown on the drawings.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ASME (BPV VIII, 1) – Boiler and Pressure Vessel Code, Section VIII, Division 1 – Rules for Construction of Pressure Vessels; 1995.

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: Provide date with dimensions, locations and size of tappings and performance date.

C. Shop Drawings: Indicate dimensions, locations and size of tappings and performance data.

1. Design Data: Indicate in sufficient detail to verify that heat exchangers meet or exceed specified requirements.
2. Test Reports: Indicate pressure tests.

D. Manufacturer's Instructions: Indicate installation and support requirements.

E. Operation and Maintenance Data: Include start up and shut down instructions, assembly drawings and spare parts list.

1.06 REGULATORY REQUIREMENTS

A. Conform to ASME (BPV VIII, 1) – Boilers and Pressure Vessels Code for manufacture of tubular heat exchangers and heat exchanger shells and plate and frame type heat exchangers.

B. Conform to ASME Code Form #U-1 for unfired pressure vessels.

1.07 DELIVERY, STORAGE AND HANDLING

A. Protect internals from entry of foreign material by temporary caps on flanged openings.

PART 2 PRODUCTS

2.01 STEAM-TO-HOT WATER SHELL-AND-TUBE HEAT EXCHANGERS (CONVERTERS)

A. Acceptable Manufactures contingent on compliance with the specification:

1. Bell & Gossett
2. Armstrong
3. Amtrol
4. Patterson Kelly

B. Provide steam-to-hot water shell-and-tube heat exchangers in accordance with the capacities, piping and valving arrangements indicated, as scheduled on the drawings, and as hereinafter specified.

C. Heat exchangers shall be installed where shown on the plans, complete with all necessary appurtenances, base supports, and adjustable saddles. Quantity capacity, physical dimensions and other characteristics shall be as scheduled on the plans.

D. Heat exchangers shall be constructed with cast iron heads, steel shell baffles, and steel or cast iron removable tube sheets for heating hot water, copper tie rods, and steel nuts and bolts.

E. Heating surface shall be 3/4" o.d. copper tubing securely expanded to one end of the tube sheets and properly supported at the other end. The copper tubing shall have a minimum thickness of 0.035".

F. Heat exchangers shall be complete with all necessary outlets for steam supply and return, water inlet and outlet, drain and vent connections, vacuum breaker, cleanout handholes, and tappings for temperature and pressure gauges.

G. Fouling factors for both tube and shell shall be minimum 0.002 or as scheduled. Tube velocity shall not exceed 7.0 fps.

H. Heat exchangers shall be designed so as to prevent entering steam from impinging directly on the tubes, shall be tested at the factory under a hydrostatic pressure of 300 psig, conform to ASME Codes for pressure vessels, and shall bear an ASME stamp for 125 psig working pressure, with certificate issued.

I. Steam-to-hot water heat exchangers shall have steam in the shell and water in the tubes. Shop drawings shall be submitted for heat exchangers with all dimensions, capacities, materials of construction and nozzle arrangements shown. Fabrication shall not commence until shop drawings have been approved.

J. Provide saddle supports per heat exchanger.

PART 3 EXECUTION

3.01 STEAM-TO-HOT WATER SHELL-AND-TUBE HEAT EXCHANGERS (CONVERTERS) INSTALLATION

A. Steam-to-hot water shell-and-tube heat exchangers shall be installed in accordance with manufacturer's recommendations, Contract Drawings, and reviewed submittals.

B. The heat exchanger shall be installed such that the shell shall pitch down toward the bottom condensate drain opening.

C. The heat exchanger shall be installed such that there shall be sufficient clearance equal to the tube length to remove the heads and clean or eddy current test the tubes.

3.02 START UP SERVICE

A. Provide start-up service by a factory approved and certified technician.

END OF SECTION

SECTION 237323

FACTORY BUILT-UP AIR HANDLING UNITS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all factory built-up air handling units. This shall include all piping, ducts and supports specified in this Division and as shown on the drawings

B. All units shall be new and manufactured for the specific purpose of providing conditioned air (heating and cooling) to the systems indicated.

C. All system components shall be installed in accordance with local codes including seismic isolation.

D. Secure all permits and local/state approval for the components as specified and included under this Section.

E. Each unit shall be seismically certified and labeled in accordance with the International Building Code.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

B. Refer to Sections:

1. 230500 Basic Mechanical Materials And Methods
2. 230513 Motors And Controllers
3. 230514 Variable Frequency Drives
4. 230523 HVAC Valves and Strainers
5. 230529 Hangers And Supports
6. 230548 Mechanical Vibration Controls And Seismic Restraints
7. 230553 Mechanical Identification
8. 230719 HVAC Piping Insulation
9. 232000 HVAC Piping and Joints
10. 233319 Sound Attenuators
11. 233900 Fans and Accessories
12. 234100 Filters
13. 238216 Coils
14. Division 26 Electrical Power Specifications

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ABMA STD 9 – Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA STD 11 – Load Ratings and Fatigue Life for Roller Bearings.
3. AMCA 99 – Standards Handbook.
4. AMCA 210 – Laboratory Methods of Testing Fans for Rating.
5. AMCA 300 – Reverberant Room Method for Sound Testing of Fans.
6. AMCA 301 – Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
7. AMCA 500 – Test Methods for Louvers, Dampers and Shutters.
8. ARI 410 – Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.
9. ARI 430 – Standard for Central-Station Air-Handling Units.
10. ARI 610 – Central System Humidifiers.
11. ARI Guideline D – Application and Installation of Central Station Air-Handling Units.
12. NEMA MG 1 – Motors and Generators (1).
13. NFPA 70 – National Electrical Code.
14. SMACNA (DCS) – HVAC Duct Construction Standards – Metal and Flexible.
15. UL 900 – Standard for Air Filter Units.
16. UL 1096 – Electric Central Air Heating Equipment.
17. 2003 International Mechanical Code
18. 2009 IECC
19. 2003 International Mechanical Code
20. 2009 IECC

1.05 SYSTEM DESCRIPTION

A. Furnish and install complete factory built-up air handling units of the size and capacity scheduled on the drawings.

B. The units shall be of one manufacturer and shall include all components hereinafter specified including fans, coils, filters, humidifiers (if shown), controls and complete double wall insulated cabinets.

1.06 SUBMITTALS

A. See Section 230500 and General Conditions for additional submittal requirements.

B. Shop Drawings: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements and duct connections.

C. The unit manufacturer shall submit without delay after receipt of notice of award, shop drawings for approval which shall indicate, but not be limited to, the following information in detail:

1. Point by point. Specification compliance specification.

    a. This shall include this section of the specification and all other applicable sections clearly indicating compliance on a line by line basis.
    b. This shall not reference “others” If someone else is doing the work it shall state who is doing the work.

2. Structural loading plan.
3. Detailed drawings and data of all proposed components.
4. To scale dimensional drawings (plans and sections) of the entire air handling unit showing all component locations, equipment arrangements, piping connections and sizes, duct connections and sizes, and all safing required.
5. Casing and hoisting details including floor structures, internal structures, panel fabrication, insulation material, equipment supports and thermal, acoustic and air pressure performance of proposed panels. Location of drains and method of piping penetration and sealing of penetrations through the casings.
6. Sound data for sound attenuators at rated flow and sound data for casing walls, floor and roof.
7. The sound power levels on all fans, fan and motor efficiency, horsepower, RPM and fan size.
8. Fan curves shall be submitted. Fan curves shall be prepared and submitted indicating performance of the fans. When units have two fans indicate curves with (2) similar fans operating in parallel and individual fans operating.
   Where fans are indicated to be controlled by variable speed drives, submit performance curves based on fans rpm from 200% to 50% of fan speed in 100-rpm increments. Where fans are in parallel, submit composite (rpm based) curves indicating parallel operation.
9. ARI certified calculations for coil selections.
10. List of proposed component manufacturers and models, such as fans, casing, coils, filters, dampers, controls, door hinges, disconnect switches, etc.
11. Structural calculation indication and compliance with performance data.
12. Pressure drop calculation indicating losses of all components, plenums, contractions, expansions at rated flow of unit. Pressure drop calculations are to be submitted in tabular form and shall indicate the total of all unit-associated losses plus the scheduled external static pressure. Calculations are to be based upon wet cooling coils and filters at recommended dirty change out pressure drop.
13. Detailed motor data for the motors to be supplied.

D. Manufacturer’s Instructions: Indicate assembly, support details, connection requirements and include start-up instructions.

E. Operation and Maintenance Data: Include manufacturer’s descriptive literature, operating instructions, installation instructions, maintenance and repair data and parts listing.

F. Warranty: Submit manufacturer’s warranty and ensure forms have been filled out in Owner’s name and registered with manufacturer.

G. No fabrication shall occur until shop drawings are reviewed and accepted by the Architect.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, as pre-qualified and in accordance with technical specifications herein.

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

C. The units shall be ETL or equivalently labeled.

D. Unit electric panels shall be labeled with the withstand rating SCCR and it shall be 100,000 AIC.

1.08 DELIVERY, STORAGE AND HANDLING

A. Cleanliness

1. Maintain a high degree of cleanliness:

a. During manufacturing
b. During shipping,
c. During storage
d. During field reconnection
e. During start up

2. Unit interior and exterior shall be fully cleaned prior to start-up by the Contractor.
3. Units shall be protected during shipping and while in storage.
4. Once the units are received by the contractor, it shall be the contractor's responsibility to take whatever steps are necessary to deliver the units in like new condition upon start-up and turn-over to the Owner, whichever occurs the latest.

B. Manufacturing

1. Casings shall be manufactured only after all panel components (structural members, facing sheets, etc.) have been thoroughly cleaned of any mill grease, oxidation, etc.
2. The interior and exterior of the casing system shall be thoroughly protected from contamination from the manufacturing process through start-up procedures and Owner's acceptance.
3. Internal components (fans, coils, air filter frames, etc.), shall be free of all grease and dirt.
4. In general, any products such as caulks, gaskets, etc., employed within the unit shall be non-petroleum based products with no outgasing characteristics. All caulk sealants shall be anti-bacterial.
5. Units shall be manufactured level.

C. Shipping

1. Shipping protection shall be provided such that both the interior and the exterior of each unit are protected from road dirt exposure during shipment. This protection shall remain on the unit until unit start-up is performed.
2. Any units damaged in shipment shall be returned to the factory for all corrective work. A representative of the manufacturer shall accept or reject the shipment.

D. On-Site Storage

1. If equipment is to be stored before use, the unit manufacturer shall have provided adequate protection at the factory to ensure that Cleanliness Standards for both the unit interior and unit exterior are met. This protection shall remain on the unit until such time as unit start-up is performed. Accommodations shall be made by the contractor to rotate fan assemblies on a periodic basis as recommended by the fan manufacturer. Fan assemblies shall be rotated without compromising Cleanliness Standards.
2. The unit interiors will not be compromised by their use for tool storage or any other type of storage during the construction of the project. This requirement is mandatory.
3. Provide commonly keyed locks on all unit access doors to eliminate misuse of unit.

E. Rigging

1. The Contractor shall be responsible for rigging under the direct supervision of the unit manufacturer.

F. Field Reconnection

1. Any and all shipping splits requiring field reconnection shall be made by the Contractor under the direct supervision of the air handling unit manufacturer.
2. The unit manufacturer shall supply all necessary gasketing, sealant, installation instructions and supervision.
3. Unit Touch-Up Painting: The contractor shall provide labor and the unit manufacturer shall provide touch-up paint as required to ensure that the appearance of each unit complies with these specifications.

G. Leveling

1. The Contractor shall level all unit sections in accordance with the unit. The contractor shall furnish and install all necessary permanent shim material to assure the levelness of the individual sections and the entire assembled unit.

1.09 WARRANTY

A. The unit manufacturer shall be responsible for and warranty the proper operation and performance of the units, all unit components, leak tightness and non-condensation of the unit casing, structural integrity of the unit including all provisions required for rigging, trucking and installation of units in the areas indicated on the drawings. Units shall be guaranteed for 1 year from date of acceptance of project by Owner.

PART 2 PRODUCTS

2.01 DOUBLE WALL BUILT-UP SUPPLY AIR HANDLING UNIT

A. General

1. Acceptable manufacturers subject to compliance with the specification:

a. All Aluminum Units

1) Air Enterprises

2) Environmental Air Systems (EAS)
3) Haakon
4) Trane Custom
5) Ventrol

2. Provide factory fabricated and factory tested air handling units with components as indicated and scheduled on the drawings, to provide the services designated.
3. Close coordination shall be exercised between the contractors and the unit manufacturer, to ensure that the unit is provided complete with all operating dampers, operators, isolation dampers, detectors, etc.
4. Units shall be suitable for indoor or outdoor installation as required by each unit's installation location.
5. Contractor designed field erected or assembled air handling units shall not be acceptable or considered as equal.
6. The unit manufacturer shall design provisions for any special requirements such as structural columns being installed through the unit.
7. Bidding manufacturers shall advise Engineer early in the bidding time frame of any problems in meeting the scheduled requirements or unit overall dimensions shown on the drawings.
8. The Contractor shall submit complete detailed assembly and component shop drawings prior to fabrication, assembly and installation of any part, portion or component of the unit.
9. The word "unit" shall mean each unit and all work associated for each unit, for the total quantity of units scheduled on the drawings.
10. The air handling unit components shall be fit together and seal properly.
11. The unit start-up and testing shall be performed by the unit manufacturer and shall be included under this Contract.
12. Unit shall be fabricated and assembled in modules in the unit manufacturer's plant or factory. Each of the units shall be assembled, sealed and tested at the factory prior to shipment.

B. Unit Construction

1. Unit housing performance

a. Minimum U value 0.07

1) Minimum insulation density 3 lbs. per square foot.

b. Provide thermal break construction between all interior and exterior surfaces.

1) Under normal internal operating conditions there shall be no condensation on the exterior of the unit at the following conditions:

Indoor Units	85ºF DB 78ºF WB
Outdoor Units	85ºF DB 78ºF WB

c. Maximum deflection of walls shall be L/250 at ±12" w.c. (L = span in inches). Span may be reduced by adding additional supports. Deflection to be measured at the joint/seam, worst case at the mid-span of the joint/seam between panels.

d. Maximum deflection of roof and floor shall be L/360 at design loading (L = span in inches).

1) Minimum floor design load 150 lbs. per square foot.
2) Minimum roof design load 75 lbs. per square foot plus snow load if exterior unit.

e. Seismic requirements shall be as a minimum in accordance with IBC and shall be certified and labeled. See Section 230548.
f. Component equipment shall also be labeled such as fans.
g. AHU service aisles to be provided with supplemental steel supports to allow for field installed piping. Pipe supports to be posted up from unit floor and unit base construction to account for the flooded piping weights.
h. AHU manufacturer shall provide coordination drawings for the field installation of all piping within the service aisle that accounts for piping, vibration isolation hangers, insulation and coil hook-ups. Coordinate control valving configurations, coil headers, coil run-outs for rooftop AHUs within their service aisle to allow for service and maintenance of AHU components.
i. Outdoor unit design conditions

1) Minimum wind loading shall be 120 miles per hour. (Note: Unit-mounted screen to be accounted for within calculations).
2) Minimum snow loading shall be 50 lbs. per square foot.

j. Maximum air leakage shall be 0.5% of the design airflow cfm when tested at ±12 inches w.c.
k. Unit minimum panel sound transmission loss shall be equal to or greater than:

Octave Band Hz	DB Reduction	Octave Bank Hz	DB Reduction
125	30	1000	46
250	42	2000	53
500	40	4000	52

l. Materials

1) Exterior

a) Painted galvanized steel, painted aluminum or unpainted stainless steel (unless noted hereinafter to also be painted).

2) Interior

a) Unpainted Aluminum.

m. Exterior paint:

1) Two coats of primer
2) Two coats of enamel
3) Color shall be white, unless otherwise noted by the Architect. The Architect shall have the no-cost option to require a custom color.

2. Minimum wall thickness shall be 4” (foam panel construction may be 3").

3. Minimum Gauge: THE FOLLOWING ARE MINIMUM GAUGES. HEAVIER GAUGES MAY BE REQUIRED TO MEET THE PERFORMANCE DEFLECTIONS SPECIFIED, SPECIFIED SOUND TRANSMISSION LOSS OR TO ALLOW FOR PROPER WELDING. FOAM PANEL CONSTRUCTION MAY UTILIZE GAUGES LESS THAN LISTED PROVIDED MANUFACTURER SUBMITS DOCUMENTATION OF COMPLIANCE WITH STRUCTURAL REQUIREMENTS.

			Steel	Aluminum
a.	Roof			
	1)	Interior	N/A	0.063”
	2)	Exterior	16 gauge	0.063”
b.	Walls			
	1)	Interior	N/A	0.063”
	2)	Exterior	16 gauge	0.063”
c.	Floor			
	1)	Interior	3/16” checker plate aluminum or 1/8” checker plate stainless steel	3/16” checker plate aluminum or 1/8” checker plate stainless steel
	2)	Exterior	20 gauge	0.063
d.	Septum Wall			
	1)	Low Side	16 gauge S/S	0.063”
	2)	High side	16 gauge S/S	0.063”
e.	Safing			
	1)	Cooling Coil	16 gauge S/S	0.071” or 16 ga S/S
	2)	All Other	16 gauge S/S	0.071”
f.	Distribution Perforated Plate			
	1)	Plate	16 gauge S/S	0.09”
	2)	Air Blender	16 gauge S/S	0.09”

4. Floor/Base Frame

   a. The floor of each unit section shall be diamond safety plate. Floor shall be continuously welded to form a guaranteed waterproof surface. The waterproof floor shall <u>not</u> be used as part of a coil drain pan/collection system. Overall floor thickness shall be a minimum of 6" and shall incorporate a solid galvanized or aluminum underliner to protect the insulation and create a vapor barrier.
   b. All openings in the floor of the units shall be dammed a minimum of 3" high.
   c. The underside of the floor shall be insulated with 6" thick, 3 lb. density fiberglass, sealed in place by a metal underliner, except for cooling coil section. Cooling coil section shall be insulated with 2” foam insulation, sprayed on application.

d. The Unit Manufacturer shall provide a "Pipe Chase" of similar construction as the unit wall as shown in the AHU Details to allow for piping and conduits to be routed through the roof slab penetration (offset as required within the AHU "curb" zone) and into the Units Service Aisle. Provide removal grating and 3" dam at the Service Aisle floor opening.

5. All supply and exhaust discharge openings shall be long radius bellmouths, mounted flush with the interior skin of the unit casing. Bellmouths shall match duct sizes indicated on the drawings.
6. Access Doors and Panels

a. Provide access doors of the same construction and thickness as the unit casing for all unit sections containing equipment requiring service, where dampers or damper operators are installed, or areas for cleaning of unit components such as coils, etc., is required. Access doors shall be equipped with continuous gaskets and shall fit in the door frame in a manner to guarantee 0% leakage at design pressure. Access door materials shall match casing material.
b. Each access door shall have a built-in static pressure probe port for ease of pressure readings across various internal components and to limit unnecessary or unauthorized access inside the unit.
c. Each access door shall be mounted with stainless steel hinges to prevent door racking and air leakage. At least (2) cast aluminum chrome plated handles operable from either side shall be provided. Other door accessories shall include handles and stainless steel hardware to ensure long-term, proper door operation.
d. Each door shall contain a thermal window of double pane safety glass at eye level when the viewer stands on the adjacent floor or grating outside the unit (coordinate with heights of housekeeping pads, vibration isolators, etc.), sized at a minimum of 10” round or 12" by 12", properly sealed to operate safely against the suction or pressure. Windows shall be non-fogging.
e. Removable access panels shall be provided in unit sections where components are larger than the door opening. Panels shall be of the same construction as doors.
f. Provide Rooftop AHUs with (minimum 36"x36" floor access hatch within service Aisle (to access curb cavity below unit.)

7. Roof

a. Unit roof performance shall be as specified above for unit housing, modified as follows:

1) All exterior air handling unit roofs

a) Shall be pitched a minimum of ¼" per foot for drainage.
b) Roof may be part of the unit or the manufacturer may elect to provide a secondary roofing system above the unit roof.
c) Outer most roof shall be a color to match the unit.
d) Refer to Unit details for roof pitching ridge requirements. Manufacturer to provide field-installed standing seam metal roof with secondary roof ridge to shed water as indicated.
e) Roof shall be 100% watertight.
f) Lifting lugs and rail for equipment removal shall be coordinated with unit top or roof.
g) All roofs shall be suitable for walking on and snow loads.

h) Roof shall be designed for earthquake loads and wind loading as well as other equipment imposed loads.
i) Provide written 20-year warranty for roofs.

8. Ladders, Walkways and Handrails

a. Provide OSHA and ANSI approved handrails, walking surfaces, toe guards, safety cages, stairs and ladders.

1) As indicated or noted on the drawings.
2) As specified.
3) As required for service of equipment.

b. They shall be galvanized steel with non-skid surfaces.
c. Coordinate with all piping, ductwork, coil pull, equipment removal and other services. Provide removable railing sections as may be necessary for proper equipment service access.
d. Coordinate platform, stairs and rails to allow for access into rooftop service aisles.

9. Coils

a. See Section 238216.
b. Provide a separate (1" minimum) drain from each pan under each coil down to the bottom pan near its drain. All drain pans shall have bottom outlets. All drain pans are to be designed to drain completely and leave no puddles or standing water.
c. Where drain pans are recessed into the floor of the units provide a non-corrosive, non-slip walk surface flush with the floor of the unit. Recessed drain pans to have minimum of 2" foam between lowest point of drain pan and underliner. Fiberglass insulated drain pans will not be accepted.
d. All coils shall be mounted to allow removal of any coil individually without disturbing any other coils. Allow sufficient space for individual isolation valves for inlet/outlet of each coil piping and all other equipment shall be mounted in a manner as such that they do not preclude coil removal.

1) All coils shall be bolt off to allow removal of any coil individually without disturbing any other coils. Coils to be coordinated to allow removal through the Service Aisle.
2) Unit Manufacturer shall provide a detailed dimensioned piping drawing for all internal unit piping whether provided or not. Provide penetration and seals in accordance with drawing.
3) Provide a label inside and outside of the unit with clear and complete instructions for cleaning upstream and downstream sides of cooling coil.
4) Coordinate the upper coils header connections for the rooftop units (to allow for piping rack within the Service Aisle.) Coils will require lower header connections.

e. All cooling coils supports shall be stainless steel.
f. Drain pans shall be welded Type 304 stainless steel, minimum 18 gauge.

g. Each cooling coil drain pan including intermediate drain pans shall:

1) The minimum drain pan size shall be from the leading face of the coil to a distance downstream from the leaving face of one half of the total assembled height of the water producing height or written certified guarantee verified by testing that the water carryover beyond the drain pan is less than 0.0044 oz per square foot at the peak design dew point and peak design air velocity

h. Drain pan slope:

1) Pan shall slope at a minimum of 1/8 in. per foot from the horizontal towards the drain outlet.
2) Drain pan outlet shall be at the lowest point or points of the pan with sufficient size to prevent overflow under any normal expected operating condition.
3) Unit manufacturer shall provide a drawing indicating the seal trap in accordance with the contract detail and verify the trap will fit with the unit sitting on a 4 inch thick housekeeping pad. If the trap does not the unit base shall be increased in height to a point at which the trap will fit.

i. The air velocity across the cooling coil shall not vary by more than 15% across the cooling coils.
j. Heating Coils - see Specification Section 238216.

10. Supply fans shall be:

a. See Specification Section 233900 fans.
b. All fan motors shall be non-overloading. All fan motors that are powered through VFDs shall have isolated bearings or shaft grounding rings equal to Aegis SGR.
c. Multiple direct drive plenum fans and driven by individual Variable Speed Drives

1) With an inlet bell and integral Piezo ring.
2) Each capable of 50% of total flow with both fans running.
3) Each capable of 70% of total flow one fan running.

d. Air Flow Measurement

1) AHU's AFMS to have piezo rings at each fan inlet with leads extended to outside of AHU casing (or extended into service aisle.)
2) The flow measuring station shall not obstruct the inlet of the fan and shall have no effect on fan performance (flow or static) or sound power levels.

e. Back Draft Damper

1) Each fan shall be provided with a back flow prevention means that produces less than .20" of static pressure drop or system effect when that fan is operating at design airflow.
2) Back draft damper pressure drops that are rated for pressure drop and performance in straight runs of ductwork per AMCA standards will not be accepted for back flow prevention in the multiple fan arrays unless the dampers are installed in accordance with the mounting arrangement under which the dampers are rated for pressure loss at a given flow.

3) The use of AMCA certified back draft damper pressure drop ratings that are not based on being located within 12” from the plane in which the fan inlet cone is located, or discharge dampers located within a distance of two fan wheel diameters from the plane of the back plate of the plenum fan wheel will not be approved.
4) Manufacturers proposing such dampers shall provide factory witnessed testing of the dampers in the proposed mounting arrangement to prove the submitted pressure drops as well as impact on submitted fan BHP and acoustical impact.
5) Corrections for both power and sound power levels shall be determined and submitted for approval. Any increase in fan system power requirements or sound power levels that exceed those as specified will be corrected at no additional cost to the owner. Any proposed remedy for such deviations shall be approved by a registered acoustical consultant as selected by the owner.

11. Return fans shall be:

a. See Specification Section 233900 fans.
b. All fan motors shall be non-overloading. All fan motors that are powered through VFDs shall have isolated bearings or shaft grounding rings equal to Aegis SGR.
c. Multiple direct drive plenum fans and driven by individual Variable Speed Drives

1) With an inlet bell and integral Piezo ring.
2) Each capable of 50% of total flow with both fans running.
3) Each capable of 70% of total flow one fan running.

d. Air Flow Measurement

1) AHU’s AFMS to have piezo rings at each fan inlet with leads extended to outside of AHU casing (or extended into service aisle.)
2) The flow measuring station shall not obstruct the inlet of the fan and shall have no effect on fan performance (flow or static) or sound power levels.

e. Back Draft Damper

1) Each fan shall be provided with a back flow prevention means that produces less than .20” of static pressure drop or system effect when that fan is operating at design airflow.
2) Back draft damper pressure drops that are rated for pressure drop and performance in straight runs of ductwork per AMCA standards will not be accepted for back flow prevention in the multiple fan arrays unless the dampers are installed in accordance with the mounting arrangement under which the dampers are rated for pressure loss at a given flow.
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4) Manufacturers proposing such dampers shall provide factory witnessed testing of the dampers in the proposed mounting arrangement to prove the submitted pressure drops as well as impact on submitted fan BHP and acoustical impact.

5) Corrections for both power and sound power levels shall be determined and submitted for approval. Any increase in fan system power requirements or sound power levels that exceed those as specified will be corrected at no additional cost to the owner. Any proposed remedy for such deviations shall be approved by a registered acoustical consultant as selected by the Owner.

12. Variable Frequency Drives (VFDs)

a. See Specification 230514 Variable Frequency Drives
b. AHU Manufacturer to provide VFDs for each fan within the AHU.
c. Coordinate unit mounted VFD and power connections. Coordinate VFD location within the service aisles to account for installation and code required clearances.

13. Dampers

a. Acceptable manufacturers subject to compliance with specifications.

1) Ruskin
2) Tamco
3) Greenheck

b. The unit manufacturer shall provide all dampers at units (outside air, return, exhaust, isolation, etc.).
c. Damper operators shall be provided in the field by the ATC Contractor except as noted below.
d. Smoke and isolation dampers:

1) Shall be industrial grade equal to Ruskin SD102.
2) Suitable for maximum system pressure, of 12.0" w.g. to 48" damper width.
3) UL555S Leakage Class 2.
4) These dampers shall be UL listed smoke dampers complete with actuators.
5) Construction aluminum or 316 Stainless Steel.
6) Provide additional structure as required to meet deflection criteria.

Note: If changed toSD-60, the maximum width will be 12” in order to meet ±12 inches w.g.

e. All other dampers shall be equal to Ruskin CD-102.

1) Provide air foil double T hinges opposed blade damper.
2) Braced and sized to withstand ±12 inches w.g.
3) Shall be industrial grade equal to Ruskin CD-102.
4) At 12 inches w.g. shall allow a maximum width of 48” per section.
5) Maximum leakage shall be 8 CFM per square foot at 48” x 48” size.
6) Damper shall be provided with operator.
7) Construction shall be aluminum or 316 Stainless Steel.
8) Provide additional structure as required to meet deflection criteria.

f. Smoke damper shall be UL555S rated and shall be sized to as not to exceed their rated velocities or pressure ratings.
g. All hardware shall be stainless steel.

14. Provide sound attenuators to isolate the supply and return fans.

    a. See Section 233319 Sound Attenuators.

15. Drains

    a. Provide drain pans for:

        1) Each cooling coil
        2) Outside air intake

    b. Pipe each to exterior of unit for piping to floor drain by Contractor.
    c. Each cooling coil drain connection shall be properly sized for a drain line at a pitch of 1/8” per foot pitch and shall not be less than 2” pipe.
    d. Each coil connector shall leave the unit a minimum of 12” to the center line of drain above the bottom of unit base.
    e. Provide with trap seal.
    f. Rooftop AHUs with service aisles to be provided with a fully welded pre-fabricated sump pit (with grating) as shown on AHU details to allow for the field installation of floor drain and sanitary piping installation by div. 22 within the AHU curb in the field. Coordinate pit to allow for draining of the Service Aisle.

16. Additional Drains

    a. Provide each section with a 1-1/4” drain.
    b. Pipe to outside unit with standard weight galvanized pipe.
    c. Cap each section drain with a schedule 40 galvanized cap.
    d. Each unit drain shall have a removable strainer cap.

17. Filters

    a. Provide prefilters and after filters complete with gauges, of types as shown and scheduled.
    b. See Specification Section 234100.
    c. Filter frames shall be stainless steel.

18. Filter Gauge

    a. See Specification Section 234100.

19. Air Blender - for Supply / Return AHUs only

    a. Provide where shown on plans to enhance the mixing of outside air with return air to a desired mixing effectiveness and provide even airflow across filters, coils and control sensors. Air mixer models shall be geometrically scaled to ensure proper performance across full range of sizes. Mixers that are not geometrically scaled are not acceptable.
    b. Acceptable manufacturers subject to compliance with the specification and performance testing

        1) Blender Products, Inc

2) AHU Manufacturers own product provided independent test data is provided.

c. Material: Static air mixers material shall be one of the following:

1) Aluminum
2) Stainless Steel
3) If unit has a specified interior finish the construction shall match that specified for that unit.
4) Mixer shall have a minimum performance of 70% effectiveness with the unit volume down to 25% of design flow.
5) At 25% of design flow, the velocity shall be a minimum of 450 FPM.
6) As full flow, pressure drop shall be less than 0.25” w.g.

d. Performance Testing and Rating

1) The mixing effectiveness rating for static air mixers shall be developed according to the following guidelines:

a) The mixing of the test unit shall be tested without any static mixer installed in order to determine the inherent mixing of the system. The inherent mixing effectiveness shall be less than 10% at the exit of the mixing chamber.
b) The temperature differential between hot and cold air streams (Th-Tc) should be at least 40 deg F. The flow rate of the cold air shall be equal to the flow rate of the hot air flow. (50% Cold air & 50% Warm air)
c) Temperature traverses shall be made at several distances downstream of the mixer. The mixing effectiveness must be developed for each model of mixer supplied unless it can be shown that the mixers are properly scaled.
d) (Emixer= 1-(Range/(Th-Tc))) Where: Range=Tmax-Tmin at downstream traverse
e) The pressure drop rating for static air mixers shall be developed according to the following guidelines:
f) The pressure drop shall be developed with the mixer mounted in a duct without dampers or other components present to disturb the flow. There should be at least one duct diameter upstream of the mixer and two duct diameters downstream of the mixer in the test setup.
g) The pressure drop shall be developed for a range of area ratios. Furthermore, the pressure drop must be determined for each different model of mixer being supplied, unless it can be shown that the mixer models are properly scaled.

e. Provide detailed documentation of performance testing.

20. Electrical Interface/Work

a. Provide a complete factory wired electrical system for each unit, so as to allow single-source responsibility and to ensure proper selection and installation of all electrical components.

b. The unit manufacturer shall provide prewired and switched non-corroding vapor-tight fluorescent lights in each compartment that has an access door and in the service corridors as follows:

1) Lights shall be equal to glass "jelly-jar" marine lights suitable with minimum 2,500 lumen output and minimum two fixtures per access compartment, suitable for use in wet and damp locations.
2) Lighting, internal wiring, switching mounted in bell boxes, and all other electrical wiring associated with the lighting shall be provided by the unit manufacturer, at the factory.
3) Lights shall have 277 volt cold weather (-20°F) ballasts and shall comply with UL 1570 and shall carry the UL label.

c. Provide duplex 20-amp electrical outlets with ground fault intervention suitable to be utilized for power tools.

1) Unit manufacturer shall provide (2) 120 volt, single-phase 20-amp electric connections for receptacles (separate circuit receptacles), via junction boxes with circuit breakers for connection in the field by the Electrical Contractor (20 amperes power supply).
2) Rooftop AHUs to be provided with duplex weatherproof GFI outlets on the outside of the units.

d. The air handling unit manufacturer shall provide a non-fused safety disconnect switch (with interlocking contactors to be wired back to its VFD). Power wiring from the power source to the VFD disconnect switch shall be provided by the Electrical Contractor under Division 26.

e. Coordinate location and switching arrangement to ensure that layout shown on the drawings is followed strictly. Lighting system for each unit shall be wired through switches and extended to a terminal block at the side, one at each end of the unit, of each unit ready to accept 277V lighting power. Provide (2) 3-way light switches for each AHU (air tunnel) to activate all of the lights inside the unit sections that have access doors on that "side" of the unit from either switch. Provide similar switching arrangement for any piping spaces provided.

f. Provide weatherproof 120 VAC electrical outlets prewired to a terminal block on the side of the unit. (Electrical convenience outlets to be provided on the units, within the service aisles and on the exterior of outdoor AHUs).

g. All unit splits shall be made with flexible metal conduit.

1) Shall comply with NEC 300.22.
2) Shall be suitable for indoor and outdoor locations.
3) Shall be suitable for wet locations

h. All sections shall be illuminated by lighting, including piping corridors when provided.

i. Wiring and Conduit (By Unit Manufacturer)

1) The unit wiring shall be No. 12 GA minimum stranded copper wire sheathed in a THHN covering, which will be distributed through the unit in Rigid steel conduit, IMC or EMT.

a) The use of aluminum wire or flexible BX cable is prohibited.

2) To allow for adjustment of fan motors provide:

a) 3'-0" section of MC Cable shall be provided at each motor.
b) MC Cable shall:

(1) Shall comply with NEC 300.22.
(2) Shall be suitable for indoor and outdoor locations.
(3) Shall be suitable for wet locations

c) A separate ground wire for each motor shall be connected to a terminal strip in the disconnect switch.

3) Enclosures

a) Outdoor electrical enclosures shall have a NEMA 3R rating.
b) Indoor enclosures shall be rated NEMA 12.

4) In addition to requirements outlined herein, all wiring shall comply with:

a) NEC requirements.
b) Division 26 of this specification.

21. ATC conduit pathways; unit manufacturer shall provide pathways and unit casing penetrations (to minimize field penetrations by the ATC Contractor)

a. Mount ATC control panel on exterior of unit.
b. Provide dual 1-1/2” conduit paths on interior of unit to 8” x 8” x 4” sealed and gasketed ACT j-boxes located at each section. (All conduit penetrations to be sealed at casing and interior section penetrations).
c. Provide provisions for connections for conduit paths at unit shipping splits.

22. Space Limitations

a. The air handling units shall be designed within the dimensions and space limitations, as indicated on the drawings and as specified.
b. The unit manufacturer shall take these dimensions and space limitations into consideration for the design required and shall submit dimensional data on the drawings.
c. Advise the Engineer early in the bid process should any problems be detected with existing space limitations.

23. Unit Painting

a. All units shall be factory painted as noted before. All necessary field touch-ups will be provided by the unit manufacturer.

24. AHU Exterior Panel Mounting

a. The air handling units shall be designed with a 304 s/s “Z-channel” to the exterior of the unit casing to accommodate field mounted louver panel screening, as indicated on the drawings and as specified.

b. The Unit Manufacturer shall provide and coordinate the method of securing (and required spacing of) a Louvered Panel similar to Greenheck Horizontal Screen Inverted Blade (EES-401) Unit Manufacturer shall coordinate and provide the field installation of the louver / screen once the unit is rigged and set on roof.

1) Greenheck EES-401 to be 4 in. deep equipment screen designed to inhibit vision from grade or lower elevations while also serving as a protective barrier. Design incorporates extruded aluminum inverted horizontal blades attached to vertical support members. The EES-401 is to be supplied with either mitered or boxed corners and man-doors in order to meet aesthetic and service specifications.

2) Construction:

a) Material; 6063-T5 extruded aluminum
b) Screen depth;4 in.
c) Blades; Inverted horizontal, 6063-T5 extruded aluminum, 0.081 in. nominal thickness spaced on 5 in. centers
d) Mitered Corners
e) Finishes
f) Reinforcing; Rear vertical Z-supports shall be designed to meet 25 psf windload.
g) Mechanically fastened to AHU mounted “Z-Channel”
h) Finish Type (to be Coordinated with the Architect)

(1) 2-coat 70% KYNAR 500®/HYLAR 5000® AAMA 2605 –Dry film thickness 1.2 mil. (AKA: Duranar®, Fluoropon®,Trinar®, Flouropolymer, Polyvinylidene Fluoride, PVDF2)
(2) Standard Colors: Any of the 24 standard colors shown can be furnished in 70% or 50% KYNAR 500®/HYLAR 5000® or Baked Enamel

i) Warranty: Finishes meet or exceed AAMA 2605, AAMA 2604, and AAMA 2603 requirements. Paint finish warranties are not applicable to steel products. 10 Years

c. The unit manufacturer shall coordinate exterior panel dimensions with access doors and removable panels to allow for access to equipment for maintenance and/or equipment removal and replacement.
d. The Unit Manufacturer shall accommodate wind force loads to be transferred to the unit structural framing. (Note: refer to the AHU details for additional info regarding the termination of screen elevation being above the unit roof.)
e. Advise the Engineer early in the bid process should any problems be detected with existing space limitations.

25. Unit Curbs (for Roof top AHUs)

a. All roof top units shall be located on Structural Posted up Dunnage. The CM is to coordinate an insulated curb to be positioned at the units perimeter. Curb to be flashed into the AHU’s base rail and be fastened to the top of roof slab/concrete. Steel dunnage members are to be “boxed-out.”

PART 3 EXECUTION

3.01 FACTORY TESTING

A. Each unit shall be tested by the unit manufacturer prior to shipping, as follows:

1. Factory full load flow Test:

a. Air volume and static pressure test shall verify that the air volume is within the range of 100% to 110% of scheduled nominal CFM requirements when operating at design static pressure.
b. The test for airflow and static capability shall include airflow measuring devices installed in all ducts returning to or leaving the unit.
c. These devices shall be installed in accordance with the measuring device manufacturer's recommendations.
d. Pressures external to the unit shall be simulated using a combination of ducts and dampers.
e. The tests shall prove design airflow and static capability of the complete assembled unit.

2. Factory 50% load flow Test:

a. In addition test all VAV units at a 50% turn down.
b. Procedure similar to factory full load flow test.

3. Factory Test: Casing leakage

a. Tests shall be run to prove that unit casing leakage is less than 0.5% of design airflow CFM at ±12.0" w.c. Test shall be in accordance with SMACNA.
b. The unit shall be tested on the positive side of the fan septum wall to +12" w.c. and on the negative side to -12" w.c. in two tests (not at the same time).
c. The leakage of both tests is to be summed (added) to derive the total unit leakage.
d. Factory test shall meet the specified valves.
e. The use of any temporary caulking at any permanent panel joints is unacceptable.
f. Temporary test caulking shall be utilized at the unit shipping splits to simulate "as installed" conditions.

4. Factory test unit casing deflection

a. Test unit casing deflection at 12" positive pressure and 12" negative pressure and measuring deflection with dial micrometer gauges.
b. All measurements to be made at the mid-span of the joint/seam (between panels).

5. Factory Test Sound

a. System sound power levels shall be measured in all none (9) octave bands (31.25 Hz through 8000 Hz) at system design operating conditions.

1) Airborne sound power levels at all openings shall be read in the test ductwork 5'-0" from the openings.
2) Transmitted sound power levels shall be read 5'-0" from the outside of the fan section.

b. Sound tests shall be conducted while the unit is running at design conditions. An octave band sound pressure level reading shall be taken at:

1) Outside louver.
2) Exhaust louver.
3) Supply discharge opening.
4) Return air opening, economizer opening.
5) Adjacent to each fan section outside of the unit casing.

6. Factory Test Vibration:

a. Each individual fan shall be tested for vibration in X-Y-Z directions at the manufacturer's facility before shipment to the unit manufacturer to assure that specified fan balancing criteria is adhered to.
b. Unit manufacturer shall test each fan in operation as installed in the unit.

1) Vibration Test

a) Centrifugal fan

(1) Each fan shall be fully assembled with motor and drive on a structural steel base and run tested at the factory prior to shipment of the unit.

(2) Testing shall be conducted at the operating speed or maximum fan class speed.
(3) The amplitude of vibration (displacement in mils) at operating speed measured at each unit fan bearing shall not exceed the values given in the following table:
(4) Maximum allowable:

Fan RPM	Displacement Mils
500	4.2
800	3.0
1100	2.3
1400	1.9
1700 or Greater	1.6

7. Deficiencies

a. Any deficiencies in unit performance must be corrected by the unit manufacturer in the manufacturing plant prior to shipping.

8. Test Procedures

a. A complete test procedure shall be submitted for approval and shall include:

1) Detailed the methods.
2) All equipment to be employed for each specific test
3) All techniques to be employed for each specific test.

4) A copy of all instrument certifications shall be submitted and shall include as a minimum:

a) All air flow measuring devices.
b) Acoustical meters.
c) Vibration meters.
d) Pressure measuring devices.
e) Electrical meters.
f) Dial measurement gauges.

5) Equipment will not be considered approved until written approval of testing procedures is reviewed.

3.02 FIELD TESTING

A. Field Pressure Test:

1. Pressurized leak testing shall be performed in the field after assembly of the unit sections by the Contractor at ±12".
2. The unit manufacturer shall correct and/or pay for the repair of all deficiencies found during testing.
3. The Contractor shall provide all field labor necessary to join the unit sections, including all electric and drain splits after they are delivered to the site and set in place.
4. All field work shall be provided under the direct supervision of a qualified Engineer employed by the unit manufacturer.
5. This test shall be performed within 2 weeks of the unit assembly and placement.

B. Drain Pans

1. Test

a. Check drain trap for seal
b. Plug pan
c. Flood drain pans with water to near top of drain pan
d. Pull plug with fan operating

2. Acceptable results:

a. Shall drain completely in 3 minutes or less
b. Trap seal still functional
c. After three minutes NO puddles shall remain in the pan larger than 2 inches in diameter and no more than 3mm deep.

C. Vibration Testing

1. All fans
2. All VFD driven fans throughout the range of control.

END OF SECTION

SECTION 238126

SPLIT SYSTEM AIR CONDITIONING UNITS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install split system air conditioning units. This shall include all piping, ducts and supports specified in this Division and as shown on the drawings

B. All units shall be new and manufactured for the specific purpose of providing conditioned air (heating and cooling) to the systems indicated.

C. All system components shall be installed in accordance with local codes including seismic isolation.

D. Secure all permits and local/state approval for the components as specified and included under this Section.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made part of the Contract Documents.

1. ABMA STD 9 – Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA STD 11 – Load Ratings and Fatigue Life for Roller Bearings.
3. AMCA 99 – Standards Handbook.
4. AMCA 210 – Laboratory Methods of Testing Fans for Rating.
5. AMCA 300 – Reverberant Room Method for Sound Testing of Fans.
6. AMCA 301 – Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
7. AMCA 500 – Test Methods for Louvers, Dampers and Shutters.
8. ARI 410 – Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.
9. NEMA MG 1 – Motors and Generators (1).
10. NFPA 70 – National Electrical Code - 2011.
11. SMACNA (DCS) – HVAC Duct Construction Standards – Metal and Flexible.
12. UL 900 – Standard for Air Filter Units.
13. 2003 international Mechanical Code
14. 2009 IECC

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional submittal requirements.

B. The unit manufacturer shall submit without delay after receipt of notice of award, shop drawings for approval which shall indicate, but not be limited to, the following information in detail:

1. Detailed drawings and data of all proposed components.
2. To scale dimensional drawings (plans and sections) of the entire air handling unit showing all component locations, equipment arrangements, piping connections and sizes, duct connections and sizes, and all safing required.
3. Casing and hoisting details including floor structures, internal structures, panel fabrication, insulation material and equipment supports. Location of drains and method of piping penetration and sealing of penetrations through the casings.
4. The sound power levels on all fans, fan and motor efficiency, horsepower, RPM and fan size.
5. Fan curves shall be submitted. Fan curves shall be prepared and submitted indicating performance of the fans.
6. ARI certified calculations for coil selections.
7. List of proposed component manufacturers and models, such as fans, casing, coils, humidifiers, filters, dampers, controls, door hinges, disconnect switches, controls, etc.
8. Pressure drop calculation indicating losses of all components, plenums, contractions, expansions at rated flow of unit. Pressure drop calculations are to be submitted in tabular form and shall indicate the total of all unit-associated losses plus the scheduled external static pressure. Calculations are to be based upon wet cooling coils and filters at recommended dirty change out pressure drop.

C. Manufacturer’s Instructions: Indicate assembly, support details, connection requirements and include start-up instructions.

D. Operation and Maintenance Data: Include manufacturer’s descriptive literature, operating instructions, installation instructions, maintenance and repair data and parts listing.

E. Warranty: Submit manufacturer’s warranty and ensure forms have been filled out in Owner’s name and registered with manufacturer.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, as pre-qualified and in accordance with technical specifications herein.

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

C. The units shall be UL or ETL or equivalently labeled.

1.07 DELIVERY, STORAGE AND HANDLING

A. Cleanliness

1. The intent of this Section is to ensure the Owner that the split system air conditioning units are manufactured, shipped, stored, field reconnected and started-up while maintaining a high degree of cleanliness. Once the units are received by the contractor, it shall be the contractor's responsibility to take whatever steps are necessary to deliver the units in like new condition upon start-up and turn-over to the Owner, whichever occurs the latest.

B. Shipping

1. Shipping protection shall be provided such that both the interior and the exterior of each unit is protected from road dirt exposure during shipment. This protection shall remain on the unit until unit start-up is performed.
2. Any units damaged in shipment shall be returned to the factory for all corrective work.

C. On-Site Storage

1. If equipment is to be stored before use, the unit manufacturer shall have provided adequate protection at the factory to ensure that Cleanliness Standards for both the unit interior and unit exterior are met. This protection shall remain on the unit until such time as unit start-up is performed.

D. Rigging

1. The Contractor shall be responsible for rigging in accordance with the requirements of the unit manufacturer.

1.08 WARRANTY

A. The unit manufacturer shall be responsible for and warranty the proper operation and performance of the units, all unit components, leak tightness and non-condensation of the unit casing, structural integrity of the unit including all provisions required for rigging, trucking and installation of units in the areas indicated on the drawings. Units shall be guaranteed for 5 years from date of acceptance of project by Owner.

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers subject to compliance with the specification:

1. Mitsubishi
2. Daikin

2.02 OUTDOOR UNIT DESIGN

A. General

1. The outdoor unit shall be equipped with an electronic control board that interfaces with the indoor unit to perform all necessary operation functions.
2. The outdoor unit shall be capable of operating at 100% capacity at 0°F ambient temperature without additional low ambient controls.
3. The outdoor unit shall be able to operate with a maximum height difference of 100 feet between indoor and outdoor units.
4. System shall operate at up to a maximum refrigerant tubing length of 100 feet for the 12,000 and 165 feet for the 24,000 BTU/h units between indoor and outdoor units without the need for line size changes, traps or additional oil.
5. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory.
6. Outdoor unit sound level shall not exceed: 48dB(A).

B. Cabinet

1. The casing shall be constructed from galvanized steel plate, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection.
2. Mounting feet shall be provided and shall be welded to the base of the cabinet and be of sufficient size to afford reliable equipment mount and stability.
3. Easy access shall be afforded to all serviceable parts by means of removable panel sections.
4. Fan cage shall be provided.
5. Cabinet mounting and construction shall be sufficient to withstand 155 MPH wind speed conditions. Mounting, base support, and other installation to meet Hurricane Code Conditions shall be by Contractor.

C. Fan

1. Units shall be furnished with a single DC fan motor.
2. The fan blade(s) shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated.
3. The outdoor unit shall have horizontal discharge airflow. The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front. The fan shall be provided with a raised guard to prevent external contact with moving parts

D. Coil

1. The condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up and allow maximum airflow. The coil shall be protected with an integral metal guard.
2. Refrigerant flow from the condenser shall be controlled by means of an electronic linear expansion valve (LEV) metering device. The LEV shall be controlled by a microprocessor controlled step motor.

3. All refrigerant lines between outdoor and indoor units shall be of annealed, refrigeration grade copper tubing, ARC Type, meeting ASTM B280 requirements, individually insulated in twin-tube, flexible, closed-cell, CFC-free (ozone depletion potential of zero), elastomeric material for the insulation of refrigerant pipes and tubes with thermal conductivity equal to or better than 0.27 BTU-inch/hour per Sq Ft / °F, a water vapor transmission equal to or better than 0.08 Perm-inch and superior fire ratings such that insulation will not contribute significantly to fire and up to 1" thick insulation shall have a - Flame-Spread Index of less than 25 and a Smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102.

E. Compressor

1. The compressor shall be a DC twin-rotor rotary compressor with Variable Speed Drive Technology.
2. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which shall result in significant energy savings.
3. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be automatically, intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant. No crankcase heater is to be used.
4. The outdoor unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.

F. Electrical

1. Power for the indoor unit shall be supplied from the outdoor unit via Mitsubishi Electric A-Control using three (3) fourteen (14) gauge AWG conductors plus ground wire connecting the units.
2. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC.
3. The unit shall have Pulse Amplitude Modulation circuit to utilize 98% of input power supply.

2.03 CEILING SUSPENDED TYPE EVAPORATOR UNIT

A. The Ceiling Suspended type indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor. The unit, in conjunction with the remote shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from the factory.

B. Cabinet: The casing shall have a white finish. Cabinet shall be designed for suspension mounting from above and horizontal operation. Indoor unit shall have removable mounting brackets. A mounting template with suspension bolt locations shall be furnished with indoor unit. Mounting bolts or threaded rod of 3/8" diameter shall be used to suspend unit and unit shall not require direct contact with ceiling or panel for proper operation. Mounting support shall be of sufficient strength and design to support full weight of indoor unit. The rear cabinet panel shall have knock-out provisions for a field installed filtered 4-5/16 diameter ventilation air intake connection.

C. Fan: The indoor unit fan shall have multiple high performance, double inlet, forward curve sirocco fans driven by a single motor. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall consist of four (4) speeds: Low, M1, M2, and Hi plus AUTO fan setting. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and sensed space temperature.

D. Vane: There shall be a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction for uniform air distribution. The horizontal vane shall provide a choice of five (5) vertical airflow patterns selected by remote control: 100% horizontal flow, 80% horizontal flow (plus 20% downward airflow), 60% horizontal airflow (plus 40% downward airflow), 40% horizontal airflow (plus 60% downward airflow), and swing. The horizontal vane shall significantly decrease downward air resistance for lower sound levels, and shall close the outlet port when operation is stopped. There shall also be a set of vertical vanes to provide horizontal swing airflow movement selected by remote control.

E. Filter Return air shall be filtered by means of an easily removable washable filter.

F. Coil The evaporator coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The multi-angled heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. An optional drain pan level switch (DPLS1), designed to connect to the control board, shall be provided and installed on the condensate pan to prevent condensate from overflowing.

G. System Control: The control system shall consist of a minimum of two (2) microprocessors, one on each indoor and outdoor unit, interconnected by control wiring. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from a wired or wireless controller, providing emergency operation and controlling the outdoor unit. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Indoor units shall have the ability to control supplemental heat via connector CN24 and a 12 VDC output.

1. For control, a three (3) conductor 14 gauge AWG wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units.
2. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.

2.04 WALL MOUNTED TYPE EVAPORATOR UNIT

A. The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor. The unit, in conjunction with the wired wall-mounted controller, wireless wall-mounted controller or wireless handheld controller, shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from the factory.

B. Unit Cabinet: The cabinet shall be formed from high strength molded plastic with smooth finish, flat front panel design with access for filter. Cabinet color shall be white. The unit shall be wall mounted by means of a factory supplied, pre-drilled, mounting plate.

C. Fan: The indoor unit fan shall be high performance, double inlet, forward curve, direct drive sirocco fan with a single motor. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall consist of three (3) speeds: Low, Mid, and Hi and Auto. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.

D. Vane: There shall be a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction for uniform air distribution. The horizontal vane shall significantly decrease downward air resistance for lower sound levels, and shall close the outlet port when operation is stopped. There shall also be a set of vertical vanes to provide horizontal swing airflow movement.

E. Filter: Return air shall be filtered by means of an easily removable washable filter.

F. Coil: The evaporator coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The multi-angled heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. An optional drain pan level switch (DPLS1), designed to connect to the control board, shall be provided and installed on the condensate pan to prevent condensate from overflowing.

G. System Control: The control system shall consist of a minimum of two (2) microprocessors, one on each indoor and outdoor unit, interconnected by a single non-polar two-wire cable. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from a wireless or wired controller, providing emergency operation and controlling the outdoor unit. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Indoor units shall have the ability to control supplemental heat via connector and a 12 VDC output.

PART 3 EXECUTION

3.01 GENERAL

A. Install unit in accordance with manufacturer’s installation instructions. Install unit plumb and level, firmly anchored in location indicated, and maintain manufacturer’s recommended clearances.

B. Complete system refrigerant charge shall be provided by the Contractor.

3.02 ELECTRICAL WIRING

A. Install and connect electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer’s electrical connection diagram submittal to the electrical contractor.

3.03 PIPING CONNECTIONS

A. Install and connect devices furnished by the manufacturer but not specified to be factory mounted. Furnish a copy of manufacturer’s piping connection diagram submittal to the piping contractor.

3.04 SUPPLY AND DRAIN WATER PIPING

A. Connect water supply and drain connections to the air conditioning unit. Provide pitch and trap per manufacturer's instructions and local codes.

3.05 START UP

A. Start up air conditioning unit in accordance with manufacturer's start up instructions. Test controls and demonstrate compliance with requirements.

END OF SECTION

SECTION 238216

COILS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Provide coils of size, capacity, location and type shown and scheduled on the drawings and as hereinafter specified.

B. Coil capacities, pressure drops and selection procedures shall be certified in accordance with ARI 410 (latest edition).

C. Furnish and install coils to make a complete and operational system.

D. All equipment shall be new and shall be of the type, style, size and capacities as scheduled.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as following:

1. ARI 410 – Forced-Circulation Air-Cooling and Air-Heating Coils.
2. SMACNA (DCS) – HVAC Duct Construction Standards, Metal and Flexible.
3. NFPA 70 – National Electrical code.

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: Provide typical catalog of information including arrangements.

C. Provide ARI Calculations.

D. Manufacturer’s Instructions: Indicate installation instructions and recommendations.

E. Provide detail drawings and each coil and recommended installations.

F. Project Record Documents: Record actual locations of components.

G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data and parts listings.

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

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five (5) years of documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriter's Laboratories Inc. testing firm acceptable to the authority having jurisdiction and suitable for the purpose specified and indicated.

1.07 PRODUCT, STORAGE AND HANDLING

A. Delivery of materials shall be made to the project by the materials supplier in accordance with the instructions to the Contractor.

B. The Contractor shall provide adequate locked storage space and shall be responsible for all items of materials after receipt from the supplier, and shall replace all materials lost or damaged after delivery and receipt.

PART 2 PRODUCTS

2.01 UNIT HOT WATER HEATING AND HOT WATER PREHEAT COILS

A. Acceptable manufacturers subject to compliance with the specifications shall be as follows:

1. Aerofin
2. Carrier
3. York
4. McQuay
5. Trane
6. Heat Craft
7. TSI
8. Precision

B. Fins shall be continuous aluminum configured plate fin type, with full fin collars for accurate spacing and maximum fin tube contact with a maximum (10) fins per inch. Minimum fin thickness shall be 0.095".

C. Tubes shall be copper expanded into fin collars for permanent fin tube bond and expanded into header for leak tight joint at 300 psig air pressure under water. Headers shall be gray cast iron, hydrostatically tested to 400 psi before assembly. All standard coils shall be proof tested at 300 psig and leak tested at 200 psig air under water.

D. Casings shall be 16 gauge, continuous coated galvanized steel with fins recessed into channels to minimize air bypass, with 3/8" holes on 3" centers in top and bottom channels for mounting.

E. Coils shall have rows as scheduled on the drawings, 5/8" o.d., with 0.025” thick tubes and 0.035” thick tube bends. End connections shall be 5/8” o.d. with 0.025” thick tubes. Each tube-to-header shall be joint reinforced with brass bushing. Bronze, spring type turbulators shall be provided to attain required capacity at the available GPM and entering water temperature.

F. Coils must be fully drainable.

2.02 IN-DUCT HOT WATER HEATING COILS

A. Acceptable manufacturers subject to compliance with the specifications shall be as follows:

1. Trane
2. Aerofin
3. Heat Craft
4. TSI
5. Precision

B. Water heating coil shall be of the extended surface type, constructed of copper tubing minimum 5/8" o.d., 0.020” thick, and having plate fins of aluminum extending at right angles to the tubes.

C. Tubes shall be pressure bonded into the fin collars by expanding the tubes. No solder bonding shall be used. All copper-to-copper joints shall be made with high temperature silver brazing material.

D. Plate fins shall be corrugated. Fins shall be spaced no closer than (12) per inch integral spacing collars that cover the tube surface.

E. Hot water coils shall be tested for 300 psig, maximum 250°F, and 400 psig air pressure under water.

F. Access doors shall be installed upstream and downstream of coil for cleaning access.

2.03 COOLING COILS

A. Acceptable manufacturers subject to compliance with the specification shall be as follows:

1. Aerofin
2. Carrier
3. York
4. Trane
5. McQuay
6. Heat Craft
7. TSI
8. Precision

B. Primary surface shall be round seamless 0.025" thick, 5/8” o.d. copper tubes on 1 1/2" centers, staggered in the direction of airflow. All joints shall be brazed. Tube bends shall be 0.035 thick.

C. Secondary surface shall consist of aluminum plate type fins for higher capacity and structural strength. Spinal fins will not be acceptable. Fins shall have a minimum thickness of 0.095" with full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer with a maximum (10) fins per inch. Bare copper tube shall not be visible between fins. Fins shall have no openings punched in them so as to accumulate lint and dirt.

Tubes shall be mechanically expanded into fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Tubes that have been expanded through the use of hydraulic expansion methods will not be acceptable.

D. Casing and tube supports shall be constructed of stainless steel with 3/8" diameter bolt holes for mounting on 8" centers. Casing shall be a minimum of 16 gauge stainless steel, reinforced flange of a minimum of 1½" deep flange.

E. Coil header shall be of copper materials using seamless copper tubing with intruded tube holes to permit expansion and contraction without creating undue stress or strain. Coil size shall be determined by coil manufacturer based upon the most efficient coil circuiting. Vent connections at the highest point to ensure proper venting and drain connections shall be provided at the lowest point to ensure complete drainage and prevent freeze-up.

F. Coils shall have foam sealing strip located between casing channels and fins along top and bottom to arrest air bypass and water carryover.

G. The complete coil core shall be pressure tested with 315 lbs. air pressure under warm water and shall be suitable for operation at 250 psig working pressure. Individual tube test and core tests before installation of headers will not be considered acceptable. Cooling coils shall be circuited for drainability and for service without removing individual plugs from each tube. Use of internal restrictive devices to obtain turbulent flow will not be acceptable since they prevent complete draining of the coil.

H. The manufacturer shall furnish coil capacities as outlined in the tabulation. Capacities shall be verified with an ARI approved computer selection method.

I. The unit manufacturer shall provide separate drains from pan under each coil section. Drains from multiple, stacked coil pans shall be routed individually to drain outlet, not cascaded from one coil pan to the next lower pan.

J. Cooling coils shall be mounted to allow removal of any coil individually without disturbing any other coils.

K. Drain pans and support members shall be stainless steel. Coil drain pans shall allow for condensate removal upstream or downstream of all coils including recirculation units.

L. Each individual coil module shall have a limited height of up to 36".

M. Coils shall be fully drainable.

N. Cooling Coils located within Rooftop Units with Service Aisle to have coil header connections coordinated with unit Manufacturer to allow for field piping and coil hook-up connections. (Select coils, such as the higher cools, require lower connections, refer to the AHU Details for additional information.)

PART 3 EXECUTION

3.01 INSTALLATION

A. Coils shall be installed in accordance with manufacturer recommendations, Contract Drawings, and specifications.

B. Coils shall be installed such that coils can be completely drainable.

C. Coils shall be installed so as to ensure easy accessibility for service or removal and replacement of control valves, shut-off valves, strainers and coils.

D. Each coil shall have a vent at the high point.

E. Provide union at each coil connection.

3.02 CLEANING

A. After construction is completed, including painting, clean exposed surfaces of units.

END OF SECTION

SECTION 238235

TERMINAL HEAT TRANSFER UNITS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install all terminal heat transfer units of the type, size and capacity as scheduled.

B. Units shall be UL and AGA listed in accordance with the specific unit's heat transfer design and construction.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as following:

1. UL 1025-89 – Electric Air Heaters.
2. UL 1042-86 – Electric Baseboard Heating Equipment.
3. ASHRAE 90.1 – Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings.
4. NFPA 54 – National Fuel Gas Code.
5. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.
6. NFPA 90B – Installation of Warm Air Heating and Air Conditioning Systems.
7. NFPA 211 – Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances.

1.05 SYSTEM DESCRIPTION

A. Furnish and install all radiation, unit heaters, radiant panels, controls, piping, wiring, enclosures, access doors, etc. to make a complete and operational system.

B. All enclosures shall be installed with aligning strips, plaster frames and end trims so as to provide a neat architectural finish.

C. All equipment shall be new and shall be of the type, style, size and capacities as scheduled. All radiation enclosures shall be continuous and of the same finish and style as adjacent enclosures.

1.06 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: Provide typical catalog of information including arrangements.

C. Shop Drawings:

1. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers and comparison of specified heat required to actual heat output provided.

a. Indicate cross sections of cabinets, grilles, bracing and reinforcing, mounting details and insulation if required and typical elevations.
b. Indicate flows, pressure drops (including interconnecting piping for radiant panels), heat outputs and mean temperatures.
c. Indicate mechanical and electrical service locations and requirements.

D. Manufacturer's Instructions: Indicate installation instructions and recommendations.

E. Project specific installation instructions and details.

F. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets and ceiling panels required for access or valving.

G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data and parts listings.

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

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years of documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriter's Laboratories Inc. testing firm acceptable to the authority having jurisdiction and suitable for the purpose specified and indicated.

1.08 PRODUCT, STORAGE AND HANDLING

A. Delivery of materials shall be made to the project by the materials supplier in accordance with the instructions to the Contractor.

B. The Contractor shall provide adequate locked storage space with shelving for the materials, shall be responsible for all items of materials after receipt from the supplier, and shall replace all materials lost or damaged after delivery and receipt.

C. The Contractor shall furnish the materials supplier with receipts for all materials and accessory items received and shall send copies of these receipts to the Architect.

1.09 WARRANTY

A. See General Conditions for additional warranty requirements.

PART 2 PRODUCTS

2.01 UNIT HEATERS

A. General

1. All type heaters, as applicable, shall be hung with vibration spring isolators as hereinbefore specified.
2. The Contractor shall provide control valves and unit or remote mounted thermostats and wire to fan, to cycle fan “on/off.”
3. The Contractor shall make provisions to "open/close" the steam or water control valves when heaters are "on/off", as indicated hereinafter.
4. Unit manufacturer shall provide starters and disconnect switches.
5. Thermostats used with all type heaters shall be coordinated with the unit manufacturer for compatibility with equipment.
6. Heater colors, where applicable, shall be as provided as standard by the unit manufacturer.
7. Heater finish color shall be as determined by the Architect during shop drawings from the colors provided as standard by the unit manufacturer.
8. Temperature Control

a. Thermostat control shall be provided on floor and wall mounted units, consisting of factory built-in thermostat or wall-mounted thermostat of fully enclosed and snap acting to prevent radio or TV interference. The thermostat shall have a temperature adjustment range between 45°F and 95°F. Integral thermostats shall have tamperproof adjustment through the discharge grille by means of a hex wrench. Ceiling and inverted mounted units shall be provided with wall mounted MHT 4015E-1007 thermostat.
b. If not indicated on the plans the unit shall have a unit mounted return airside thermostat.
c. Thermostat shall operate the single-phase holding coil circuit of the integrally mounted power control relay(s). This single-phase relay holding coil circuit shall either be powered from the cabinet unit heater main power supply or from a separate 120V or 24V single-phase circuit.
d. An integral fan delay switch shall be provided to prevent discharge of cold air, by delaying start-up of the fan motor until heating elements have warmed up. This same fan delay switch shall maintain motor operation after heating elements have been de-energized to dissipate any residual heat.
e. Floor, wall and inverted mounted units shall be equipped as standard with a 2-speed/2-heat selector switch which will permit simultaneous tamperproof "high/low" adjustment of fan speed and heat output by means of a hex wrench through the discharge grille. Ceiling mounted units shall be wired for medium speed.

B. Hot water or steam propeller type unit heaters

1. Provide unit heaters of arrangement (floor or ceiling mounted, exposed or recessed) as indicated on the drawings.

2. Acceptable manufacturers subject to compliance with the specifications shall be as follows.

    a. Sterling
    b. Trane
    c. Modine
    d. Vulcan
    e. Airtherm
    f. Sigma

3. Casing shall be 2-piece with "picture frame" front formed into wrap-around sides, top and bottom with horizontal louvers and louver keepers. Back panel shall be 18 gauge with deep draw fan orifice for extreme rigidity. Heaters shall have cast brass coil supply and return pipe tap connectors bolted to back corners and casings phosphatized to prevent corrosion.
4. Fans shall have aluminum blades and shall be factory balanced for standard application.
5. Coils shall be one-row deep in the direction of flow, headerless, single tube, single serpentine type. Fins shall be aluminum Sigma-Flo, mechanically bonded to seamless copper tubing. Coils shall be one-row deep in airflow direction and shall be tested at 300-psig air, under water.
6. Motors shall be totally enclosed, insulated, shaded pole. Motors shall have built-in overload protection and shall be permanently lubricated.
7. Provide four (4) direction control louvers with lateral diffusion and clips suitable for support off louvers.

C. Electric propeller type unit heaters shall be as follows:

1. Provide electric unit heaters of the type, size, capacity and voltage as specified on the drawings.
2. Acceptable manufacturers subject to compliance with the specifications shall be as follows:

    a. Trane
    b. Chromalox
    c. Markel

3. Enclosures shall be fabricated from heavy gauge zinc coated steel, finished in high gloss beige enamel. Enclosures shall contain heating elements, contactors and control transformers where required. Air shall be drawn in the back of the heater and discharged through independently adjustable horizontal louvers on the front. In the low portion of the front, a large hinged access door extending the width of the heater shall be provided for easy wiring and inspection of controls. Heater and supply wiring diagram shall be attached permanently to the inside of this door. Motor shall be mounted on a heavy gauge formed wire protective guard. A castle nut with cotter key shall be supplied on the top of the unit at center of gravity to allow easy support and adjustment.
4. Elements shall consist of helically coiled nickel chromium alloy resistance wire embedded and completely surrounded in magnesium oxide, enclosed and swaged into corrosion resistant sheaths to which are permanently attached corrosion resistant steel fins. Element assemblies shall be circular in shape and enclosed in a closely fitting cylinder creating a pressure chamber to assure uniform airflow.

5. Motors shall be totally enclosed industrial rated single-phase, permanently lubricated and equipped with thermal overload protection with automatic reset. Units rated 20 KW and less shall have shaded pole motors. Those over 20 KW shall have permanent split capacitor motors.
6. Fan blade shall be of the axial flow type designed for high efficiency and quiet operation. Fan speed shall not exceed 1700 rpm.
7. All heaters shall be equipped with a manual reset thermal cutout which disconnects elements and motors in the event normal operating temperatures are exceeded.
8. Heaters shall be designed for a single supply circuit, with elements, motor and control circuits subdivided and fused to conform to the National Electric Code, Occupational Safety and Health Act (OSHA) and Underwriters' Laboratories, Inc., Standard 573-1968. All 3-phase heaters shall have balanced phases.
9. Contactors and control circuit transformers, where required, shall be factory assembled and wired with only direct line supply and thermostat connections required in the field.
10. Heaters are to be listed under the Re-Examination Service of Underwriters' Laboratories, Inc. Heaters shall be guaranteed to be free from defective material and workmanship for a period of one (1) year, with the exception of the heating elements which shall be guaranteed for five (5) years.

2.02 CABINET UNIT HEATERS

A. Hot water

1. Acceptable manufacturers subject to compliance with the specifications shall be as follows.

   a. Sterling
   b. Trane
   c. Modine
   d. Vulcan
   e. Airtherm
   f. Sigma

2. Units shall include chassis with galvanized steel wrap-around structural frame with all edges flanged. Insulation shall be faced, heavy density glass fiber. Where applicable, cabinet unit heaters shall be suitable to be installed in a manner to receive ductwork (supply and/or return).
3. Cabinets shall have a minimum 16 gauge steel front panels, 18 gauge steel end and top panels and channel formed edges around entire panel perimeters. Front panel shall be insulated over the entire coil section. Integral stamped outlet grilles shall be with 15-degree deflection from vertical. Provide stamped lattice discharge grilles, access door on coil connection side of unit filter and front panel removable without tools.
4. Cabinet finish shall be cleaned, bonderized, phosphatized and flow coated with baked-on primer and final paint finish as directed by the Architect in the field.
5. Coils shall have 5/8 inch O.D. seamless copper tubes bonded to configured aluminum fins with continuous fin collars and sleeved coil and supports. Maximum working pressure shall be 300 psig, factory burst test, 450 psig (air) and leak test 300 psig (air under water).
6. Fan wheels shall be centrifugal, forward curved, double width of non-corrosive, molded, fiberglass reinforced thermoplastic material. Fan housings shall be of formed sheet metal.

7. All motors shall have integral thermal overload protection and start at 78% of rated voltage. Motors shall operate satisfactorily at 90% of rated voltage on all speed settings and at 10% overvoltage without undue magnetic noise.

B. Electric cabinet type unit heaters shall be of the size and capacity as scheduled.

1. Acceptable manufacturers subject to compliance with the specifications shall be as follows:

   a. Marley
   b. Q Mark
   c. Trane
   d. Markel
   e. Vulcan

2. Provide electric unit heaters cabinet type of arrangement (floor or ceiling mounted, exposed or recessed) as indicated on the drawings.
3. Unit shall be flow-thru design with motor and fans in the airstream below the electric heating bank. Fan discharge shall be baffled to ensure even airflow through entire area of heating bank for even outlet temperatures. Leveling bolts shall be provided on floor models. Unit types shall be provided with suitable arrangements to receive ductwork where applicable and shall be recessed, surface mounted or ceiling hung, as scheduled on the drawings and as required by job conditions.
4. All solid panels of the front, top and bottom panels shall be internally insulated to provide quiet operation and low surface temperatures. Complete unit assembly shall be UL listed and approved.
5. Base color shall be light neutral gray. Casing shall be given a 5-stage phosphatizing treatment prior to application of high gloss baked enamel finish. Casing top and front shall be 16 gauge with 18-gauge front accent panel. Discharge grille shall be a continuous stamped louver. Front access panel fasteners shall be Phillips head.
6. The electric heating coil shall consist of metal sheath heating elements. The elements shall have a copper clad steel sheath for strength and corrosion resistance, and aluminum fins for faster heat transfer. Fintubes shall be installed or removed individually, and shall be center anchored to ensure noiseless expansion and contraction. Automatic reset snap action type thermal protection shall be furnished through holding coil circuit of the control system relay(s) for protection in the event of overheating due to air blockage from any cause. Thermal protector shall be linear type to sense temperatures the entire length of heating elements, to detect localized overheating from partial air blockages.
7. Motor and fan assembly shall be direct drive on all unit sizes, using extended motor shaft on single-fan unit, double extended motor shafts on 2-fan units and coupling with hollow steel shafts and end bearings on 3-fan, 4-fan and 5-fan units. Two-speed permanent split capacitor type motors with built-in automatic reset motor overload protection shall be standard.
8. Fans shall be forwardly curved, double inlet, centrifugal type, aluminum construction, and shall be modular in design.
9. Motor and fans shall be mounted on an extra heavy 14 gauge galvanized mounted plate, forming an easily removable assembly. Motor leads shall be plug-in type for easy removal of the motor and fan assembly. Combination 2-speed, 2-heat tamperproof switch shall be located with access through discharge air grille, using a hex wrench for adjustment.
10. Units shall be provided with throwaway type filters. Filter access shall be through removable front access panel.

11. All recessed units shall have wall guard type recess flanges which will protect the wall (or ceiling) from direct contact and damage when access panels are removed or replaced for normal maintenance. Recess depths shall be available from 1" minimum to 9 1/2" maximum on all floor, wall or ceiling recessed units. Recess flanges shall be factory assembled to depth specified, but can be field adjusted for greater recess depth if necessary.

2.03 FINNED TUBE RADIATION

A. General

1. Provide finned tube radiation of size, capacity, location and enclosure style as shown and scheduled on the drawings and as hereinafter specified.
2. Acceptable manufacturers subject to compliance with the specifications shall be as follows:

   a. Vulcan
   b. Sterling
   c. Sigma

3. Radiation shall have net I=B=R approved ratings in accordance with the Hydronics Institute "Testing and Rating Standard for Finned Tube Radiation".

B. Heating Elements (Typical All Radiation Types)

1. Heating elements shall be steel or copper/aluminum supported at 4'-0" intervals with a wall mounted slide-cradle type hanger. Provide additional horizontal pipe hangers as required.
2. All hangers for heating elements shall be of the ball bearing or nylon coated slide-cradle type, galvanized die formed. Hanger shall provide for lengthwise movement of element during expansion and contraction, as well as alignment of element to prevent contact with bracket, wall or enclosure. Hangers shall allow a minimum of 1 1/2" of vertical adjustment.
3. Steel heating elements shall have steel fins permanently bonded to steel tube and guaranteed for working pressures up to 125 psi at 330°F. The bond of fin to tube shall be guaranteed under normal operating conditions for the life of the installation. Minimum tube wall thickness shall be 0.125". Minimum fin thickness shall be 0.032". Tube size, fin size and fin spacing shall be as indicated on the drawings. Elements shall be painted black with NPT threaded ends.
4. Copper/aluminum heating elements shall have aluminum fins collared and mechanically bonded to copper tubes and guaranteed for working pressures up to 100 psi at 330°F. The bond of fin to tube shall be guaranteed under normal operating conditions for the life of the installation. Minimum tube wall thickness shall be 0.025". Tube size, fin size and fin spacing shall be as indicated on the drawings.

C. Enclosures

1. General

   a. Enclosures shall be of the types shown on the drawings, manufactured of 16-gauge steel. Joining of enclosures shall be accomplished with interlocking slip joints to provide rigidity. All enclosures shall be chemically phosphatized before priming with baked primer.

Finish painting shall be manufacturer standard color as selected by the Architect. Accessories shall be die-formed with beaded or flanged edges. Access doors shall be provided where shown on the drawings and where required for access to valves, vents, etc. Access doors shall be hinged with tamperproof latch. No sheet metal screws or other fastening or joining device shall be visible when enclosure is installed below eye level.

b. Provide all end caps, corner pieces, seams and accessories as required for a complete radiation installation. Enclosures shall be wall-to-wall, except where otherwise specifically noted on the drawings. Where not wall-to-wall, provide minimum of 12" cover each side of fin tube to allow for installation of valves and other accessories. Ordering and installation of all radiation related accessories and exact lengths of radiation covers shall be based on the actual job conditions.

c. Provide partial backplate die formed for rigidity. Plate shall be off-the-wall allowing for removal of enclosure without wall scratching. Provide rubber gasket at wall for complete air seal.

d. Brackets shall be die formed for rigidity and must be designed to support the partial backplate at the top, as well as the front skirt of the enclosure. Brackets shall incorporate a tamperproof system for fastening the enclosure, eliminating removal of enclosure without the use of tools.

e. Radiation enclosure shall be suitable for installing return pipe main under fin tube or double finned elements, where applicable and shown on the drawings.

2. Radiation Enclosure Types

a. Type "A" radiation shall have floor mounted pedestal type enclosure with extruded aluminum top outlet grille and 16 gauge steel side plates.

1) Aluminum grille shall be of pencilproof design, formed from a continuous extrusion with vanes directed toward room. Grille shall have hard coat with clear anodized finish.
2) Steel side plate shall have baked primer and finish painting with manufacturer’s standard color as selected by the Architect.
3) Floor mounted pedestal bracket shall provide rigid support for heating element and enclosure.

b. Type "B" radiation shall be bare element finned tube with no enclosure, for installation in concealed ceiling or soffit space as shown on the drawings. HVAC Contractor shall provide all pipe hangers and supports.

c. Type "C" radiation shall have extruded aluminum top outlet grille and 16 gauge steel front plate.

1) Aluminum grille shall be of pencilproof design, formed from a continuous extrusion with vanes directed toward room. Grille shall have hard coat with clear anodized finish.
2) Steel front plate shall have baked primer and finish painting with manufacturer’s standard color as selected by the Architect.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install equipment exposed to finished area after walls and ceiling are finished and painted. Do not damage equipment or finishes.

C. Protection: Provide finished cabinet units with protective covers during balance of construction.

D. Radiation: Locate on outside walls and run cover continuously wall-to-wall unless otherwise indicated. Center elements under windows. Where multiple windows occur over units, divide element into equal segments centered under each window. Install end caps where units butt against walls or have exposed ends. Align cabinet joints with window mullions. Install wall angles where units butt against walls.

E. Unit Heaters: Hang from building structure and not from piping, with gas pipe hangers anchored. Mounts as high as possible to maintain greatest headroom unless otherwise indicated.

F. Cabinet Unit Heaters: Install as indicated. Coordinate to assure correct recess size for recessed units.

G. Install electric heating equipment including devices furnished by manufacturer but not factory-mounted. Furnish copy of manufacturer's wiring diagram submittal. Install electrical wiring in accordance with manufacturer's submittals and Section 260520.

3.02 FINNED TUBE RADIATION INSTALLATION

A. Finned tube radiation shall be installed in accordance with manufacturer recommendations, Contract Drawings, and reviewed submittals.

B. Pitch heating elements in direction of flow. Provide manual air vent at high point and drain valve at low point.

C. Provide access to all valves, vents, drains, etc., for all radiation types as required. Install control valves in ceilings above radiation where valves do not fit within enclosure or as indicated on the drawings.

D. Height of installed radiation shall be a minimum of 4" above finished floor. Final location shall be determined and approved by the Architect prior to installation.

E. Ordering and installation of all radiation related accessories and lengths of radiation enclosures shall be based upon actual job conditions.

3.03 CLEANING

A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

C. Install new filters at all cabinet unit heaters prior to completion of the project.

END OF SECTION

SECTION 239000

HVAC SPECIALTIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Section 230500 and other Division 1 Specification Sections, apply to this Section.

1.02 WORK INCLUDED

A. Furnish and install a complete and operable system as specified herein.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.
2. NFPA 90B – Installation of Warm Air Heating and Air Conditioning Systems.
3. SMACNA (DCS) – HVAC Duct Construction Standards – Metal and Flexible.

1.05 SUBMITTALS

A. See Section 230500 and General Conditions for additional requirements.

B. Product Data: Include equipment fittings and accessories. Provide manufacturers catalogue information.

C. Manufacturer’s Installation Instructions: Indicate hanging and support methods, joining procedures.

D. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.06 QUALITY ASSURANCE

A. Manufacturer shall have adequate experience of building ductwork of the types required for this project as well as successful experience with projects of similar scope.

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable manufactures subject to compliance with the specifications shall be as follows:

1. Space Visual Pressure Indicator

a. Air Flow Direction Inc.

2.02 VISUAL PRESSURE INDICATOR

A. Space visual pressure indicators shall be located for the following rooms:

1. As indicated on the drawings.

B. Provide visual room pressure indicator model ADI-69-V-N negative pressure. Indicator shall be mounted directly above the door(s) to the space.

PART 3 EXECUTION

3.01 INSTALLATION

A. The drawings shall be followed where they are definite and provided such procedures do not cause objectionable conditions for equipment provided installed under this Contract. The drawings are intended to indicate the sizes of ductwork and if certain sizes are omitted or unclear, obtain additional information before proceeding.

B. The installation shall be done under the direct supervision of the manufacturer.

C. Duct connections to equipment shall be in no case smaller than the equipment openings.

D. Primary Elements shall be installed in strict accordance with the manufacturers published requirements, and with ASME guidelines effecting non-standard approach condition. These elements serve as the primary signals for the airflow systems; therefore, it shall be the responsibility of the contractor to verify and installation, to assure that accurate primary signals are obtained.

E. Install all UL classified devices in accordance with their UL approved installation sheets.

F. An identification label shall be place on each primary flow element showing airflow direction and listing the Model No.; System Served, Size and Identifying Tag No.

G. An identification label shall be placed on each airflow indicating transducer listing the Model No., Flow Elements Served, Full Scale Value, and Identifying Tag No.

END OF SECTION