

PART 1 GENERAL

1.01 ALTERNATES

- A. The Mechanical Contractor shall provide an alternate price to add or delete from the base bid of the mechanical contract documents for the following:
 - 1. Add alternate M-1: Furnish and install where shown on the plans, new relief air fans RF-1, RF-2, and RF-3 instead of repairing and reusing the existing fans. See plans and specifications for descriptions and capacities of the fans.

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS AND CONDITIONS

- A. The General Conditions, Supplementary General Conditions, General Requirements, Special Requirements, Instructions to Bidders, Alternates and Temporary Services of the Project Contract Documents are hereby incorporated into and shall be a part of these specifications.
- B. Before submitting proposal for the work for these specifications and drawings, each bidder shall study the contract documents, examine the site, and familiarize herself/himself with all existing conditions such as utility service pressure, locations, invert elevations, and materials. No extra compensation will be allowed because of a misunderstanding as to the amount of work involved or lack of knowledge of existing conditions. Also consult drawings and specifications of other trades for correlating.

1.02 WORK INCLUDED

- A. The work under this section of the specifications consists of furnishing all labor, equipment and materials necessary for and reasonably incidental to the complete installation of the mechanical systems as herein described and indicated on the drawings, including such minor details not specifically mentioned or shown as may be necessary to complete the system ready for successful operation, and subject to the terms and conditions of the contract. All work under this section shall be done in accordance with the best modern practice, using new first grade equipment and shall be arranged to avoid interference with other trades and existing conditions. All mechanical systems and portions thereof shall be concealed unless otherwise indicated or specified.
- B. Concrete foundations and pits: The Mechanical Contractor shall provide suitable concrete foundations, pads, pits, and necessary anchor bolts, tie plates, openings, curbs, caulk, etc. for his/her systems unless otherwise noted or specified.
- C. Electrical Work: The Mechanical Contractor shall provide related electrical removal and new control systems for all of the HVAC system upgrades including new and existing remaining components of the HVAC system.

1.03 DRAWINGS AND SPECIFICATIONS

- A. Furnish all labor, equipment and materials for the complete installation of the mechanical systems indicated and specified. The drawings accompanying the specifications are diagrammatic and are intended to indicate the approximate and relative locations of services and equipment; the drawings shall not be scaled. Verify building dimensions with dimensions on Architectural drawings and dimensions at the job site prior to installation. Where conditions observed at the site or on the drawings require minor changes, contractor shall make such changes without additional cost to the owner. Because the drawings are diagrammatic, and on a small scale, all risers, drops, offsets, etc. have not been shown and shall be provided under this contract. If any errors, discrepancies or omissions appear in the drawings or specifications, the

contractor shall notify the engineer immediately prior to any work being performed. In the event of the contractor failing to give such notice he/she will be held responsible for the results of any such errors, discrepancies or omissions and the associated cost of rectifying. Install all systems and individual equipment according to the manufacturer's installation instructions and recommendations. Where these differ from these contract documents, contact the Engineer immediately. All pipes, ducts and equipment shall be placed to avoid interference; also coordinate with all other trades. Except for piping and ductwork in equipment rooms, piping shall be concealed unless specifically indicated otherwise or directed by the Architect. Field changes necessary or as a result of varying construction conditions shall have the written acceptance of the Architect/Engineer prior to modifications. Notwithstanding any other provisions of the contract documents, the contractor bears ultimate responsibility for compliance of the installation with the local authority having jurisdiction. Everything necessary for the complete and successful operation of the work whether or not definitely specified or indicated on the drawings shall be provided.

- B. The Contractor shall maintain an up-to-date set of plans and specifications at the job site. Transfer all field changes to one (1) clean set at time of substantial completion and submit to Engineer prior to final acceptance.
- C. In specifying particular materials and/or methods, the intent is to indicate the minimum standard of quality acceptable to Owner. In all cases where these contract documents do not meet the minimum standards of existing federal, state and local codes, regulations and requirements, then those governing codes, regulations and requirements shall prevail.
- D. The word "provide" shall mean furnish and install, including equipment, piping and controls, and making all connections. The words "As required" shall mean as needed to provide a complete and satisfactorily operating system complying with all governing codes and the intent of the project contract documents. The word "indicated" shall mean as shown or noted on the Contract Drawings.

1.04 APPROVAL OF MATERIALS

- A. Where one manufacturer, model or brand name is specified alone, no substitution will be allowed, except as an alternate. Where more than one manufacturer, model or brand name is specified for the same item, the Contractor may choose between them. When one or more manufacturers, models or brand names are mentioned and followed by the phrase "or approved equal", it shall be understood that the names mentioned are to set a standard, and another manufacturer, model brand name may be used if fully equal or superior.
- B. Should equipment furnished be different from the Model Numbers in the specification, schedules, or drawings, the Contractor initiating such change will be responsible for all extra costs. Acceptance of substitutions shall in no way relieve the Subcontractor from the responsibility for any deficiency which may exist in the substitute product or from performing the required work. If the accepted substitutions shall require changes or modifications to the work of any other trades, such changes shall be considered part of the substitution and shall be coordinated and performed by the Subcontractor at no additional cost to the Owner. Verify and

coordinate all dimensions and other pertinent characteristics of the substituted materials with the requirements of all other parts of the building.

- C. No prior approval of equipment, or materials will be required. However, no contract or letter of intent will be awarded until a list of all equipment has been submitted and approved by the Engineer. The "apparent low bidder" shall submit the list within forty-eight (48) hours after notification from the Architect/Engineer; if such is not submitted by that time, it will be assumed that all items of equipment and materials to be used, if awarded a contract, shall be exactly as specified.
- D. Section 1605 of the Recovery Act (ARRA) requires that projects funded by the Recovery Act, for the construction, alteration, maintenance, or repair of a public building or public work use American iron, steel, and manufactured goods on the project except where a certain product is not an American product and only manufactured elsewhere.

1.05 SHOP DRAWINGS

- A. The equipment manufacturer shall submit a minimum of seven (7) copies of shop drawings to the Contractor. The Contractor shall review, stamp, retain three (3) copies and send four (4) to the Engineer for review. The Engineer shall retain one (1) reviewed copy of his files, forward one (1) copy to the Architect and return two (2) copies to the Contractor to be incorporated into the Maintenance & Operating Instructions Manual. The Contractor, with the use of the reviewed copies shall make any necessary changes to the remaining three (3) copies and retain one (1) copy for his files, forward one (1) copy to the General Contractor and provide one (1) copy on file at the job site.

1.06 MAINTENANCE AND OPERATING INSTRUCTIONS

- A. Two (2) bound copies of manufacturer's recommended cleaning and maintenance procedures and shop drawings with internal wiring diagrams for all equipment shall be submitted to the Owner prior to final inspection and acceptance of the building.
- B. After all tests and adjustments have been made, the Contractor shall furnish the necessary qualified attendants and shall put the plant in continuous operation during which time he shall give complete operating and maintenance instructions to the Owner's representative.

1.07 GUARANTEES

- A. This Contractor shall guarantee all materials, workmanship and the successful operation of all apparatus furnished and installed by him for a period of one (1) year from the date of the final acceptance of the whole work; he shall guarantee to repair or replace at his own expense any part of the apparatus which may show defect, in the opinion of the Architect or Engineer, due to imperfect material, equipment, or workmanship. Individual warranties are as per manufacturers

standard unless extended warranties are specified. Copies of manufacturer's warranty for each piece of equipment shall be given to Owner.

1.08 COMPLAINTS DUE TO ADJUSTMENT OR REPAIR

- A. Any complaints received by the Architect or Engineer due to adjustments, operations, difficulties or repairs, within the construction time or guarantee time will be turned over to the Contractor.
- B. Upon the receipt of complaint by letter, wire or telephone, the Contractor shall investigate complaint immediately, and complete the necessary work within seventy-two (72) hours, or as directed by the Architect or Engineer.

1.09 UTILITY PERMITS, FEES, LICENSES AND SERVICES.

- A. All permits, licenses, fees and service charges required in connection with the work of this division shall be secured and paid for by this Contractor. This includes water and sewer hookup charges and meter deposits.
- B. Schedule and coordinate all work with government agencies and utility companies. Arrange for all inspections and furnish Owner with certification of final inspection and any other approvals as required by enforcement authorities.

1.10 CODES AND STANDARDS

- A. The installation shall comply with the latest Codes, Ordinances, Regulations and Standards applicable to the work involved.
- B. Inform the Engineer of any discrepancies between the contract documents and the prevailing codes. Any work completed prior to notification of the Engineer will be paid for by this Contractor.
- C. All work shall conform to the following codes and regulations amended to this date:
 - 1. Local and State Heating, Ventilating, Air Conditioning and Refrigeration Codes
 - 2. State and Local Plumbing Codes
 - 3. Local and State Board of Health Regulations
 - 4. Local Electrical Installation Codes
 - 5. Local applicable ordinances
 - 6. State and Local Fire Codes and Regulations
 - 7. Gas Company Requirements
 - 8. OSHA-Occupational Safety and Health Act
 - 9. State Energy Code
- D. All materials and equipment supplied shall conform to the following standards amended to this date:
 - 1. American Standards Association
 - 2. American Society of Mechanical Engineers

3. American Gas Association
4. Sheet Metal and Air Conditioning Contractors National Assoc. Inc.
5. Underwriters Laboratories
6. National Electrical Manufacturers Association
7. Manufacturer's Standardization of the Valve & Fitting Ind.
8. American Welding Society, Inc.
9. American Society for Testing Materials (ASTM)
10. American National Standards Institute
11. American Water Works Association
12. American Society of Mechanical Engineers Boiler Code
13. Air Moving and Conditioning Association
14. Air Conditioning and Refrigeration Institute
15. American Society of Heating, Air Conditioning and Refrigeration Engineers
16. Sheet Metal and Air Conditioning Contractors National Association

- E. Section 1606 of the Recovery Act (ARRA) requires that all laborers and mechanics employed by contractors and subcontractors on construction, alteration, or repair projects funded by or assisted in whole or in part by ARRA Funds shall be paid wages at rates not less than those prevailing on projects of a similar character in the locality as determined by the Secretary of Labor in accordance with subchapter IV of chapter 31 of title 40, United States Code (USC).

1.11 CORRELATION OF WORK

- A. Correlate work with that of other Contractors prior to and during installation. Organize work so that it will not interfere with or delay the work of other Contractors.
- B. Field verify all dimensions, elevations, and field conditions before starting work.
- C. Consult the drawings and specifications for work to be provided by other trades for correlating information including details, dimensions, foundations, pits, etc. to avoid possible installation conflicts. Should changes from the original plans be made necessary to resolve such conflicts, notify the Engineer and secure approval and agreement on necessary adjustments before the installation is started. Make all arrangements for the entry of equipment to the installed locations.
- D. Do not install any mechanical systems or portions thereof above electrical panels and within code distances in front of and on sides of electrical panels.
- E. Route all mechanical systems or portions thereof around transformer vaults, other electrical spaces, elevators, elevator equipment rooms, or electrical equipment spaces and enclosures.
- F. Layout all Piping and Duct Systems in careful coordination with the Drawings and site conditions. Determine proper location and elevation of all components. Use the minimum number of bends possible to produce a satisfactory functioning system. Layout all pipes and ducts to fall within partitions, walls, or roof cavities, and to not require furring other than as shown on the Drawings.

1.12 PROTECTION OF EQUIPMENT AND MATERIALS

- A. Receive and properly protect all materials and equipment against physical damage. Damaged equipment shall be placed in first class operating condition or returned to source of supply for repair or replacement, as determined by the Architect/Engineer. Equipment, ducts and piping systems shall be protected against entry of foreign matter on inside during installation and shall be cleaned both inside and outside before operation and painting. Receive and properly house equipment and materials in approved locations away from damaging traffic and interference with other trades and functions.
- B. Protect and take precautions to prevent damage to existing equipment, piping, ductwork, electrical, fireproofing, insulation, structure and other building systems, elements and components. Also protect these existing systems against entry of foreign matter during construction from all trades. Any indoor or outdoor building systems, elements and components that are accidentally or purposely disturbed or damaged by this contractor's work shall be restored to the original undisturbed condition. Water damage or other subsequent damages caused by this contractor shall also be restored to the original undisturbed condition at this contractor's expense.

1.13 CONNECTIONS

- A. Make connections at terminal points of contact. Where connections are made to equipment furnished by others, obtain exact locations of connections from persons furnishing the equipment and make the connections.

1.14 START-UP AND DEMONSTRATION

- A. Put all systems in proper operating condition. Provide all lubrication, check, test, and start-up services, supervise the initial operation of all equipment, and demonstrate to the Owner's Representative that all equipment is properly operating. Make adjustments and repairs as required for the Owner's complete satisfaction. Also see section 15990.

1.15 REMODELING AND DEMOLITION WORK IN EXISTING BUILDING

- A. Verify all existing conditions prior to bid.
- B. Remove, relocate and/or reroute existing work as required for the installation of construction. Materials and equipment removed shall be shown to and inspected by Owner. Those materials and equipment not claimed by the Owner shall be removed from the site. Recycle or properly dispose of all materials and equipment.
- C. Dust, dirt, noise and vibration shall be controlled and held to a minimum. Provide plastic sheet temporary walls around all work where not provided by the General Contractor. Piping and ductwork shall be capped behind finished surfaces.
- D. This project will consist of alteration work within, and construction of building additions to an operating facility. Demolition work shall be coordinated and conducted in a manner that will not

interfere with the normal operation of the building. All work shall be planned with the Owner and Architect.

- E. Materials and equipment noted to be reused shall be examined and repaired as required to put these materials and equipment in acceptable working order.
- F. It may be found necessary to interrupt services to existing building or portions thereof during the progress of this work. When such interruptions are likely to occur, make previous arrangements with the Owner as to the most convenient time for such interruptions. Provide temporary service connections where the Owner cannot permit service interruptions. The existing or temporary services shall be maintained in operation until such time that the new services have been installed and are ready for permanent operation.

PART 2 PRODUCTS

Section not used.

PART 3 EXECUTION

Section not used.

END OF SECTION



PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Refer to Section 15010 - Mechanical General Provisions.

1.02 DESCRIPTION OF WORK

- A. Extent of mechanical work required by this section is indicated on drawings and specified in other Division 15 Sections.
- B. Types of mechanical basic materials and methods specified in this section include excavation and backfill, piping specialties, housekeeping, painting and touch-up, electrical, access, escutcheons, chases, sleeves and openings.
- C. All materials and equipment covered in this specification shall be new unless specifically indicated otherwise.

1.03 PROJECT CONDITIONS

- A. Existing Utilities: Locate and protect existing utilities and other underground work in a manner which will ensure that no damage or service interruption will result from excavating and backfilling.
- B. Protect property from damage which might result from construction.
- C. Protect persons from injury at excavations, by barricades, warnings and illumination.
- D. Coordinate excavations with weather conditions, to minimize possibility of washouts, settlements and other damages and hazards.
- E. Provide temporary covering or enclosure and temporary heat as necessary to protect bottoms of excavations from freezing and frost action. Do not install mechanical work on frozen excavation bases or subbases.

PART 2 PRODUCTS

2.01 EXCAVATING FOR MECHANICAL WORK

- A. Subbase Backfill Material: Graded mixture of gravel, sand, crushed stone or crushed slag.
- B. Finely-Graded Subbase Backfill Material: Well graded sand, gravel, crushed stone or crushed slag, with 100% passing 3/8" sieve.

- C. Backfill Material: Soil material suitable for compacting to required densities, and complying with AASHO Designation M145, Group A-1, A-2-4, A-2-5, or A-3.
- D. Drainage Fill Material: Washed and uniformly graded gravel, crushed stone or crushed slag, with 100% passing 1-1/2" sieve and not more than 5% passing No. 4 sieve.

2.02 PIPE HANGERS AND SUPPORTS

- A. Hangers and supports shall conform to the latest edition of the "Manufacturer's Standardization Society of the Valve & Fitting Industry MSS Standard Practices". Strap hangers shall not be used.
- B. Where pipes are not insulated, provide plastic isolation between hanger and pipe, Hydra-Zorb or approved equal.
- C. Hangers and supports used for insulated piping shall be sized to surround insulation and metal shield. Insulation at hangers and supports shall be high-density 360 degree to encompass entire pipe and shall be the same thickness as the adjoining pipe insulation. High-density insulation shall be the same length as the metal shield except on all cold lines, high density insulation shall extend one inch minimum beyond the metal shield at both ends. High-density insulation shall be calcium silicate treated with water-resistant silicon solution or high density styrofoam structural inserts of Marinite shall be provided where required for additional reinforcement. Provide Pipe Shields, Inc. (Insul-Shield, Uni-Grip, or approved equal) galvanized steel metal shields. Shields shall encompass the lower half of all high-density insulation, 180-degree minimum. If pipe hanger spacing exceeds ten feet, and for all pipe roller applications, use a double layer shield on bearing surfaces. For outdoor installations use stainless steel shields. Provide shields of length and gauge in accordance with the table which follows:

<u>Pipe Size</u>	<u>Shield Length</u>	<u>Min. Gauge</u>
1/2" to 1-1/2"	4"	26
2" to 6"	6"	20
8" to 10"	9"	16
12" to 18"	12"	16

- D. In wood and steel stud wall, provide drop eared ells on all water piping to fixtures and hose bibbs. In concrete wall, provide proper backing so branch stub outs to fixtures and hose bibbs are rigid.
- E. Provide copper plated hangers and supports for copper piping systems.

2.03 EXPANSION JOINTS AND LOOPS

- A. Expansion compensators shall be Flexonics, (Amtrol or approved equal) corrugated packless expansion joints. Piping 3/4" through 2-1/2" shall be Type H, with stainless steel elbows, internal guides, liners and screwed ends. Use Flexonics type HB for copper piping. Piping 3" size and over shall be Flexonics controlled flexing type with stainless steel elbows, internal

liners, limit rods, guide rods, and welded ends. Provide pipe anchors and guides as required by the expansion compensator manufacturer.

2.04 ESCUTCHEON PLATES

- A. Based on products by Grinnell, Frost, Dearborn Brass and Bridgeport.
- B. Plates shall be steel, nickel or chromium plates. Plates shall be large enough to conceal entire sleeve. Use type with set screw.

2.05 ACCESS PANELS

- A. Provide all access panels for access to valves, dampers, control devices, drain cocks, air vents, duct and pipe cleanouts, equipment, and other items and equipment that require maintenance, adjustment or that are subject to failure located in or behind walls, ceilings and floors. Maintain fire rating as required by local and state authorities. Access panels shall be hinged metal with metal frames, of type, style, location, finish, color, size, shape and other characteristics as selected by the Architect.

2.06 PRESSURE GAUGES AND THERMOMETERS

- A. Pressure Gauges:
 - 1. Pressure gauges shall be U.S. Gauge (Weiss, Trerice or approved equal) 5801-4-1/2" size L.M. 0-100 psi.
 - 2. Shop drawings are required.
- B. Thermometers:
 - 1. Thermometers for 4" pipe and over shall be Trerice or approved equal vari-angle type with 7" case and separate socket 1/2 reading 30 to 240° F. For pipes 2" and under, vari-angle type with 6" case reading 30 to 240° F.
 - 2. Shop drawings are required.

PART 3 EXECUTION

3.01 CHASES, SLEEVES AND OPENINGS

- A. The Mechanical Contractor shall be responsible for and include in his bid all cutting, patching, removal, rerouting, relocations, replacement, building surfaces reconstruction, openings and sleeves to accommodate his work. This includes but shall not be limited to walls, ceilings, roofs, floors, structure, equipment, mechanical and electrical piping, wiring, conduit, ductwork, equipment and other components of systems. X-ray to avoid cutting tendons in prestressed concrete systems.

- B. Patch all openings around pipes and ducts as required for sound deadening and to prevent permeation of air to adjacent spaces. See paragraph F. below for fire separations and waterproof surfaces.
- C. For roof mounted equipment, prefabricated roof curbs are furnished by the Mechanical Contractor and installed by the General Contractor. Curbs not furnished with equipment, such as for goosenecks, air-cooled condensing units, etc., are furnished and installed by the General Contractor. Roof vents, hoods, fans and other mechanical roof mounted equipment is furnished and installed by the Mechanical Contractor. Flashing is by the General Contractor; counter flashing is by the Mechanical Contractor. Roofing and roofing cement is by the General Contractor. Exterior wall mounted equipment, louvers and wall caps are furnished and installed by the Mechanical Contractor; caulking is by the General Contractor. For roof and exterior wall mounted equipment, hoods, louvers, etc., the General Contractor is responsible for making water tight.
- D. All cutting, drilling, and patching done by this Contractor shall be subject to the direction and approval of the Architect. This Contractor shall not endanger the stability of the structure by cutting or digging or otherwise and shall not at any time cut or alter work of other Contractors without the Architect's consent.
- E. Any pipe which passes through poured concrete floors (floors on grade excluded), concrete or masonry walls, fire walls, ceilings and floors, equipment room floors and waterproof floors shall be sleeved. Use steel sleeves for steel pipe and copper sleeves for copper pipe. Provide an individual sleeve for each pipe.
 - 1. In poured concrete construction except slab on grade, sleeves shall be schedule 40 steel pipe and copper for copper piping and galvanized sheet metal for ductwork. Sleeves shall be sized to accommodate insulation.
 - 2. In exterior walls, sleeves shall pitch downward to the outside wall and opening between pipe and sleeve shall be caulked water-tight.
 - 3. In fire rated walls, floors and ceilings, the space between the pipe and the sleeves shall be filled with intumescent packing fire stop system (3M Brand Fire Barrier Caulk #CP-25, or approved equal) to a depth of not less than 4 inches. Packing shall be done in strict accordance with U.L. and manufacturer's instructions. Install a dam of packed fiberglass thermal insulation behind the intumescent packing if the open space is deeper than 4 inches. Verify fire separations with Architectural plans. Apply non-hardening silicone caulk, water-tight, over fire barrier caulk in wet areas.
 - 4. Sleeves through waterproof floors shall extend 2" above finished floor. Fill entire void between service and sleeve with non-hardening silicone caulk, water tight, and over fire barrier caulk for fire rated floors in wet areas.
 - 5. Roof sleeves shall extend from 4 inches below to 12 inches above the roof deck and shall be furnished with welded attachment brackets. Provide a weather skirt for each pipe passing through the roof.

6. The Mechanical Contractor shall fill and patch all mechanical openings including but not limited to piping and ductwork penetrating floors, ceilings, and fire walls with an approved fire stop system to maintain fire rating as required.

3.02 EXCAVATION AND BACKFILLING

- A. EXCAVATION: Excavate as required to install pipe to depth shown on plans and as required. The bottom of all trenches shall be accurately graded to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along its entire length, except for "bell holes" which shall be dug after the trench bottom has been graded. Excess excavation below the required level shall be backfilled with washed sand and thoroughly tamped. Contractor shall remove by pumping, or other means, any water which has accumulated in the excavation. Contractor shall do all shoring and bracing necessary to perform his work and required by safety. Temporary bridges shall be built by Contractor where required to maintain traffic. Refer to soil boring tests for dewatering. Refer to architectural specifications for soil boring tests and other special requirements. Locate underground ducts by flags, or other means, to prevent accidental damage to them by other trades.
- B. Backfill:
 1. Do not backfill until installed mechanical work has been tested and accepted. Install drainage fill where indicated, and tamp to uniform firm density. Backfill with finely-graded subbase material to 6" above wrapped, coated, and plastic piping and tanks, and to centerline of other tanks. Other fill material shall be clean and free from debris, clay, top soil, boulders, or other such elements. Each layer shall be kept level and smooth before the succeeding layer is placed. Each layer shall be thoroughly compacted by mechanical tamping over its entire surface until there is no loss of elevation. Backfill shall be brought to grade plus or minus 1 inch.
 2. Condition backfill material by either drying or adding water uniformly, to whatever extent may be necessary to facilitate compaction to required densities. Do not backfill with frozen soil materials.
 3. Backfill simultaneously on opposite sides of mechanical work, and compact simultaneously; do not dislocate work from installed positions.
 4. Backfill excavations in 8" high courses of backfill material, uniformly compacted to the following densities (percentage of maximum density, ASTM D-1557), using power-driven hand-operated compaction equipment.
 - a. Lawn and Landscaped Areas: 85% for cohesive soils, 90% for cohesionless soils.
 - b. Paved Areas, Other than Roadways: 90% for cohesive soils; 95% for cohesionless soils.
 - c. Roadways and Under Building Floor: 90% for cohesive soils; 95% for cohesionless soils.
 5. Backfill to elevations matching adjacent grades, at time of backfilling excavations for mechanical work.

6. Street and yard surfaces shall be restored to their original undisturbed condition after services are installed.
 7. Compaction Tests:
 - a. Where compaction tests indicate lower densities of backfill than specified, continue compaction (and re-excavation and backfilling where necessary) and provide additional testing as directed by Architect/Engineer. Allowable density tolerance is not more than one test out of 5 falling more than 2 percentage points below specified density.
 - b. Provide at least five (5) density tests taken as directed and paid for by this Contractor. Further compaction and retesting, if necessary, shall be the responsibility of this Contractor and shall be paid for by him. Tests shall be made by an independent testing laboratory, acceptable to the Engineer. Remove floor, pavement, lawn or other finish, add backfill material, compact, and replace surface treatment.
- C. Replacement and Repair:
1. Repair and replace sidewalks, streets, pavements, shrubbery, lawns, curbs and other finished surfaces that are disturbed during excavation or accidentally damaged during the progress of this work. Reconstruction shall match existing and final surfaces.

3.03 PAINTING AND TOUCH UP

- A. Unless specified otherwise, equipment will be factory finish painted. All scratched or damaged finishes shall be touched up and restored to original conditions and appearance including prime paint finishes.
- B. Provide one coat of shop primer to materials and equipment not protected against corrosion.

3.04 ELECTRICAL REQUIREMENTS

- A. All electrical work furnished, installed, and/or wired by this contractor under the mechanical specifications and drawings shall meet the requirements of Division 16000, Electrical.
- B. Disconnects, Starters/Overload, Controls:
 1. Disconnects and magnetic motor starters and/or overload protection shall be furnished, installed and wired by the Electrical Contractor unless otherwise noted. Mechanical Contractor shall furnish, install, and wire all controls unless otherwise noted; this includes complete control systems and all control components and wiring for a complete and properly operating system. Electrical Contractor shall power wire all mechanical equipment, unless otherwise noted.
 2. Control valves and motorized dampers including damper operators are always furnished and field installed by the mechanical contractor unless otherwise specified, and shall be 120 Volt, single phase unless otherwise noted. Provide transformers and wiring as required for proper operation.

3. Refer to electrical contract documents and coordinate with Electrical Contractor as required for proper installation and operation to comply with all codes and the sequence of operation.
4. All wiring, disconnects, starter/overload protection and other electrical work in connection with mechanical systems and equipment shall meet the requirements of Division 16000, Electrical.

C. Motors:

1. All motors shall be furnished with mechanical equipment by Mechanical Contractor and shall conform to the Standard Specifications of NEMA and shall bear nameplate of manufacturer, with current and operating characteristics thereon.
2. Electrical characteristics such as voltage and phase, shall be as given in the contract documents. Where this information is not given, Contractor shall contact the Engineer prior to bidding. No extra compensation will be allowed because of failure to contact the engineer to obtain electrical characteristics not given.
3. Motors supplied under the mechanical contract shall be set in place by the Mechanical Contractor unless otherwise noted.
4. Notify the Electrical Contractor as soon as possible of any changes in mechanical equipment horsepower and/or electrical characteristics.

D. Wiring Diagrams:

1. Complete wiring diagrams for all mechanical equipment, systems and controls shall be furnished by the equipment suppliers.

3.05 ACCESSIBILITY OF VALVES, CONTROLS, ETC.

- A. All valves, controls, etc., shall be located so that easy access can be attained for operation, repair or maintenance.
- B. Install access panels in unremovable finished surfaces for access to valves, control devices, drain cocks, air vents, duct and pipe cleanouts, equipment, etc. located behind walls, ceilings and floors.

3.06 CLEANING AND FINISHING

- A. Thoroughly clean all existing items noted, all existing items being relocated, and new equipment such as strainers, motors, fans, piping, coils, units, burners, etc. after completing system installation. Furnish and install one new set of filters for all new and existing HVAC units upon completion of the work of all trades. Remove old filters from the job site. Flush out piping systems with clean water before proceeding with required tests.

- B. Furnish all equipment with finish paint unless otherwise specified. Refinish and restore to the original condition and appearance, all mechanical equipment that has sustained damage to the manufacturer's prime and finish coats of enamel or paint.
- C. Mechanical Contractor shall periodically remove waste and rubbish and maintain order in regards to his work. Premises shall be left clean and free of debris and unused construction materials before acceptance.

3.07 ESCUTCHEONS INSTALLATION

- A. Install escutcheon plates on all piping passing through walls, floors or ceilings of finished rooms, unfinished rooms and equipment rooms.

3.08 EXPANSION JOINTS AND LOOPS

- A. Install pipe loops with anchors and guides as required. Pipe loops shall be fabricated with long radius elbows and pipe of material specified for that service. Loops shall be installed with "cold spring" so that loop in operation will have approximately equal contraction and expansion from the fabricated position.
- B. Where space is not available for loops, expansion compensators shall be installed.
- C. Provide swing joints to allow for expansion at risers and branches to system components.

3.09 INSTALLATION OF PIPE HANGERS AND SUPPORTS

- A. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Support fire protection piping independently of other piping.
- C. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
- D. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- E. Install hangers and supports to allow for a noiseless and vibrationless operation of mechanical systems throughout the building.
- F. Install pipe guides so movement is directed along axis of pipe only.

3.10 PRESSURE TESTS

- A. All work shall be inspected, tested and approved as required by governing codes. Tests shall be made in the presence of the proper inspector. Test pressures shall remain constant for the

required period without addition to the testing medium. Thoroughly clean out the piping systems and all connected equipment after testing has been completed. Do not cover up, backfill, or enclose work until it has been properly and completely tested, inspected and approved by all pertinent officials. Should any of the work be covered up, backfilled or enclosed prior to inspection, this Contractor shall uncover the work as required and make all repairs and replacements necessary at no additional cost to the Owner.

3.11 GAUGES AND THERMOMETERS INSTALLATION

- A. Install gauges and thermometers so they are easily read from floor and shall be provided with 1/4" shut-off cocks.
- B. Install pressure gauges and thermometers where shown on the drawings and piping diagrams.

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Refer to Section 15010 Mechanical General Provisions, and 15050 Mechanical Basic Materials and Methods.

1.02 PIPE AND PIPE FITTINGS

- A. Furnish and install where shown on the drawings, pipe, pipe nipples and fittings of type and material listed below as required to connect fixtures and equipment.
- B. With plastic piping, use copper or ferrous pipes at penetrations of fire rated assemblies or other approved means to maintain fire ratings in accordance with all codes. Verify fire separations with Architectural drawings. Plastic piping is not permitted in return air plenums and walls or spaces open to return air plenums.

PART 2 PRODUCTS

2.01 PIPING: The following types of pipe are acceptable only if they meet State and Local codes and ordinances. Any of the materials listed under each service, such as 1, 2, or 3, are optional. Other types of pipes that meet codes and ordinances will be considered.

A. Natural Gas (Above Ground):

- 1. Pipe: Schedule 40 black steel
Fittings: Butt welded factory fabricated welded fittings
Note: All sizes of gas piping with welded fittings may be used in return air plenums and concealed locations.
Note: All outdoor gas piping shall be galvanized schedule 40 steel, or if black steel or copper is used, provide rustproofing paint.
Note: Where passing through an outside wall, the piping shall be protected against corrosion by coating or wrapping with an inert material. Where piping is encased in a protective sleeve, the annular space between the piping and the sleeve shall be sealed.
- 2. Pipe 1/2"-2": Schedule 40 black steel
Fittings 1/2"-2": Malleable screwed
Note: Do not install gas piping with screwed fittings in concealed locations or return air plenums.
Note: All outdoor gas piping shall be galvanized schedule 40 steel, or if black steel or copper is used, provide rustproofing paint.
Note: Where passing through an outside wall, the piping shall be protected against corrosion by coating or wrapping with an inert

material. Where piping is encased in a protective sleeve, the annular space between the piping and the sleeve shall be sealed.

- 3. Pipe: Type L hard copper
- Fittings: Copper tubing joints and fittings shall be made with approved gas tubing fittings or brazed with a material having a melting point in excess of 1000F. Brazing alloys shall not contain more than 0.05 percent phosphorus. Flared joints shall be used where experience or tests have demonstrated that the joint is suitable for the conditions and where provisions are made in the design to prevent separation of the joints.
- Note: All copper gas piping through return air plenums and in concealed locations shall be silver solder or silfos brazed at 1100F.
- Note: All outdoor gas piping shall be galvanized schedule 40 steel, or if black steel or copper is used, provide rust proofing paint
- Note: Where passing through an outside wall, the piping shall also be protected against corrosion by coating or wrapping with an inert material. Where piping is encased in a protective sleeve, the annular space between the piping and the sleeve shall be sealed.

B. Natural Gas (Below Ground)

- 1. Pipe: Type K soft copper
- Fittings: None where below ground (or silver solder or silfoss brazed at minimum 1100 degrees F if allowed by the building official and the gas company).
- Note: Coat and cathodically protect as approved by local gas company and codes.
- Note: Where it is necessary to run underground piping through the basement wall of a building, do so with prior approval from the building official and the local gas company, and by the method prescribed by them.

- 2. Pipe: Schedule 40 black steel
- Fittings: Butt weld factory fabricated welded fittings
- Note: Coat and cathodically protect as approved by local gas company and codes
Sleeve and vent to atmosphere all gas piping underground inside and outside the building where required by the building official and the gas company.
- Note: Where it is necessary to run underground piping through the basement wall of a building, do so with prior approval from the building official and the local gas company, and by the method prescribed by them.

B. Hot Water Heating:

- 1. Pipe: Schedule 40 black iron
- Fittings 1/2"-2": Welded or cast iron screwed, 125 psi
- Fittings 2 1/2" & Up: Standard weight steel welded, 125 psi

- 2. Pipe: Type M or L hard copper, ASTM B88
Fittings: Cast bronze solder or wrought solder type
Solder: 95/5

C. Refrigerant:

- 1. Pipe: Soft copper factory insulated line sets.

D. Domestic Cold Water

- 1. Pipe all sizes: Type L Hard Copper, ASTM B88
Fittings ½" – 1": Cast bronze solder or wrought solder type
Fittings 1-1/4" & Up: Wrought solder type, ANSI B16.22
Solder: 95/5

E. Condensate Drains and Other Drains from Drain Pans

- 1. Pipe: Type M hard copper
Fittings: Cast bronze solder or wrought solder type
Solder: 95/5 or 50/50

2.02 PIPE IDENTIFICATION

- A. Provide permanent plastic bands for identification.

PART 3 EXECUTION

3.01 PIPING INSTALLATION

- A. All piping shall be cut to measured fit on the job and shall be installed parallel to walls and ceilings and to properly clear all openings and provide necessary clearances for the operation of doors, windows, access panels, valves, etc. All changes in direction shall be made with fittings except bends will be permitted in soft temper tubing. Piping shall be concealed in shafts, wall chases, spaces or furrings provided except in equipment rooms. Unions shall be provided where required for disconnection and to facilitate quick repair without dismantling long lengths of piping. Provide valves and unions at each piece of equipment, outlet and fixtures. Provide shut-off valves on all pipe risers and branches.
- B. All piping shall be installed to properly clear all openings through framing members and other building components in a manner that will allow for settling, shrinking, expansion and contraction of building and mechanical systems. Piping shall be centered in bored holes and other openings provided for the passage of piping. Piping shall be properly supported. However,

piping supporting devices or methods shall not interfere with the ability of piping to expand, contract or otherwise move with the building.

C. Protection During Construction:

1. All pipe openings shall be closed with metal plugs or caps during construction. The plugs or caps shall be installed with the piping as it is roughed-in, and shall not be removed until the final connection is made. The interior of all pipe shall be kept free of cuttings, dirt, scale and loose materials of any nature.
2. All plumbing fixtures and trim, equipment, piping and supports shall be protected against any and all damages incidental to all phases of construction.
3. All leaks and damages caused by disconnected pipes, fittings and overflow of fixtures in the temporary or permanent systems shall be the responsibility of this Contractor.
4. Before erection, all piping, valves and fittings (compressed air only) shall be washed in a hot solution of sodium carbonate or trisodium phosphate and dried by stacking pipe vertically.

D. Dielectric Unions: Provide dielectric unions or brass couplings and fittings where pipes of dissimilar materials are joined.

E. Unions and Flanges: Provide at pipe connections to all fixtures, equipment, etc.

F. Swing Joints: Provide swing joints to allow for expansion at all piping risers and branches.

G. Hydronic Piping:

1. Pitch piping upward in direction of flow, 1" per 40 ft. Install drain cocks at low points and manual air vents at high points. Where points are inaccessible, extend to an accessible area; see "Access Panels" in this section.

H. Gas Piping:

1. Gas piping shall be graded in such a manner that low points or traps shall be avoided. If traps are unavoidable, cleanout tees with capped nipples should be provided at low points. Provide access panels as hereinafter specified at all cleanout tees and drain valves.
2. Install drip legs in gas piping with bottom outlet plugged or capped at bottom of pipe risers, where indicated, and as required. Use dielectric unions where dissimilar metals are joined together.
3. For gas piping installed under a floor slab and other locations as required, encase in a schedule 40 black steel pipe sleeve with welded joints with the gas pipe and its sleeve sealed together inside the building and open to the outside and the sleeve vented with a 3/4" riser to 2'-0" minimum above grade, and a return "ell" with screen.

4. Connect gas piping to each gas-fired equipment item, with drip leg and shutoff gas cock. Comply with equipment manufacturer's instructions.
5. The gas piping systems shall be electrically continuous. Subcontract the Electrical Contractor to provide required grounding connections. Install drip legs in gas piping where indicated, and where required by code or regulation.

3.02 PIPE IDENTIFICATION

- A. Provide permanent plastic bands for identification at not more than 15 foot intervals on straight pipe, and at all 90 degree elbows. Whenever a pipe passes through a wall, bands shall occur close to the wall on both sides.

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Refer to Section 15010 Mechanical General Provisions and 15050 Mechanical Basic Materials and Methods.

1.02 SHOP DRAWINGS

- A. Furnish shop drawings for all types of valves used on the project.
- B. Product Data: Including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.

1.03 MANUFACTURERS

- A. Apollo, Powell, Crane, DeZurik, Nibco, Stockham, Muessco, Universal Industrial Products, and Gustin-Bacon are considered equal.
- B. Where grooved piping systems are installed, grooved connection butterfly, silent check and triple service valves as manufactured by Gustin-Bacon or Muessco may be used.

1.04 VALVE FEATURES

- A. All valves shall be easily accessible for maintenance.
- B. Pressure and Temperature Ratings: As scheduled and required to suit system pressures and temperatures.
- C. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.
- D. Operators: Provide the following special operator features:
 - 1. Lever Handle on quarter-turn valves 6 inches and smaller except for plug valves. Provide one wrench for every 10 plug valves.

PART 2 PRODUCTS

2.01 VALVES

- A. The following types of valves are acceptable only if they meet State and Local codes and ordinances. Any of the valves listed under each service as 1, 2, 3, or 4, are optional. Other types of valves that meet codes and ordinances will be considered for approval.

2.02 SHUT OFF VALVES

A. Hot Water Heating

1. 1/2"-3": Apollo 70-100-03 or Nibco T-580-BRR-70 screwed, 600# WOG
2. 1/2"-3": Apollo 70-120-03 with balancing stops, 600# WOG or Nibco T-580-BRR-70 with memory stops, 600# WOG
3. 1/2"-3": Apollo 70-140-03. 150# SWP
4. 2-1/2"-Up: Nibco F-617-0, Gate, iron body, flanged, 125# SWP or UIP/Muessco butterfly, lug style, 200# Model 52SANI6-1/5

B. Natural Gas

1. 1/2"-3": Apollo series 70 or 80 ball valve, bronze, lever handle, 600# WOG
2. 2-1/2"-Up: DeZurik #118, eccentric plug, semi-steel body with handle, 150# WOG

C. Domestic Cold Water

1. 3/8"-2": Apollo 70-200 or 82-200 or Nibco S-580-BRR-70 screwed, 600# WOG
2. 1/2"-3": Apollo 77-100-03 or 82-100-03 or Nibco T-580-BRR-70 screwed, 600 WOG

2.03 FLOW CONTROL VALVES

- A. Control valves shall be two-way straight through or three-way type as shown on the drawings with polished stainless steel stems and spring loaded Teflon packing. Valves shall be modulating except where otherwise specified or indicated. Maximum allowable pressure drop for open valve shall be 5 psi.

2.04 BALANCING VALVES

- A. Gerand Engineering Company balancing valves

2.05 VALVE IDENTIFICATION

- A. All valves installed above ceilings shall be provided with permanent metal or plastic tags for identification.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide valves as indicated on the drawings and as required by good engineering practice for the proper sectionalizing or operation of piping systems. Provide shut-off valves for isolation of all pieces of equipment, except those specified to be equipped with stop valves. All valves shall be installed for easy access without a ladder unless otherwise noted.

3.02 VALVE ENDS SELECTION

- A. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select valves with ends or types of pipe/tube connections compatible with pipe fittings specified in Section 15060.

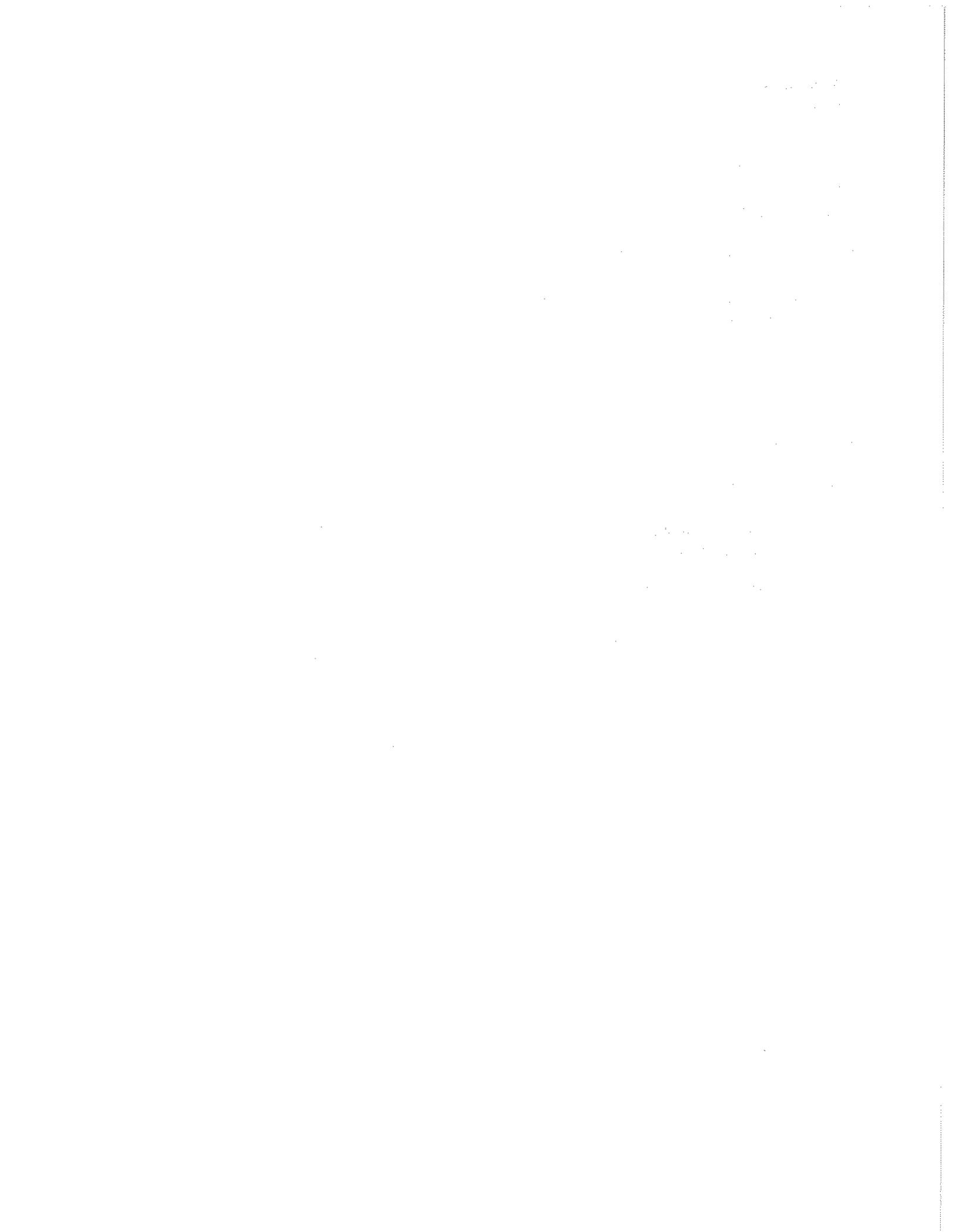
3.03 VALVE INSTALLATIONS:

- A. General Application: Use gate, ball, and butterfly valves for shut-off duty; globe, ball, and butterfly for throttling duty. Refer to piping system specification sections for specific valve applications and arrangements.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves and unions for each fixture and item of equipment in a manner to allow equipment removal without system shut-down. Unions are not required on flanged devices.
- D. Install 3-valve bypass around each pressure reducing valve using throttling type valves.
- E. Install valves in horizontal piping with stem at or above the center of the pipe.

3.04 CLEANING

- A. Clean mill scale, grease, and protective coatings from exterior of valves and prepare to receive finish painting or insulation.

END OF SECTION



PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Refer to Section 15010 Mechanical General Provisions and 15050 Mechanical Basic Materials and Methods.

1.02 SCOPE OF WORK

- A. Provide complete insulation on ductwork, pipes, tanks, and equipment as specified and as required by all governing codes and to prevent condensation.

PART 2 PRODUCTS

2.01 PIPE INSULATION

- A. Pipe insulation shall be Johns-Mansville flame safe pipe insulation with all-purpose jacket, A.P.; self sealing lap system. Provide high-density insulation at hangers and supports as described in Section 15050.
- B. Fittings and valves shall be insulated with fiberglass insulation equal in thickness to the adjoining piping and covered with Zeston pre-molded PVC insulating covers. In air plenum spaces the type of Zeston covers and accessories used shall meet the flame spread and smoke developed ratings noted below.
- C. Provide one piece PVC insulated fitting covers JM Uni-Fit, Zeston, or Speed-Line, except in return plenum ceilings.
- D. Insulation shall have fire and smoke hazard ratings not exceeding the following unless otherwise specified in accordance with ASTM-E84:
 - 1. Flame Spread 25
 - 2. Smoke Developed 50
- E. Provide insulation with vapor barrier jackets on all cold surfaces, applied with a continuous unbroken vapor seal with all seams additionally sealed with tape, continuously along length, at joints, fittings, and tape banding every two feet.
- F. The Mechanical Contractor has the option to use the following pipe insulation products or approved equal:
 - 1. Owens-Corning 1 or 3 piece pipe insulation (Fiberglass 25ASJ, all service; Fiberglass 25 ASJ-SSL all service).

- 2. Johns-Manville flame safe pipe insulation (all purpose jacket, AP self-sealing lap system).
- 3. Certain-Teed/St. Gobain fiberglass

- G. Insulation for refrigerant suction piping and fittings shall be IMCOA Imcolock pre-glued, pre-slit polyolefin insulation. On all piping in air plenums and for hot gas piping, insulation shall be Johns-Manville, or equal, flame safe fiberglass pipe insulation with AP vapor barrier jacket. Fittings shall be insulated with fiberglass and covered with Zeston PVC covers. The type of Zeston covers and accessories used shall meet the flame spread and smoke developed ratings noted above.
- H. On piping outside the building and in areas where pipe insulation is exposed in the building, install a 30-mil PVC or aluminum jacket in equipment or other unfinished rooms and a stainless steel jacket in finished rooms. On fittings and valves, install Zeston PVC covers. Jacket and covers shall be sealed watertight and installation shall be in accordance with USDA standards.

2.02 DUCT INSULATION

A. Products:

- 1. Internal Duct Insulation: All ducts calling for thermal and/or acoustical lining shall be lined with flexible glass fiber dual density duct liner with black plastic spray coating with average density 1-3/4 lb. Duct liner shall have conductivity not to exceed .23 BTU per square foot per degrees F per hour at mean temperature of 75° F. Liner must have sound absorption coefficient of .67 at 500 frequency based on #6 mounting. Acceptable manufacturers are Johns-Manville, Certain-Teed, or approved equal. Comply with thermal resistive requirements as described in paragraph 2 below. Increase thickness or add external insulation to comply with all codes. Increase duct sizes to maintain the required inside dimensions.
- 2. External Duct Insulation: Fiberglass 1 lb. density 1-1/2" thick (R=3.3) blanket insulation with vapor barrier jacket, 2-1/2" thick (R=5), and 4" thick (R=8) as manufactured by Certain-Teed, Owens-Corning, Johns-Manville, or approved equal. Provide 3# density fiberglass board with FSK foil faced vapor barrier jacket for ductwork in equipment rooms and outside the building. See the table below for installation requirements.

DUCT LOCATION	REQUIREMENTS
Attics, garages, and ventilated crawl spaces	R-8 and V
Exterior of building	R-8, V and W
Inside of building and in unconditioned spaces TD less than or equal to 15F	None required
TD greater than 15F and less than or equal to 40F	R-3.3 and V

TD greater than 40F	R-5 and V
Within conditioned spaces, in basements with insulated walls, and in plenums within conditioned spaces	None required
Intake and exhaust ducts within conditioned spaces*	R-3.3 and V
Within cement slab or within ground (also see IMC Section 603.7)	R-3.5

Notes:

*Insulation required for a distance of 3 feet from the exterior

TD= Design temperature differential between the air in the duct and the ambient temperature outside of the duct.

V = Vapor retarder required in accordance with IMC Section 604.11. When a vapor retarder is required, duct insulation required by this section shall be installed without respect to other building envelope insulation.

W = Approved weatherproof barrier.

3. Kitchen Exhaust Duct Insulation: Firemaster fire barrier duct wrap, 2 hour rated.
 4. Duct Insulation Covering: Alumaguard waterproof jacket, or Ventureclad waterproof jacket, or aluminum sheet metal waterproof jacket fabricated according to SMACNA standards over the fiberglass board insulation.
- B. All insulation shall have a flame spread rating not greater than 25 and a smoke developed rating of not greater than 50, in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilation Systems".

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

- A. All work covered by this specification consists of furnishing all labor, equipment, accessories and materials and in performing all operations in strict accordance with the insulation section of this specification, applicable drawings and subject to the terms and conditions of the contract. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. All insulation shall be installed in a workmanlike manner by skilled workmen engaged in this type of work.

- C. Repair of Existing Insulation: Wherever insulation and/or covering on new or existing pipes, ductwork, tanks, or equipment is damaged due to this work, or omitted through construction which has been removed as part of the project, it shall be repaired or replaced.
- D. Protect outdoor pipe, ductwork, tanks, and equipment insulation from weather by installing outdoor protective jacketing as specified in this section.

3.02 INSTALLATION OF PIPE INSULATION

- A. Support inserts for all pipe shall be furnished and installed by the Insulation Contractor. Refer to Section 15050 for Pipe Hangers, Supports, Anchors & Guides.
- B. Fiberglass pipe insulation shall be installed continuously with all joints tightly butted. All lap and butt joint strips shall be securely sealed.
- C. Fittings, valve bodies and flanges for pipe sizes 4" and smaller shall be finished with mineral fiber cement to a thickness of adjoining pipe insulation. Over 4" shall be insulated with 3/4 lb. density fiberglass blanket compressed to a thickness equal to adjoining pipe insulation or mitered pipe insulation segments or pre-molded fittings secured with 3-ply jute twine, fiberglass tape or 18 ga. galvanized steel wire and finished with a smooth coat of mineral fiber cement. After cement is dry, fittings shall be finished with a 4 oz. Osaburg canvas or equal, smoothly adhered with a suitable adhesive. Use only return air plenum approved covers in return air plenums.
- D. Fittings and valves shall be wrapped with pre-cut hi-lo temp. insulation inserts, fully insulating the fitting equal in thickness to the adjacent straight pipe insulation and covered with Zeston cover.
- E. In place of methods outlined in paragraph C. and D. above, the Contractor, at his option, may use PVC insulated fitting covers except in return plenum ceilings.
 - 1. The pre-cut insulation shall be applied to the fittings to make a snug fit of equal thickness against the adjoining pipe insulation. Fitting covers shall be secured by stapling and taping the ends to the adjoining pipe insulation.
 - 2. On cold water piping, all cover seam edges shall be additionally sealed with vapor barrier adhesive and ends wrapped with vapor barrier tape overlapping the adjacent jacket, continuously along length, at joints, fittings, and tape banding every two feet.
- F. Encase pipe insulation exposed in finished rooms with stainless steel jacketing and in unfinished rooms with PVC or aluminum jacketing.
- G. Insulation on all cold surfaces shall be applied with a continuous vapor barrier jacket with an unbroken vapor seal.
- H. Fittings and valves shall be wrapped with fiberglass material compressed to the same thickness as the adjacent pipe covering or fitted with segments of the pipe insulation material. Fiberglass material shall be secured in place with 3-ply jute twine. Finish with mineral fiber cement and

glass fabric embedded and coated with vapor barrier lagging adhesive, white in color to match the adjacent jacketing or with preformed PVC fitting covers. On cold domestic water piping, 4" size and smaller, mineral fiber cement may be used, finished same as above.

I. The following pipe shall be insulated:

1. All domestic cold water piping mains and branch piping, a minimum of 1/2" thick.
2. All waste and domestic cold and hot water piping under handicapped lavatories and sinks a minimum of 1/2" thick.
3. All waste, storm, heating and domestic water piping located within 10'-0" of combustion air intakes shall be insulated 1" thick minimum.
4. All heating and cooling piping mains and runouts to risers shall be insulated in accordance with the table which follows:

Insulation Thickness in Inches for Pipe Sizes**						
Piping System Types	Fluid Temp. Range F.	Runouts up to 2"*	1" & less	1-1/4" to 2"	2-1/2" to 4"	5" to 6"
PIPING SYSTEM (Type: Heating)						
High pressure/temp.	Above 350	1-1/2	2-1/2	3	3	4
Med. pressure/temp.	251-350	1-1/2	2	2-1/2	3	3-1/2
Low pressure/temp.	201-250	1	1-1/2	1-1/2	2	2
Low pressure/temp.	141-200	1/2	1-1/2	1-1/2	1-1/2	1-1/2
Low temperature	105-140	1/2	1	1	1	1-1/2
PIPING SYSTEM (Type: Cooling)						
Cold temperature	40-60	.5	.5	1	1	1
Cold temperature	Below 40	1	1	1.5	1.5	1.5

Insulation Thickness in Inches for Pipe Sizes**					
Piping System Types	Fluid Temp. Range F.	Runouts up to 1-1/4"*	1-1/4" & less	1-1/2" to 2"	Over 2"
DOMESTIC HOT WATER WITH CIRCULATING SYSTEM					

High temperature	Above 160	1/2	1	1-1/2	2
Medium temperature	131-160	1/2	1/2	1	1-1/2
Low temperature	Below 130	1/2	1/2	1	1

DOMESTIC HOT WATER WITHOUT CIRCULATING SYSTEM

High temperature	Above 160	1/2	***	***	***
Medium temperature	131-160	1/2	***	***	***
Low temperature	Below 130	1/2	***	***	***

- * Runouts not exceeding 12 feet in length to individual terminal units.
- ** For piping exposed to outdoor air, increase thickness by 1/2" greater than in the table.
- *** Insulate the first eight feet from water heater, the first eight feet from unfired storage tank, and all pipes between water heater and storage tank with the same pipe thickness as "domestic hot water with circulating system", and all pipes that are externally heated such as heat trace or impedance heating.

Insulating thicknesses are based on insulation having thermal conductivity of 0.27 BTU-in/hr-sqft-F.

For applications with fluid temperatures of 32F and below, a vapor retarder shall be installed in accordance with IMC Section 604.11.

5. All suction and hot gas refrigerant piping. Place insulation over piping and butt all joints. Seal all joints and mitered fittings with No. J-M 57 adhesive to maintain the integrity of the vapor barrier on the cold pipe. Paint the pipe insulation installed outside the building with weatherproof paint as recommended by the manufacturer.

10. Provide PVC jackets over all insulated piping where exposed in all spaces.

3.03 INSTALLATION OF INTERNAL DUCT INSULATION

- A. All duct liners shall be held in place by applying fire resistant 3M adhesive over the entire metal surface, then pressing insulation firmly in place. The spray-coated surface shall face the air stream. Ducts 18" and wider shall have the duct liner additionally secured by welded pins and clips not greater than 12" centers on top and side surfaces of the duct. All butt edges shall be coated with adhesive and pressed together. All leading edges must be covered with metal nosing strips. Increase duct sizes to maintain the required inside dimensions shown on the plan.

- B. The following ducts shall be internally insulated:
 1. All rectangular return ductwork within 20 feet of air handler, 1" thick.

2. The first ten feet of rectangular supply ductwork from each air handler, 1" thick. (The remainder externally insulated with 6" minimum overlap of external and internal insulations.) Exposed spiral ductwork in air conditioned cooled spaces is not required to be insulated.
3. All rectangular transfer ductwork, 1" thick.

3.04 INSTALLATION OF EXTERNAL DUCT INSULATION

- A. The insulation shall be applied with edges, tightly butted and secured to the metal surfaces with strips of insulation bonding adhesive. At all joints, the facing shall be lapped over the adjacent facing 2" and sealed with lap adhesive. The lap shall be further secured with staples on 6" centers.
- B. On ducts over 24" wide, the blanket or board shall be additionally secured to the bottom of the duct with mechanical fasteners such as welded pins and clips on not greater than 18" centers. All pin clips shall be sealed with matching tape patches.
- D. The following ducts shall be externally insulated with fiberglass blanket and vapor barrier:
 1. All supply ductwork with thickness described in 2.02.A.2 above. Exception: Supply ductwork insulation is not required in return plenum ceilings beyond the equipment rooms and beyond the first ten feet of internal duct insulation.
 2. All outside air, mixed air and combustion air ductwork with thickness described in 2.02.A.2 above or 1-1/2" thick whichever is the greater thickness.
 3. All relief and exhaust air plenums including drip pans and two feet upstream of plenums, motorized dampers, backdraft dampers, or points of discharge whichever is the greater length, and in accordance with 2.02.A.2, 1-1/2" thick.
 4. Return ductwork in a type C application with thickness described in 2.02.A.2 above.
 5. All exhaust air ducts located in attic space and from attic space to four (4) feet below top floor ceiling, 1" thick.

3.05 INSTALLATION OF RIGID EXTERNAL DUCT INSULATION

- A. Rigid duct insulation shall be installed on welded pins, with pre-finished fastening caps and sealed with 3" wide matching joint tape.
- B. The following ducts shall be externally insulated with rigid duct installation.
 1. All rectangular ductwork insulated in accordance with 3.04.D and 2.02.A.2 in equipment rooms and other locations eight (8) feet and less than eight (8) feet above the floor.

2. Outside exposed supply, return, and mixed air ductwork, type C application, R value = 8.
See 2.02.A.2 above, rigid fiberglass board for rectangular and semi-rigid for round and oval ductwork.

3.06 INSTALLATION OF DUCT INSULATION COVERING

- A. On ductwork installed outside the building where external duct insulation is used, install Alumaguard waterproof jacket, or Ventureclad waterproof jacket, or aluminum sheet metal waterproof jacket. Covering shall be installed to allow drainage of water and prevent standing water on the top of the duct.

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Refer to Section 15010 Mechanical General Requirements, Section 15050 Mechanical Basic Materials & Methods, 15060 Pipe and Pipe Fittings, 15100 Valves, 15185 Insulation, and 15990 Testing and Balancing.
- B. See Plumbing Riser Diagrams, Details and Schedules for pipe sizes, vents and runs not shown on plans.
- C. Verify exact locations and mounting heights of all plumbing fixtures with architectural plans, kitchen plans and Architect.
- D. Verify exact locations of all structural footings.

1.02 SCOPE OF WORK

- A. The plumbing work shall include, but shall not be limited to all labor, materials and methods required for the complete installation of the following items and systems:
 - 1. Building Sanitary and Storm drainage
 - 2. Water distribution
 - 3. Plumbing fixtures and trim
 - 4. Cleanouts
 - 5. Floor drains
 - 6. Piping and Pipe insulation
 - 7. Water heater(s) and breeching
 - 8. Hose bibbs and wall hydrants
 - 9. Gas Service and distribution (Delete if there is a Section 15600)
 - 10. Domestic Hot Water Circulating Pump(s)
 - 11. Sewage Ejector(s) and Sump Pump(s)
 - 12. Interceptor(s) and Trap(s)
 - 13. Roof drain(s)
 - 14. Water Softener

1.03 COORDINATION

- A. Verify starting and leaving invert elevations with building slab elevations, grade elevations, existing piping elevations, and with City Utilities invert elevations.
- B. Connect all piping to all new fixtures, Owner-furnished fixtures and equipment, Kitchen Contractor's equipment, and existing fixtures and equipment being relocated unless otherwise described or shown on the Mechanical or the Kitchen Consultant's contract documents. Verify exact locations, quantities and sizes. Also see Kitchen Consultant's contract documents for all valves, regulators and other miscellaneous components to be furnished and/or installed by the Mechanical Contractor.

- C. Make arrangements with the General Contractor to provide necessary recesses and openings in walls, floors, ceiling, roof, and other building surfaces to receive plumbing fixtures and equipment.
- D. Provide access panels at all tub/shower units if required by local plumbing inspector.
- E. Complete all required tests for water and waste, before building interior finishing commences.
- F. Coordinate installation of work with General, Electrical, Site Utilities, Fire Protection, Heating, Ventilation, Temperature Control, and all other contractors and resolve all disputes prior to installation.
- G. Furnish copy of manufacturer's wiring diagrams to Electrical Installer. This applies to all mechanical equipment requiring an electrical connection.
- H. All work shall be performed as required by the construction schedule.

PART 2 PRODUCTS

2.01 BUILDING SANITARY AND STORM DRAINAGE

- A. Provide a complete system of soil, waste and vent and storm piping for the plumbing fixtures, floor drains, roof drains, etc. Connect to existing. Connect to the sanitary sewer and storm sewer brought to the outside of the building by the Mechanical Site Utility Contractor.
- B. Provide at least one (1) 3" main vent for each building, carried full size from base of riser thru roof, at or near the most remote portion of the drainage system of each building.

2.02 WATER DISTRIBUTION

- A. Provide a complete system of domestic hot and cold water piping to all plumbing fixtures, hose bibbs, water heater(s), water softener, etc. Connect to existing. Connect to the water service brought to the inside of the building by the Mechanical Site Utility Contractor. Provide a meter with shut-off valve on both sides of the meter. Water meter shall meet the city requirements. Provide tee for fire sprinkling connection.

2.03 CLEANOUTS

- A. Cleanouts shall be Josam (Wade, Zurn, Smith or approved equal). Cleanout plugs shall be screwed bronze with four (4) raised square lugs on cast iron pipe and PVC plugs on plastic pipe. Cleanouts shall be full line size up through 4" pipe and 4" on pipes larger than 4".
- B. Floor Cleanouts: Josam #56010 cleanout with internal gasketed cleanout plug and adjustable housing with scoriated secured round satin nikaloy top. In areas where waterproof membrane is required, use Josam #56010-41 with clamp ring and flange.

- C. Wall Cleanouts: Josam #58600 stainless steel wall cover.
- D. Shop drawings are required.

2.04 ROOF JACKS

- A. Provide lead top and clamp on cast iron vent pipe and vent cover, and vinyl vent top on PVC vent pipe.
- B. Roof jacks shall be manufactured by Moore.
- C. Shop drawings are required.

2.05 FLOOR DRAINS

- A. Floor drains shall be Josam (Zurn, Wade, Smith or approved equal) 30000-A with adjustable nickel bronze strainers.
- B. Floor drain strainers in Equipment Rooms and in Garages shall be Josam 32100 cast iron.
- C. Floor drains located below outdoor grade level shall be Josam (Zurn, Wade, Smith or approved equal) 30650-A floor drain body with adjustable strainers and integral backwater valve.
- D. Shop drawings are required.

2.06 WATER SOFTENER

- A. Water softener shall be Lindsay (Culligan or approved equal) LSF series of size and capacity as shown on the details. Mineral tank shall be constructed of galvanized steel having an operating pressure of 125 psi and maximum operating temperature of 120 degrees.
- B. Refer to detail drawings for resin capacity, regeneration capacity and total maximum recharge water consumption.
- C. The brine tank shall be of polyurethane, including a cover. The system shall include a float operated brine valve constructed of non-corrosive plastic material to control refill shutoff and refill flow rate. The brine valve shall be repeatedly accurate within 10% and not dependant on salt bed void space for brine volume.
- D. The main control valve shall be motor driven, plunger operated type controlled by a time clock to actuate the cycles of backwash, brine, slow rinse, fast rinse, and return of service. The control valve shall not depend on water pressure for positioning and/or actuation. Regeneration shall be initiated by the time clock or by manual control. Time clock shall have seven (7) day regeneration selector, which allows selection of days regeneration and time of day to regenerate.
- E. The complete control valve, including the time clock and drive assembly shall have all electrical components within an enclosure and shall be U.L. listed.

- F. Furnish a standard soft water test kit along with a complete set of instructions, including installation, loading, start-up adjustments, servicing and parts list.
- G. Mineral tank shall be guaranteed for ten (10) years and salt storage tank shall be guaranteed for three (3) years. All other parts shall be guaranteed for a one (1) year period.
- H. Shop drawings are required.

2.07 HOSE BIBBS

- A. Provide Woodford (Wade, Josam, Zurn or approved equal) ¾" Model 67 Series automatic draining freezeless wall faucet with vacuum breaker. All internal parts shall be renewable from the outside face of the hydrant. Provide a side port air bleed shut off valve inside the building for each hose bibb, wall faucet and wall hydrant.
- B. Provide indoor hose bibbs where shown, Woodford (Wade, Josam, or Zurn) ¾", Model 24-P with vacuum breaker.
- C. Shop drawings are required.

2.08 WATER HEATER & BREECHING

- A. Water Heater: Water heaters shall be State, Lochinvar, A.O. Smith, Rheem, Rudd, or approved equal, of sizes and capacities as indicated on the detail. Units shall be gas and/or electric as detailed, complete with glass lined tank, magnesium tank saver, baked enamel heavy steel jacket and fiberglass insulation, relief valve, drain valve with ¾" hose connection, automatic controls including overheat control, lifetime 400F dip tube and three (3) year guarantee against leakage. Water heater shall be AGA certified. Pipe relief valve to 8" above floor. Provide PVC vent up through the roof next to the rooftop HVAC unit gas vent without installing any PVC piping in return air plenum ceilings. Provide PVC combustion air up through the roof next to the HVAC rooftop unit outdoor air intake without installing any PVC piping in return air plenum ceilings.
- B. Gas fired water heater shall be provided with reflector plate under burner.
- C. Flue is specified in Heating Section 15600.
- D. Provide galvanized breeching from water heaters as shown.
- E. Shop drawings are required.

2.09 PLUMBING FIXTURES AND TRIM

- A. Provide plumbing fixtures and trim of manufacturer, model number, style and accessories noted in the schedule. Plumbing fixtures shall be Kohler, American Standard, Crane, Eljer, Elkay, Kimstock, Mustee or approved equal. Supply fittings shall be Delta, Sloan, Chicago Faucet, Zurn, Moen, Sayco, American Standard, Kohler or approved equal. Bathtubs by Briggs, Peerless or approved equal are acceptable. Stainless steel sinks shall be Elkay, Republic, Polar, Just,

Dayton or approved equal. Toilet seats shall be Kohler, Church, Beneke, Olsonite or approved equal. Vanity tops by Spartan, Gransey Corp. or approved equal are acceptable. Stops for each fixture shall be Kohler, Brasscraft or approved equal. Provide all fittings necessary for a complete installation. Color of all fixtures and toilet seats shall be white.

- B. All fixtures fitted to walls shall have the mating surface ground square and true.
- C. Plumbing Fixture Schedule:

<u>Type</u>	<u>Hot</u>	<u>Cold</u>	<u>Waste</u>	<u>Vent</u>
F-1 Water Closet	---	1/2"	4"	2"
<ul style="list-style-type: none"> - Kohler, or approved equal, model K-3458-0 Wellworth Lite, floor mounted, siphon jet, vitreous china, elongated rim, fittings, lever flushing valve, bolt caps, 1.6 gallon per flush, open front seat, pressure assisted. 				
F-2 Water Closet, HCP	---	1/2"	4"	2"
<ul style="list-style-type: none"> - Kohler, or approved equal, model K-3544-0 Highline Lite, floor mounted, siphon jet, vitreous china, 18 inches high, elongated rim, fittings, lever flushing valve, bolt caps, 1.6 gallons per flush, open front seat, pressure assisted. 				
F-3 Countertop Lavatory	1/2"	1/2"	1-1/2"	1-1/2"
<ul style="list-style-type: none"> - Kohler, or approved equal, model K-2195 Pennington, vitreous china with Chicago Faucet model 1802A, chrome plated faucet open grid strainer, fittings and p-trap. 				
F-4 Countertop Lavatory, HCP	1/2"	1/2"	1-1/2"	1-1/2"
<ul style="list-style-type: none"> - Kohler, or approved equal, model K-2195 Pennington, vitreous china with Chicago Faucet model 895-317, chrome plated faucet with wrist blade handles, open grid strainer, fittings and p-trap. 				
F-5 Electric Water Cooler, HCP	---	1/2"	1-1/2"	1-1/2"
<ul style="list-style-type: none"> - Elkay, or approved equal, model EHfSA-8 with stainless steel top and backsplash, front and side push bars, mounting bracket, p-trap, air cooled refrigerated, capacity 7.6 gph of 50° F. water with inlet at 80° F. and room temperature of 90° F, 1/5 hp compressor motor. 				
F-6 2 Comp. S.S. Sink	1/2"	1/2"	1-1/2"	1-1/2"
<ul style="list-style-type: none"> - Elkay, or approved equal, Lustertone LR-3322, 18GA, 7" deep with Chicago Faucet model 1201A chrome plated faucet with side spray, strainers, fittings and p-trap. 				

F-7 Janitor Sink	1/2"	1/2"	1-1/2"	1-1/2"
- Powers Fiat, or approved equal, MSB-242410 with Chicago Faucet #897 polished chrome with vacuum breaker, wall hook and hose.				
F-8 Urinal, HCP	3/4"	---	2"	1-1/2"
- Kohler, or approved equal, Water Guard Stanwell K-4970-T with Sloan Royal 180-1 flush valve, 1 gallon per flush.				
F-9 Laundry Tub	1/2"	1/2"	1-1/2"	1-1/2"
- Fiat L-1 Mustee 18W, or approved equal, single compartment, wall hung with Chicago Faucet model 891 polished chrome faucet with strainer, fittings and p-trap.				
F-10 S.S. Sink	1/2"	1/2"	1-1/2"	1-1/2"
- Elkay, or approved equal, Lustertone LR-1918, 18GA, 7-1/2" deep with Chicago Faucet model 1895 chrome plated faucet with strainer, fittings and p-trap.				

Note: HCP shall mean furnish and install plumbing fixtures for the handicapped at handicapped code required height and in accordance with all other state and local handicapped code requirements.

D. Shop drawings are required.

2.10 PLASTER TRAP

- A. Shall be Josam, or approved equal, model #61030-1 top access, constructed of painted cast iron. Unit shall have galvanized steel bracket and bronze screen.
- B. Shop drawings are required.

2.11 HAIR INTERCEPTOR

- A. Shall be Josam, or approved equal, model #61000 1/2 bottom access, off-floor type, constructed of painted cast iron (polished bronze -chrome plated bronze -polished nickel). Unit shall have galvanized steel bracket and bronze screen.
- B. Shop drawings are required.

2.12 SEWAGE EJECTOR

- A. Provide Weil sewage ejector, or approved equal, of capacity given on the drawings, for 2" sphere passage, 120 volt, single phase, differential mercury float switch, high water float switch and bell, all controls prewired where possible (field wire the remainder), suitable fiberglass tank with steel gastight cover, vent, and discharge openings. Provide all single phase motors with built in

overload protection. Provide all three phase motors with a disconnect switch and a magnetic motor starter with over load protection. Units shall be completely factory assembled, packaged and factory wired including a single source power connection. Units shall be U.L. labeled or wired in accordance with the National Electrical Code.

- B. Shop drawings are required.

2.13 SUMP PUMP

- A. Provide Weil sump pump, or approved equal, of capacity given on the drawings. All controls prewired where possible (field wire the remainder), suitable fiberglass tank with cover, vent and discharge openings as shown. Provide all single phase motors with built in overload protection. Provide all three phase motors with a disconnect switch and a magnetic motor starter with overload protection. Units shall be completely factory assembled, packaged and factory wired including a single source power connection. Units shall be U.L. labeled or wired in accordance with the National Electrical Code.

- B. Shop drawings are required.

2.14 WATER SOFTENER (FUTURE)

- A. Provide capped tees and valve in water supply for installation of future water softening equipment.

2.15 ROOF DRAINS

- A. Provide Josam (Zurn, Wade or approved equal) 21500 cast iron roof drains with aluminum dome and under deck clamp. Provide options necessary to adapt above drain to applicable roofing system and roof insulation in accordance with manufacturer's recommendations.

- B. Provide storm drain piping from roof drains to terminal points.

- C. Shop drawings are required.

2.16 GAS SERVICE & DISTRIBUTION (Delete this Article 2.16 if there is a 15600)

- A. Make arrangements with the local gas company and pay all costs and fees for firm gas service/gas service modifications including gas regulator and gas meter with shut-off valves, one on each side of the meter and regulator.

- B. Provide gas piping to each new/relocated appliance and unit of equipment requiring gas. Disconnect, reconnect and extend as required. Remove branch gas piping back to the main for units and appliances being removed.

- C. Provide a shut-off valve and approved gas pressure regulator at each appliance and unit of equipment; in addition provide solenoid valves for all appliances requiring gas.

- D. Make the final connections to each appliance and unit of equipment except the HVAC Contractor shall make final connections to all space heating equipment.

2.17 CIRCULATING PUMP

- A. Provide for domestic water recirculation, a Bell & Gossett (Taco, Thrush or approved equal) in-line pump, Model NBF-8S/LW capable of pumping 1 gpm @ 7 ft. of head with 35 watt, 120 volt, single phase motor.
- B. Pump shall be horizontal, oil lubricated type with all bronze body. Motor shall be of the open, drip-proof sleeve bearing rubber mounted construction.
- C. Provide all single phase motors with built-in overload protection. Units shall be completely factory assembled, packaged and factory wired including a single source power connection. Units shall be U.L. labeled or wired in accordance with the National Electrical Code. Electrical Contractor shall interlock pump with main lighting.
- D. Shop drawings are required.

2.18 TRENCH DRAIN GRATES AND FRAMES

- A. Furnish heavy duty trench frames and grates, Neenah R-4990-C with type A grate openings and type L frame of length shown on plans and 12" width. Turn over to General Contractor for installation.
- B. Provide premanufactured trench drain system to be minimum of 8" wide similar to Jay R. Smith/ACO 9812 system or Econodrain #8 by Multidrain. Channel sections to be presloped and connected to provide a complete unit with concrete anchors. Provide load class "E" extra heavy duty 9870-461 slotted ductile iron grate. Provide shovel heads 9853 and 9854 strainers to fit 4" diameter outlet holes. Coordinate with the General Contractor.
- C. Shop drawings are required.

2.19 FLAMMABLE WASTE TRAP

- A. Provide a flammable waste trap and gas tight cover as detailed. Provide a manufactured flammable trap as manufactured by Brown Minneapolis Tank Company or approved equal. Trap shall be 42" in diameter and depth determined from drawings and site conditions with holding capacity of 35 cubic feet. Material shall be 3/16" thick steel plate with corrosion resistant coating painted on the inside and outside of the tank.
- B. Shop drawings are required.

2.20 POINT-OF-USE WATER HEATERS

- A. Water heaters shall be State #110E, or approved equal, with temperature-pressure relief valve, 1440 watts, 2 gallons, 9"x9"x12", 9 gph at 90° F. rise, suitable for 115 volt, single phase power. Pipe temperature-pressure relief valve to near floor. Provide suitable mounting brackets.
- B. Shop drawings are required.

2.21 TRAPS

- A. Running traps, "P" traps or drum traps shall be furnished and installed in the drain connection from each fixture and piece of equipment connected to the drainage system, except where a grease interceptor, flammable waste trap, or other type of trap is indicated on the plans. Traps, including integral traps in floor drains, shall be in accordance with the State Plumbing Code. Unions on the sewer side of the trap shall be ground, metal to metal contact, and made watertight without the use of washers or other packing material. Traps exposed below plumbing fixtures, countertops, and other non-concealed traps shall be chrome plated.

2.22 WATER HAMMER ARRESTERS

- A. Provide bellows type water hammer arresters, stainless steel casing and bellows, pressure rated for 250 psi, tested and certified in accordance with PDI Standard WH-201.

2.23 DOMESTIC WATER BOOSTER PUMP

- A. Furnish and install a Bell and Gossett model 2A20 minibooster pumping unit with capacity of 65 psig when supplied with a minimum suction pressure of 30 psig. The booster system shall be capable of a total flow of 85 gpm at a boost of 35 psig. Provide unit to utilize 203 volt, 3 phase inlet power.
- B. Minibooster shall be factory assembled, wired and tested as a packaged pressure boosting system. Unit shall be a skid mounted package consisting of two Bell and Gossett 3530 close-coupled stainless steel pumps with open drip-proof motor, non corrosive piping and valves and UL listed NEMA 1 panel with panel-mounted system pressure switches. Bronze check valve shall be mounted in pump discharge piping. Base shall be formed steel. Package shall be rated for maximum working pressure of 135 psig and maximum operating temperature of 225 F.
- C. Panel features shall include a control power transformer, Hand-Off-Auto switch, minimum start timer to prevent start-cycling, automatic pump alternation, low pressure cutout, high temperature cutout, WT-405 hydropneumatic tank (shipped loose for field installation), Cla-Val epoxy coated pressure reducing valve (shipped loose for field installation), door-interlocked disconnect switch and short circuit protection. The system shall start upon a drop in system pressure and stop upon detection of no flow.
- D. Unit shall be completely factory assembled, packaged and factory wired including a single source power connection. Units shall be UL labeled or wired in accordance with the National Electrical

Code. Provide unit with a magnetic motor starter with overload protection.

- E. Shop drawings are required.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Plumbing fixtures shall be mounted at standard heights, except for handicapped use and where mounting height is indicated with the fixture type specification.
- B. Provide chrome plated escutcheons on exposed pipes passing through walls, ceilings, and floors, including those inside cabinets.
- C. Kitchen plumbing fixtures will be furnished and set in place as specified in another Division. Assemble and mount supply and waste fittings. Provide traps, stops, valves, regulators and other miscellaneous components as required. Also see Article 1.03 in this Section.
- D. Where a riser to a sillcock occurs in an outside wall the Contractor shall insulate the recess with 2" styrofoam insulation on all sides of the recess, except the inside wall of the chase. Check details and drawings for wall thicknesses for proper length of sillcock.
- E. Install cleanouts at the bottom of all stacks.
- F. Make adjustments so floor drains, roof drains, tank covers, and cleanouts are flush with finished surfaces.
- G. All fixtures fitted to walls shall have the mating surface ground square and true.
- H. Install all piping concealed except in equipment rooms and unless otherwise noted.
- I. All domestic water piping to fixtures shall be anchored securely inside plumbing walls with proper cross bracing and drop eared ells.
- J. Terminate plumbing vents 12" above roof each in frost proof galvanized roof jacket.
- K. The entire water system, including piping and accessories, shall be thoroughly disinfected prior to use. The minimum disinfection requirement shall be in accordance with Minnesota Rules part 4715.2250. Also contact the local health authorities and comply with all other disinfection requirements.

3.02 INSTALLATION OF DOMESTIC WATER HEATERS

- A. Install gas-fired water heaters as indicated, in accordance with manufacturer's installation instructions, and in compliance with applicable codes.

- B. Connect to gas line with drip leg, tee, gas cock, and union; full size of unit inlet connection. Locate piping so as not to interfere with service of unit.
- C. Connect flue to vent damper and draft hood with gas-tight connection.
- D. Start-up, test, and adjust gas-fired water heaters in accordance with manufacturer's start-up instructions, and Utility Company's requirements. Check and calibrate controls, adjust burner for maximum efficiency.

3.03 INSTALLATION OF PUMPS

- A. Install plumbing pumps (all water and drain type) where indicated, in accordance with manufacturer's published installation instructions, complying with recognized industry practices to ensure that plumbing pumps comply with requirements and serve intended purposes.
- B. Install electrical devices furnished by manufacturer but not factory-mounted. Furnish, install and wire controls with sequence of operation as described in these specifications and/or according to the manufacturer's recommendations. Electrical power wiring is specified in Division 16, not work of this section.

3.04 BASIC IDENTIFICATION

- A. Install mechanical identification in accordance with Sections 15060 and 15100.

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Refer to Section 15010 Mechanical General Provisions, Section 15050 Mechanical Basic Materials and Methods, 15060 Pipe and Pipe Fittings, 15100 Valves, 15185 Insulation, and 15990 Testing and Balancing.

1.02 SCOPE OF WORK

- A. The work shall include, but shall not be limited to all labor, materials, methods, etc., for the complete installation of the following items and systems:
 - 1. Hot water heating piping and pipe insulation
 - 2. Hot water boilers
 - 3. Pumps
 - 4. Control valves
 - 5. Expansion tank and air control accessories
 - 7. Hydraulic separator(s)
 - 4. Hot water unit heaters
 - 5. Natural gas service and gas piping
 - 7. Heat exchanger
 - 8. Water treatment

1.03 COORDINATION

- A. Verify starting and leaving pipe elevations with building elevations and maintain required clearances.
- B. Connect all piping to all equipment unless otherwise described or shown. Verify exact locations, quantities and sizes.
- C. All work shall be performed as required by the construction schedule.
- D. Provide temporary heat as needed.

PART 2 PRODUCTS

2.01 PIPING SYSTEM

- A. Provide a complete system of insulated supply and return pipes connecting to all components of the new parts of the system.
- B. The piping system shall be a completely sealed system with uniform and noiseless circulation of the medium throughout the system.

2.02 EXPANSION TANK AND AIR CONTROL

- A. Provide Bell & Gossett or approved equal expansion tank of size and capacity as shown on the drawings.
- B. Provide Bell & Gossett or approved equal air vents at all high points of the system. Air vents shall be suitable for a working pressure of 45 psi. Each vent shall have a brass body with float of solid non-ferrous material suitable for an operating temperature of 240 degrees F. Provide a shut off valve upstream of each air vent.
- C. Provide Bell & Gossett or approved equal centrifugal type air separator as shown on the drawings. Fittings shall be cast iron construction and suitable for maximum working pressure of 125 psi.
- D. Shop drawings are required, seven copies submitted to the General Contractor.

2.02 CIRCULATING PUMPS

- A. Pumps shall be Grundfoss or approved equal centrifugal type of capacities as required. Pumps shall be cast iron bronze fitted.
- B. Pumps shall be non-overloading and shall be selected or the impeller trimmed for non-overloading over the entire curve. Provide all single phase motors with built-in overload protection. Units shall be completely factory assembled, packaged and factory wired including a single source power connection. Units shall be U.L. labeled or wired in accordance with the National Electrical Code.
- C. Provide OSHA guards as required.
- D. Furnish, install, and wire all controls for pumps. This shall include an "ON-OFF-AUTO" switch for each pump. Pumps shall be energized and de-energized by the boiler controls when in the AUTO position.
- E. Shop drawings are required, seven copies submitted to the General Contractor.

2.03 HOT WATER BOILERS – HIGH EFFICIENCY

- A. Boilers shall be Mod Con 850s, three natural gas fired high efficiency boiler modules each with an input of 850 MBH and an output of 800 MBH output, complete with all accessories installed in accordance with manufacturer's instructions and in compliance with all rules and regulations of all authorities having jurisdiction.
- B. Each heating module shall be completely factory assembled with entire heat exchanger constructed of stainless steel, burner constructed of high grade Inconel modulating with a 5 to 1 turndown, sealed combustion, temperature/pressure gauges, digital control device with

temperature and spark or hot surface igniter, gas valve, and pressure regulator. Gas regulator shall be capable of reducing gas pressure down to the required pressure for proper burner operation. Each heating module construction shall be in accordance with ANSI Standard of Gas Fired Low-Pressure steam and hot water boilers, ANSI Z21.13/CSA 4.9.

- C. Boiler modules shall be certified and listed by UL and CSA under the latest edition of the harmonized ANSI Z21.13 test standard for the U.S. and Canada. The boiler shall bear the ASME "H" Stamp for Low Pressure Heating Boilers of 125 psi working pressure and shall be national board (UL) listed. The boiler shall operate at a minimum of 94% thermal efficiency. The boiler heat exchanger shall be constructed of all welded stainless steel and certified and stamped for 160 psi, and National Board Listed. The complete heat exchanger assembly shall carry a 10 year limited warranty.
- D. Vent the boilers with PVC, CPVC, and/or Category IV approved Stainless Steel sealed vent material terminating with manufacturer's specified vent termination. Each air inlet must terminate with the exhaust.
- E. Furnish, install, and pipe domestic make-up water with an approved backflow preventer and a pressure reducing valve for boiler domestic make-up water.
- F. Controls for each boiler module shall be factory tested and suitable for firing each module individually. Furnish, install, and wire boiler controls including a control cabinet, DHW thermostat/sensors, high and low gas pressure switches, UL 353 approved low water cutoff switches, high limit temperature controls with manual resets, blocked vent pressure switch, flue temperature sensor, flow switches, built-in freeze protection, outdoor air reset, ASME certified temperature/ pressure relief valves, ON/OFF power switches, sequencing control temperature reset to cycle boilers as required to maintain the boiler water temperature required based on the outdoor air temperature.
- G. After completion of the installation, the heating plant shall be test started in the presence of a representative of the boiler manufacturer and a start-up report, including control settings, and a performance chart of the step control system shall be furnished. Perform all testing required by all governing authorities. See Part 3 of this specification.
- I. Furnish, install, and wire "emergency burner cutoff switches" to the burner control cabinet burner circuit, one on each side of the boiler room door.
- J. Shop drawings with wiring diagrams are required, seven copies submitted to the General Contractor.

2.04 HORIZONTAL AND VERTICAL UNIT HEATERS

- A. Provide where shown on the plans Sterling or approved equal unit heaters. See section 15900 for controls.

- B. Casings shall be manufactured from heavy gauge steel, phosphatized for rust and corrosion prevention and painted with baked enamel. Casings shall be equipped with weld nuts for threaded hanger rods. All hardware shall be plated for rust resistance.
- C. Horizontal models shall be furnished with individually adjustable 2-way discharge louvers and fan guard. Vertical unit heaters shall be equipped with fan guard and diffuser.
- D. Fans shall be factory balanced, suitable for standard applications. Motors shall be rubber mounted to solid bases. Motors shall be built to NEMA standards and shall be selected and tested for each unit heater. Provide all single phase motors with built in overload protection. Units shall be completely factory assembled packaged and factory wired including a single source power protection. Units shall be U.L. labeled or wired in accordance with the National Electrical Code.
- E. Coils shall be constructed with steel headers, seamless copper tubes hydraulically expanded into die formed aluminum fin collars. All copper to steel joints shall be made with high temperature brazing material. Coils shall be tested at 1500 psi hydrostatic pressure.
- G. Shop drawings are required, seven copies submitted to the General Contractor.

2.05 HEAT EXCHANGER

- A. Furnish and install where shown on the drawings a brazed plate glycol heater. Heater shall be manufactured by GEA-PHE Systems, or approved equal, of model number and capacity noted on the drawings. Heater shall be constructed of 316L stainless steel plates, copper brazed. Capacity of the heater shall be based on a minimum of 0.0005 fouling factor.
- B. Test and label heat exchangers in accordance with ASME Boiler and Pressure Vessel Code.
- C. Furnish and install a floor stand for support of the heat exchanger, all bolted down with the stand bolted down to the floor.
- D. Furnish and install a shut off valve, dielectric union, and thermometer on each inlet and outlet connection.
- E. Furnish and install a pressure tank and tank fitting for the glycol side.
- F. Shop drawings are required, seven copies submitted to the General Contractor.

2.06 NATURAL GAS SERVICE

- A. Make arrangements with the local gas company and pay all costs and fees for firm gas service including gas regulator and gas meter with shut-off valves, one on each side of the meter/regulator.
- B. Provide gas piping to each unit of equipment requiring gas.

- C. Provide a shut off valve and approved gas pressure regulator at each unit of equipment.
- D. Make the final connections to each unit of equipment.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Where piping passes through a wall common to two rooms, pack void around piping with an approved fire and smoke stop.
- B. The heating system shall be a completely sealed system with uniform and noiseless circulation of the heating medium throughout the piping, coils, radiation, and heating, ventilating, and/or air conditioning units.
- C. Provide chrome plated escutcheons on exposed pipes passing through walls, ceilings and floors.
- D. Install all piping concealed except in equipment rooms and unless otherwise noted.

3.02 CLEANING THE SYSTEM AND WATER TREATMENT

- A. After the new portion of the hydronic piping system has been installed, the Contractor shall drain, refill, and keep refilling and circulating with clean water until clean.
- B. Immediately after the final fill, circulate the entire system while adding oxygen scavenger/inhibitor chemicals in the proper amount.
- C. Chemicals shall be Rhomar, Dow, Norman, Mogul, or Dearborn.
- E. Furnish and install 40% industrial inhibited propylene anti-freeze and 60% clean water to the protected side of the heat exchanger only. Solution shall have the proper amounts of rust inhibitor.

3.03 INSTALLATION OF GAS VENTS

- A. Support vents from building structure in manner indicated and, where not otherwise indicated, anchor with bolts, concrete inserts, steel expansion anchors (not lead-shield type), welded studs, C-clamps or special beam clamps.
- B. Install gas vents in accordance with manufacturer's installation instructions. Maintain UL-listed minimum clearances from combustibles. Assemble pipe and accessories as indicated for complete installation.

3.04 INSTALLATION OF BOILERS

- A. Install boilers in accordance with manufacturer's installation instructions, requirements of State and local codes, the requirements of the insurance company and the local utility company. Install units plumb and level, to tolerance of 1/8" in 10' in both directions. Maintain manufacturer's recommended clearances around and over boilers.
- B. Install boilers on concrete pad; add as shown to same height as the existing pad. Concrete shall be 3,000 Lbs. concrete reinforced with 2" x 4" welded wire mesh.
- C. Assemble boiler trim shipped loose or unassembled for shipment purposes. Follow manufacturer's installation instructions.
- D. Connect gas piping to boiler, full size of boiler gas train inlet, provide union with sufficient clearance for burner removal and service.
- E. Connect hydronic piping, drain piping, vent and combustion air piping.
- F. Install equipment, specialties, materials and accessories indicated on the drawings and in all sections of these specifications.
- G. Flush and clean boiler upon completion of installation, in accordance with manufacturer's start-up instructions.
- H. Start-up boiler, in accordance with manufacturer's start-up instructions, and in the presence of the boiler manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- I. Hydrostatically test boiler and piping in accordance with applicable sections of ASME Boiler and Pressure Vessel code.
- J. Perform the "Try Lever Test", "Pop Test", capacity test, and any other tests required by all governing authorities.

- K. Install electrical devices furnished by manufacturer but not factory-mounted. Furnish, install and wire controls with sequence of operation as described in these specifications/manufacturer's requirements. Provide electrical power wiring as required.

3.04 INSTALLATION OF PUMPS

- A. Install HVAC pumps where indicated in accordance with manufacturer's installation instructions, complying with recognized industry practices to ensure that HVAC pumps comply with requirements and serve intended purposes.
- B. Connect with hydronic piping so as not to interfere with service of pumps. Provide access space around HVAC pumps for service, but in no case less than that recommended by the manufacturer. Install equipment, specialties, materials and accessories indicated on the drawings and in all sections of these specifications.
- C. Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer, and in the presence of manufacturer's service representative. Energize pumps only after aligning, not before.
- D. Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.
- E. Install electrical devices furnished by manufacturer but not factory-mounted. Furnish, install and wire controls with sequence of operation as described in these specifications. Electrical power wiring is specified in Division 16, not work of this section.

3.05 INSTALLATION OF UNIT HEATERS

- A. Install unit heaters as indicated and in accordance with manufacturer's installation instructions.
- B. Connect with hydronic piping so as not to interfere with service of unit.
- C. Install electrical devices furnished by the manufacturer that are not factory mounted. See section 15900 for controls. Electrical power wiring is specified in Division 16, not work of this section.
- D. Install equipment, specialties, materials, and accessories indicated on the drawings and in all sections of these specifications.

3.05 INSTALLATION OF RELATED EQUIPMENT

- A. Install valves, thermometers, pressure gauges, and related equipment as indicated and as specified in the sections of this specification.
- B. Fabricate and install piping components in accordance with applicable requirements of Division 15 sections, ASME B31.9, and, where not otherwise indicated, comply with recognized industry practices to ensure that components serve intended function.

3.06 MECHANICAL IDENTIFICATION

- A. Install mechanical identification in accordance with sections 15060 and 15100.

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Refer to Section 15010 Mechanical General Provisions, Section 15050 Mechanical Basic Materials and Methods, 15060 Pipe and Pipe Fittings, 15100 Valves, 15185 Insulation, and 15990 Testing and Balancing.

1.02 SCOPE OF WORK

- A. The work in this section shall include, but shall not be limited to, furnishing materials and labor for the complete installation of the following items and systems:
 1. Supply, return, transfer and exhaust ductwork
 2. Registers, grilles and diffusers
 3. Access doors
 4. Flexible fan connections
 5. Fans
 6. Duct insulation
 7. Dampers (fire, fire/smoke, backdraft, manual volume, motorized)
 8. Louvers
 9. Air control devices
 10. Humidifiers
 11. Energy recovery ventilators
 12. City Multi HVAC system
 13. Duct coils
 14. Removal work
 15. Connections of new to existing systems

1.03 COORDINATION

- A. Verify exact location of all ceiling registers, grilles and diffusers with lighting fixtures, other ceiling mounted equipment and reflected ceiling plan. Run all ductwork above the ceiling unless otherwise noted; avoid light fixtures where necessary.
- B. Provide fire or combination fire/smoke dampers in all grilles, registers, diffusers, and ductwork penetrating fire rated ceilings, walls and floors as required.
- C. Verify ductwork and equipment elevations with building elevations and maintain required clearances.
- D. Connect all ductwork to all Owner-furnished equipment and Kitchen Contractor's equipment unless otherwise described or shown on the Mechanical or the Kitchen Consultant's contract documents. Verify exact locations, quantities and sizes.
- E. Make arrangements with the General Contractor to provide necessary recesses and openings in new walls, floors, ceilings, roof, and other building surfaces to receive ductwork and equipment.

- F. Complete all required tests before building interior finishing commences.
- G. Coordinate installation of work with General, Electrical, Plumbing, Heating, Fire Protection, Temperature Control, and all other contractors and resolve all disputes prior to installation.
- H. Coordinate duct installations with existing conditions and with installation of accessories, dampers, coil frames, equipment, controls, and other associated work of this section.
- I. Furnish copy of manufacturer's wiring diagrams to Electrical Installer. This applies to all mechanical equipment requiring an electrical connection.
- J. All work shall be performed as required by the general construction schedule.
- K. Provide temporary heat. Do not use the building heating equipment as temporary heat.
- L. After all ductwork has been tested and proved tight, thoroughly clean all components of the ductwork and remove all dirt, scale, oil, and other foreign substances which may have accumulated during the installation process.
- M. After the equipment has been started and proved operational, carefully clean all accessible parts of each piece of equipment. Thoroughly remove all traces of dirt, oil, grease, and other foreign substances. New filters shall be installed in all HVAC units just prior to balancing.

PART 2 PRODUCTS

2.01 DUCTWORK (GALVANIZED)

- A. GENERAL: All ducts shall be new galvanized sheet metal and shall conform to the dimensions indicated on the drawings. These dimensions are free duct inside dimensions. Where thermal or sound insulation is specified to be installed on the interior of the duct, the duct size shown shall be increased to accommodate the insulation. Use another equivalent duct size where the noted size encounters a space limitation in either dimension. Ducts shall be fabricated so that the gauges are indicated on the outside of the ducts.
- B. SHEET METAL DUCTS: Ducts shall be straight and smooth on the inside with neatly finished joints. Ductwork shall be installed in accordance with the recommendation of the ASHRAE Guide & Data Book, for low pressure ducts. Gauges of metal shall be as follows:

Rectangular Ducts

<u>WIDTH (inches)</u>	<u>GAUGE</u>
Thru 12	26
13-18	24
19-30	24
31-42	22

43-54	22
55-60	20
61-84	20
85-96	18

Round Ducts

<u>DUCT DIAMETER</u>	<u>GAUGE</u>
Thru 8	26
9-13	26
14-22	24

- C. DUCT CONSTRUCTION DETAILS: Cross breaking and hangers shall be in accordance with the Low Velocity Duct Construction Standard as issued by the Sheet Metal & Air Conditioning Contractors National Association, Inc.
- D. All square elbows shall have double thickness acoustical turning vanes, unless otherwise noted.
- E. Furnish and install aluminum ductwork for dishwasher exhaust; solder watertight. Use full radius elbows without turning vanes. Connect to dishwasher hood(s) provided by others.
- F. Increase duct sizes as required to account for internal insulation thicknesses. Maintain duct inside dimensions shown on the Drawings.

2.02 FLEXIBLE DUCTWORK

- A. Flexible ductwork shall be Thermaflex Type M-KE, Wiremold or approved equal, of the sizes shown on the drawings. Ducts shall be factory fabricated assembly consisting of an inner sleeve of continuous spring steel helix bonded to a vinyl inner layer, one inch (1") thick fiberglass insulation, and a reinforced metalized Mylar/neoprene laminate outer moisture barrier. Ductwork shall have a pressure rating of at least 2" W.G. with leakage guaranteed to not exceed 0.010 cfm/ft/inch diameter. In return air ceilings use Omniaire, or approved equal, #1300 uninsulated flexible ductwork spiral-wound spring steel with flame-proof vinyl sheathing, or corrugated aluminum, complying with UL181. Installation shall be in complete accordance with manufacturer's instructions. Flexible ducts shall be the same size as the diffuser necks unless otherwise noted. Maximum flexible duct length for each diffuser shall not exceed 6'-0" unless otherwise noted.

2.03 SPIRAL STEEL DUCTWORK

- A. All exposed round ducts and fittings shall be United Sheet Metal Co. spiral UniSeal duct (or approved equal spiral ductwork) manufactured from galvanized steel meeting the ASTM A-93 59T in the following gauges:

<u>DIAMETER (inches)</u>	<u>GAUGE</u>
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3"-14"	26
15-26	24
27-36	22
37-50	20
52-60	18
61 or larger	16

- B. All round elbows shall have a minimum radius of 1-1/2 times the duct width.
- C. Spiral steel ducts shall be constructed in accordance with High Velocity Duct Construction Standards as issued by the Sheet Metal & Air Conditioning contractors National Association. Low and medium pressure fittings shall be spot welded and sealed. High pressure fittings shall be welded.
- D. Drops to shop equipment shall be rigid spiral steel duct except for the last 18 inches to equipment.
- E. All exposed spiral ductwork shall be painted by the General Contractor.

2.04 AIR CONTROL DEVICES

- A. Provide splitter dampers on all main ducts and where shown on the drawings. Provide Ventlok #690 or approved equal, self-locking splitter assembly on each damper.
- B. Provide at all round duct branch take offs at main, Clevepak (or approved equal) type DESC damper extractor with spin collar.
- C. All branch take offs shall be Pivot elbow type take offs and all branch duct take offs shall be provided with quadrant dampers. Provide flush mounted, key operated, extended damper operators which can be operated from below the ceiling for all gypsum board, plaster, and other nonlay-in ceilings.

2.05 FLEXIBLE FAN CONNECTIONS

- A. Provide flexible connections to isolate all fans and fan units. Connections shall be Glassfab conforming to the requirements of the NFPA 90 Standards.

2.06 ACCESS DOORS

- A. Where motorized dampers, backdraft dampers, fire dampers, fire/smoke dampers, coils and control equipment are installed in ductwork, provide suitable size, gasketed doors in ducts. Doors shall be provided with Ventlok #220 door pull and #90 sash type latches. Provide doors on one or both sides of each device as required for proper adjustment, maintenance, resetting, and cleaning. Use sponge rubber or felt gasketing material on door openings. Access doors in insulated ductwork shall be double wall construction with 1" insulation between walls.

2.07 MOTORIZED DAMPERS

- A. Provide all motorized dampers shown on the plans and as required for system operation as described in this section and not being furnished with equipment. Dampers shall be opposed blade, Ruskin model C036, or approved equal, low-leak type with neoprene edges and shall have 8" maximum blade widths with 4'-0" maximum length blade. Damper blades shall be of not less than 16 gauge galvanized steel, formed for strength and high velocity performance. Damper frames shall be of not less than 13 gauge galvanized steel, formed for extra strength with mounting holes for enclosed duct mounting.
- B. Size damper operators to operate their appropriate dampers or valves with sufficient reserve power to provide smooth modulating action or two-position action as specified. When so specified in the sequence of operation or where more than two (2) actuators are to be operated in sequence to each other, provide position feedback positive positioners with adjustable start-point and operating range. Mixing box damper motors shall be so constructed that diaphragms are easily replaceable without removal of the damper motor from its mounting bracket. The Contractor shall be responsible for sizing and installing additional damper operators for each damper if more than one (1) operator is required for sufficient reserve power and smooth operation. All damper operators shall be 24 volt unless otherwise noted. Furnish and install transformers for dampers using 24 volts.

2.08 FIRE DAMPERS AND FIRE/SMOKE DAMPERS

- A. Provide all fire and fire/smoke dampers shown on the plans and as required by all codes, Ruskin D1BD2 and D1BD23, or approved equal, fusible link fire dampers and Ruskin FSD36, or approved equal, fire/smoke dampers of required hourly rating at all locations indicated on the drawings and all other locations required by the State Fire Marshall, the National Fire Protection Association, and prevailing codes.
- B. Fire and fire/smoke dampers shall be constructed and installed in accordance with NFPA Bulletin #90A. Fire and fire/smoke dampers shall be U.L. listed. Fire smoke dampers shall meet UL555S requirements. Furnish fire/smoke dampers with 120 volt operators.
- C. Dampers shall be designed to close automatically with the flow of air and remain closed by the use of a spring clip. Hinges or bearings shall be made of corrosion resistant material. Provide a sleeve, approved access door, counterweight or spring and fusible link. Sleeve shall extend through the full thickness of the wall.
- D. The fusible link shall be designed to melt 50° above the maximum temperature normally encountered.
- E. Dampers located behind grilles or registers shall have the linkage and spring catches accessible by removing the grille or register.
- F. Dampers manufactured by Air Balance, Advanced Air, Tuttle & Bailey, Ruskin, Action Air, Phillips Air or Airstream shall be considered equal.

- G. Access panels to be installed inside or bottom of duct shall be a minimum size of 14"x14". For smaller ducts, panel width shall be 2" smaller than duct.
- H. Fire dampers installed in ducts with an inside free area of 300 square inches or less shall be provided with fire dampers having an inside free area equal to the ductwork connected to the fire damper.
- I. Furnish smoke detectors as required to operate fire/smoke dampers, complete with module, relay, and contact kit. Electrical contractor shall install and wire smoke detectors and related control components. Smoke detectors upon detection of smoke shall cut power to dampers and close dampers. Electrical contractor shall provide 120 volt power wiring to smoke detectors and fire/smoke dampers and control wiring to close dampers upon detection of smoke.
- J. Shop drawings are required, seven copies submitted to the General Contractor.

2.09 LOUVERS

- A. Provide Ruskin model L811, or approved equal, 4" deep 18 gauge galvanized steel louver with frame or flange to match building construction and 1/2" mesh 19 gauge galvanized 0.014" birdscreen. Provide baked enamel finish of color selected by Architect from standard manufacturer's colors. See plans for sizes of louvers. Provide model L811 unless otherwise noted on the plans.
- B. Shop drawings are required, seven copies submitted to the General Contractor.

2.10 REGISTERS, GRILLES AND DIFFUSERS

- A. Provide all registers, grilles and diffusers as shown on the drawings and specified in schedules, Titus or approved equal. All wall mounted grilles, registers and diffusers shall be secured to the ducts. Provide gaskets and secure all air outlets and return devices to walls, ceilings and floors to prevent streaking. All registers, grilles and diffusers shall be furnished in baked enamel finish, off white unless otherwise shown or specified. All registers and diffusers shall be furnished with opposed blade dampers. Provide UL listed fire or fire/smoke dampers as required for all registers, grilles and diffusers in fire rated walls, ceilings and floors.
- B. Registers, grilles and diffusers shall be Titus, or approved equal, in accordance with the following schedule:

Location	Model No.	Comments
Ceiling	TMA	Round diffusers (on ceiling or below ceilings on exposed ducts)
Ceiling	TMS	Square diffusers
Ceiling	250-AA-S4	Square diffusers with SR square-to-round adapters for kitchen and dishwasher rooms only.
Ceiling	50F-1	Eggcrate grilles with 1-1/2" overlap margin.

Ceiling	50	Eggcrate grilles for lay-in ceiling
Ceiling	50F-3	Eggcrate grilles for lay-in ceiling and direct duct connection
Wall	23-RS or 23-RL	Return, exhaust and transfer air grilles, with blades installed horizontally
Wall	300-RS5 or 300-RL5	Supply air registers with front blades installed horizontally
Floor	CTH480	Heavy duty floor diffuser with clear anodized aluminum finish

See Mechanical Plans for sizes and air quantities (CFM). All ceiling diffusers in lay-in ceilings shall be 24"x24" with neck sizes indicated on the plans, unless otherwise noted. Verify types of ceilings and/or floors in each room.

- C. Shop drawings are required, seven copies submitted to the General Contractor.

2.11 FANS

- A. Fans shall be Greenheck, or approved equal, of sizes and capacities and with accessories as shown in the schedule on the drawings.
- B. Fans shall be constructed of corrosion and fire resistant material, and shall be tested and rated in accordance with AMCA Bulletin 210. The label shall state the CFM capacity.
- C. Fans shall comply with the air flow and sound test procedures of the HVI, be tested and rated in accordance with related rating procedures. Evidence of compliance shall be an HVI or manufacturer's label, showing model no., cfm, static pressure and sound characteristics. Tests shall be made by a qualified independent laboratory.
- D. Provide all ceiling fans, power roof ventilators and in-line fans with disconnect switches. Provide all three phase motors with magnetic motor starters with overload protection. Provide all single phase motors with built-in overload protection. Units shall be completely factory assembled, packaged and factory wired including a single source power connection. Units shall be U.L. labeled or wired in accordance with the National Electrical Code. Individual controls for all fans will be the responsibility of the Electrical Contractor.

- E. Shop drawings are required, seven copies submitted to the General Contractor.

2.12 CITY MULTI HVAC SYSTEM

- A. Furnish, install, pipe, and wire a Mitsubishi City Multi VRFZ (Variable Refrigerant Flow Zoning) variable capacity heat pump heat recovery air conditioning system. The City Multi VRFZ systems shall be the R2-Series (simultaneous cooling and heating) and the Y-Series (cool/heat) split system heat pump. Field wire the control system and provide complete factory start up. The City Multi VRFZ system shall be installed by a contractor with factory City Multi

training at the Mitsubishi three-day course and at least 150 tons of Mitsubishi split system installations within the past two years. Furnish, install, pipe, and wire all of the devices described below and shown and described on the drawings, as required for a complete properly operating system. Cooling capacity shall be based on outdoor temperature of 95F and heating capacity shall be based on outdoor temperature of 43F.

- B. The R2-Series system shall consist of outdoor units, BC (Branch Circuit) Controllers, multiple indoor units and direct digital controls. Each indoor unit shall be capable of operating in any mode independently of the other indoor units. System shall be capable of changing mode with no interruption to system operation. Outdoor units shall be Pury of sizes and capacities as indicated on the drawings. Units shall be complete with condenser fans, variable speed inverter-driven compressors, coil, R410A refrigerant, circuit boards, accumulators, high pressure safety switches, over-current protection, crankcase heaters, DC buss protection, low ambient kits, oil separators, bonderized and finished casings, 5 year compressor warranty, service fittings and valves. Units shall be listed and labeled by Electrical Laboratories (ETL). All wiring shall be in accordance with the National Electrical Code. Units shall be completely factory assembled, packaged, factory run tested, and factory wired including a single source power connection.
- C. The Y-Series system shall consist of outdoor units, multiple indoor units and direct digital controls. Outdoor units shall be Pury of sizes and capacities as indicated on the drawings. Units shall be complete with condenser fans, variable speed inverter-driven compressors, coil, R410A refrigerant, circuit boards, accumulators, high pressure safety switches, over-current protection, crankcase heaters, DC buss protection, low ambient kits, oil separators, bonderized and finished casings, 5 year compressor warranty, service fittings and valves. Units shall be listed and labeled by Electrical Laboratories (ETL). All wiring shall be in accordance with the National Electrical Code. Units shall be completely factory assembled, packaged, factory run tested, and factory wired including a single source power connection.
- D. PKFY Wall-Mounted Indoor Units: Each PKFY unit shall be factory-built Mitsubishi of size and capacity as shown on the drawings, consisting of fan, coil, drain pan, expansion valve, piping, filter, white finish casing, back plate, and controls including wall mounted thermostats. Units shall be completely factory assembled, packaged and factory wired including a single source power connection. Units shall be U.L. or ETL labeled or wired in accordance with the National Electrical Code. PKFY indoor units shall be used with R2-Series outdoor units and BC Controller or Y-series outdoor units.
- E. PLFY Ceiling Recessed Indoor Units: Each PLFY unit shall be factory-built Mitsubishi of size and capacity as shown on the drawings, consisting of fan, coil, drain pan, expansion valve, piping, filter, white finish casing, four-way automatic independent vane control and temperature controls including wall mounted thermostats. Units shall be completely factory assembled, packaged and factory wired including a single source power connection. Units shall be U.L. or ETL labeled or wired in accordance with the National Electrical Code. PLFY indoor units shall be used with R2-Series outdoor units and BC Controller or Y-series outdoor units.
- F. PVFY Vertical Air Handlers: Each PVFY unit shall be factory-built Mitsubishi of size and capacity as shown on the drawings, consisting of fan, coil, drain pan, expansion valve, piping,

factory painted and insulated casing, controls including wall mounted thermostats. Units shall be completely factory assembled, packaged and factory wired including a single source power connection. Units shall have the capability to be mounted in either the vertical or horizontal position. Furnish and install filter rack and clean filters. Units shall be U.L. or ETL labeled or wired in accordance with the National Electrical Code. PVFY indoor units shall be used with R2-Series outdoor units and BC Controller or Y-series outdoor units.

- G. See section 15900 for temperature controls.
- H. Verify all electrical requirements with the Electrical Engineer and Electrical Contractor.
- I. Mechanical Contractor will be required to provide manufacturers' computer generated piping and wiring schematic for all VFR Systems and ACAD drawings showing complete refrigerant piping layout. Mitsubishi Distributor to have Mitsubishi inventory in stock within 25 miles of project site during construction and for full term of warranty.
- J. Shop drawings are required, seven copies submitted to the General Contractor.

2.13 DUCT COILS

- A. Provide Trane (McQuay, Witt or approved equal) coils of size and capacities specified in the schedules. Coils shall have flanged outer casings to receive duct connections. All coils shall be 5/8" o.d. copper tubes and aluminum fins spaced 8 per inch. Coils shall be designed for use with chilled water/hot water and shall be circuited completely drainable with a vent connection at the highest point and a drain connection at the lowest point. Coils shall have 5/8" o.d. copper tubes of not less than .025" wall thickness with aluminum fins of thickness not less than 0.009" for plate type fin and 0.012" for spiral wrapped fins. Turbulators shall not be used unless specified. Maximum water velocity in the tubes shall not exceed 7 FPS. Coils shall be tested for 150 psig working pressure.
- B. Hot water coils shall be Trane or approved equal completely drainable as indicated in the schedule. Coils shall have flanged outer casings to receive duct connections and shall be installed on an angle iron frame work independent from housing.
- C. Furnish, install and wire individual temperature controls to accomplish the following sequence of operation. Individual heating/cooling thermostats shall modulate three-way control valves.
- D. Do not use equipment specified in this article for temporary heat.
- E. Shop drawings are required, seven copies submitted to the General Contractor.

2.15 HUMIDIFIERS

- A. Furnish and install where shown and scheduled on the plans Carnes HGH self contained electronically controlled steam generating or approved equal humidifiers. Humidifiers shall be of the dry steam type with insulated stainless steel jacketed distribution manifold for installation in air duct systems, drip free with jacketed separating chamber. Units shall be U.L. listed and shall

be complete with disposable generator cylinders and electrodes, automatic drain cycle, prewired, and shall have capacities as noted on the drawings. Cabinets shall be constructed of 18 gauge steel painted with enamel then an epoxy finish, with access doors, monitoring ammeter and indicating lights. Units shall include steam distributor pipe for each steam generator circuit, adjustable steam orifice, steam hose, condensate return line, and hardware required for proper installation. Humidifiers shall generate steam from ordinary tap water. Humidifier shall utilize disposable ionic bed cartridges. Humidifiers shall have all internal components contained in a steel cabinet, key locked to prevent unauthorized access.

- C. Humidifier controls shall monitor tank operating history with a display of when cartridges need to be replaced, prevent unsafe operation, on-off control, drain cycle control, control water feed, and generate steam as needed. Humidifiers shall incorporate electrical terminals for installation of controlling stat, duct high limit stat, fan interlock switch, and Class 2 alarm device. Humidifiers shall accept external DDC control signals to modulate the output of the humidifiers. Humidifiers will also accept internal building management system signals.
- D. Install units in strict conformance to manufacturer's recommendations with steam distributor piping in ductwork. Provide water fill piping with backflow preventor, flow regulating control, and strainer, stainless steel overflow pan in the duct under the humidifier, and drain piping.
- E. Shop drawings are required, seven copies submitted to the General Contractor.

2.16 ENERGY RECOVERY VENTILATORS

- A. Furnish and install where shown on the plans RenewAire or approved equal energy recovery ventilators (ERV) with capacities and model numbers noted on the drawing with filters, supply and exhaust fans, fixed plate heat exchanger, back draft dampers, disconnect switches, vibration isolators, U.L. listed, and single source power connection.
- B. Shop drawings are required, seven copies submitted to the General Contractor.

PART 3 EXECUTION

3.01 INSTALLATION OF METAL DUCTWORK

- A. Assemble and install ductwork in accordance with recognized industry practices which will achieve air-tight (5% leakage for systems rated 3" and under; 1% for systems rated over 3") and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor.
- B. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or,

if not otherwise indicated, run ductwork in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. In finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Noted sizes are inside clear dimensions. Increase duct sizes to accommodate internal insulation where internal duct insulation is specified or indicated. Use another equivalent duct size where the noted size encounters a space limitation in either dimension. Coordinate layout with suspended ceilings and lighting layouts and similar finished work.

- C. Do not route ductwork through transformer vaults and their electrical equipment spaces and enclosures.
- D. Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap openings on 4 sides by at least 1-1/2". Fasten to duct and substrate.
- E. Where ducts pass through fire-rated floors, walls, or partitions, provide firestopping between duct and substrate. Where ducts pass through corridor walls provide 26 gauge ductwork.
- F. Install metal ductwork in accordance with SMACNA HVAC Duct Construction Standards.
- G. After each duct system which is constructed for duct classes over 3" is completed, test for duct leakage in accordance with SMACNA HVAC Air Leakage Test Manual. Repair leaks and repeat tests until total leakage is less than 1% of system design air flow.
- H. Connect metal ductwork to equipment as indicated. Provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors as indicated.
- I. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.
- J. At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.
- K. Construct and seal duct systems to specific duct pressure classifications indicated on drawings. Where not indicated on drawings, construct and seal ducts to a pressure classification of 1" WG. Contractor shall pressure test all ductwork and make repairs as required.

3.02 INSTALLATION OF FLEXIBLE DUCTS

- A. For any duct run using flexible ductwork, do not exceed 6'-0" extended length. Provide sheet metal ductwork for the remaining length from the main duct to the flexible duct.
- B. Install in accordance with Section III of SMACNA's "HVAC Duct Construction Standards, Metal and Flexible".

3.03 INSTALLATION OF DUCT ACCESSORIES

- A. Install duct accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function. Duct accessories shall include air inlets and outlets, hoods, VAV boxes, VVT boxes, access doors, dampers (all types), air control devices, flexible connectors and other devices attached to ductwork.
- B. Install turning vanes in square or rectangular 90° elbows in supply, return and exhaust air systems, and elsewhere as indicated.
- C. Install sound attenuators in accordance with the manufacturer's recommendations to obtain the published acoustical and air flow performance. Locate as shown in the drawings. Locate no rectangular or circular sound attenuators within one duct diameter from elbows, fan suction or discharge openings, takeoffs, etc., unless indicated on the drawings and/or approved by the consultant.
- D. Install exhaust system components in accordance with the manufacturer's written instructions.
- E. Bracket ducts to joists to provide rigidity.
- F. Install all required components specified in accordance with manufacturer's written instructions.
- G. Install fire dampers conforming to the manufacturer's recommendations or instructions, ""UL" Laboratories suggested recommendations (NFPA 90A), and local governing codes. Where dampers are installed in a horizontal position (vertical airflow) they shall be provided with stainless steel closure springs and cam type blade locks. Locking device shall be designed so as to permit dampers to be reset easily without removal from wall or partition. Provide access doors in ducts suitable for resetting dampers.
- H. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter. Provide access doors in ducts at motorized dampers, backdraft dampers, fire/smoke dampers, coils and control equipment.
- I. Coordinate with other work, including ductwork, as necessary to interface installation of duct accessories properly with other work.

- J. Operate installed duct accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

3.04 INSTALLATION OF ENERGY RECOVERY VENTILATORS AND AIR HANDLING UNITS

- A. Install ERVs and air handling units where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.
- B. Provide access space around ERVs and air handling units for service as indicated, but in no case less than that recommended by manufacturer.
- C. Install floor-mounted ERVs and air handling units on 4" high reinforced concrete pad, 4" larger on each side than unit base.
- D. Mount ERVs and air handling units on vibration isolators, in accordance with manufacturer's instructions.
- E. Install electrical devices furnished by manufacturer, but not factory-mounted. Furnish, install and wire controls with sequence of operation as described in these specifications. Electrical power wiring is specified in Division 16, not work of this section.
- F. Upon completion of installation of air handling units, start-up and operate equipment to demonstrate capability and compliance with requirements.
- G. Provide a trapped condensate drain from drain pans to nearest drain.

3.05 INSTALLATION OF FANS

- A. Install fans where indicated, in accordance with manufacturer's installation instructions, and with recognized industry practices, to ensure that fans comply with requirements and serve intended purposes.
- B. Provide access and service space around and over fans as indicated, but in no case less than that recommended by manufacturer.
- C. Provide 4" high concrete pad under floor-mounted fans.
- D. Set fans on vibration isolators, fasten in accordance with manufacturer's installation instructions.
- E. Install prefabricated curb and flashing for each power roof ventilator. Top of curbs shall be level. Flashings shall extend over the roofing, extend up the side of the cant and curb, and cover the top of the curb. The flashing shall be made of galvanized sheet metal, and all joints shall be soldered watertight. Insulate with 2" thick fiberglass 9-pound density board between the exhaust duct and its curb. Solder bottom joints and up 2" of side joints of duct under roof ventilators forming a watertight 2" deep drip pan to retain any moisture entering ventilator.

- F. Install electrical devices furnished by manufacturer, but not factory-mounted. Furnish, install and wire controls with sequence of operation as described in these specifications. Electrical power wiring is specified in Division 16, not work of this section.
- G. Upon completion of installation of fans, and after motor has been energized with normal power source, test equipment to demonstrate compliance with requirements. Field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected. Do not operate fans for any other reason except test purposes.

3.06 INSTALLATION OF GRAVITY VENTILATORS

- A. Install ventilators in accordance with manufacturer's installation instructions and recognized industry practices to ensure that ventilators serve their intended function.
- B. Install prefabricated curb and flashing for each gravity roof ventilator. Top of curbs shall be level. Flashings shall extend over the roofing, extend up the side of the cant and curb, and cover the top of the curb. The flashing shall be made of galvanized sheet metal, and all joints shall be soldered watertight.
- C. For all goosenecks and ventilators that do not have a proper counterflashing integral with the base, provide a counterflashing which shall have soldered joints.
- D. Wash all flashings and counterflashings with acetic acid, and paint with one coat of lead and oil paint, black in color.
- E. Insulate with 2" thick fiberglass 9-pound density board between the exhaust duct and its curb.
- F. Solder bottom joints and up 2" of side joints of duct under roof ventilators forming a watertight 2" deep drip pan to retain any moisture entering ventilator.

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Refer to Section 15010 Mechanical General Requirements, Section 15050 Mechanical Basic Materials & Methods, 15060 Pipe and Pipe Fittings, 15100 Valves, 15185 Insulation, 15800 HVAC Systems, and 15990 Testing and Balancing.

1.02 DESCRIPTION OF WORK

- A. Furnish all materials, equipment, skill, tools and labor to provide a complete system of automatic temperature controls and motor controls for all mechanical systems herein described and referenced. Contractor shall abandon all pneumatic controls. Control system shall be DDC type and shall be complete with necessary temperature sensors, thermostats, control valves, damper operators, relays, speed signalers, transmitters, control panels, 24 volt and up to and including 120 volt wiring, software, programming, data base entry, and start up services required to maintain and monitor the conditions described on the drawings and in the specifications. Replace all pneumatic thermostats, pneumatic control valves, and all other pneumatic controls for all HVAC devices remaining in use (such as unit heaters and cabinet unit heaters) with electronic controls of DDC controllable type. Other pneumatic controls for HVAC devices no longer being used will be abandoned. Also replace all line voltage thermostats throughout the building with low voltage thermostats along with their control valves. Work of this section shall also include all accessories and appurtenances required for a complete installation, programmed, tested and ready for operation. Power wiring and VFDs are provided by the Electrical Contractor.
 - 1. Provide a Mitsubishi City Multi Controls Network (CMCN) HVAC control system consisting of but not limited to thermostats, schedule timers, controllers and web interface. The City Multi Controls Network shall support operational monitoring, scheduling, and online maintenance support. Provide a Siemens model DDC HVAC control/ building management system to control all HVAC equipment including but not limited to all new and existing fans, pumps, dampers, control valves, thermostats, duct stats, aquastats, unit heaters, and cabinet unit heaters. Provide Johnson Controls interface with the Mitsubishi City Multi Controls Network for occupied/unoccupied changeovers and any other control functions as required, operating as one, for a complete HVAC control system.
 - 2. City Multi control wiring shall be installed in a daisy chain configuration from outdoor units to indoor units to system controllers to the power supply.
- B. All wiring up to and including 120 volt necessary for control systems is work of this section. It shall be installed concealed in the building construction and suitable for return plenum ceilings. Connectors and couplings for the tubing shall be steel set screw type. Electrical work shall be done in accordance with the National Electrical Code, and the electrical section of the State Building Code. Install control wiring without splices between terminal points, color coded. Install wiring located in concrete or in walls or exposed in occupied areas, in electrical conduit.

- C. Electrical Standards: Provide electrical products which have been tested, listed and labeled by Underwriters' Laboratories (UL) and comply with NEMA standards.
- D. All materials and equipment covered in this specification shall be new unless specifically indicated otherwise.
- E. The engineering, installation, calibration, software programming, commissioning/checkout necessary for complete and fully operational control system as specified herein shall be provided by the Mechanical Contractor.
- F. This specification defines the minimum equipment and performance requirements for a DDC/BMS.

1.03 WORK BY OTHERS

- A. Power wiring and VFDs shall be furnished and installed by the Electrical Contractor.

1.04 SUBMITTALS

- A. Submit manufacturer's specifications for each control device furnished, including installation instructions and start-up instructions. Submit control diagrams and verbal descriptions of control sequences for each control item.
- B. Label each control device with the final setting.
- C. Submit maintenance data and spare parts lists for each type of control device.

PART 2 PRODUCTS

2.01 BUILDING CONTROL SYSTEM

- A. The system, as specified, shall independently control the building's HVAC equipment to maintain a comfortable environment in an energy efficient manner. The building operator shall be able to communicate with the system and control the sequence of operation within the building from the operators station in this building as well on the internet, web based with full graphics.
- B. The building control system shall consist of a network of independent, stand-alone control unit (SCU) panels, auxiliary input/output panels and local terminal control units. The system shall use full distributed processing and be capable of direct digital control.
- C. All new controls shall be available through a local factory authorized dealer.
- D. The new control system shall be installed by a factory trained technician who has experience on other similar projects with the installation, commissioning and servicing of this particular model of controls.

2.02 STAND-ALONE CONTROL UNIT

- A. Each stand-alone control unit (SCU) panel shall include its own microcomputer controller, power supply, input/output modules, and battery. The battery shall be self-charging and be capable of supporting all memory within the control unit for a minimum of eight (8) hours if the commercial power to the unit is interrupted or lost. The stand-alone control unit shall be listed by Underwriters Laboratories (UL) against fire and shock hazard as a signal system appliance unit. The unit shall also be listed by UL Canada (ULC) and Canadian Standards Association (CSA).
- B. Each control unit shall be capable of full operation either as a completely independent unit or as a part of the building-wide control system. All units shall contain the necessary equipment for direct interface to the sensors, actuators and operator's terminal devices connected to it.
- C. Each SCU shall be capable of sharing point information with other panels, such that control sequences or control loops executed in one control unit may receive input signals from sensors connected to other panels within the network. If the network communication link fails or the originating SCU malfunctions, the control loop shall continue to function using the last value received from the failed SCU. Failure of one SCU shall have no other effect upon any of the other SCU's in the network.
- D. It shall be possible to define control strategies at each stand-alone control unit, and for any of the stand-alone control units in the system from any operator terminal in the system. Each control unit shall provide the ability to support its own operator terminal if so desired.
- E. Auxiliary input/output panels shall connect directly to stand-alone control unit through a local area data trunk. These panels shall provide additional local digital and analog point capacity while utilizing an SCU's processing and networking capabilities. All control program and point database shall reside within the associated stand-alone control unit.

2.03 LOCAL TERMINAL CONTROL UNITS

- A. Control of all equipment shall be accomplished by the Mitsubishi microprocessor based, independent stand-alone DDC controller which shall be able to interface with the building control system network through a local area data trunk connected to any system SCU panel.
- B. Each terminal device controller shall contain resident programs which are field selectable for each specific application. Local terminal controllers that use volatile memory shall supply a 72-hour battery for memory backup at each terminal controller. Systems using central control system SCU type panels to control groups of local terminal devices are not acceptable. Each terminal controller shall perform its primary control functions independent of other network devices or communications. Reversion to a fixed failure mode of operation upon loss of data communications trunk is not acceptable.
- C. Each terminal controller on the data communication trunk shall be accessible for monitoring and control from the central operator's terminal, remote operator's terminal or portable terminal device. Under no circumstances will it be necessary to identify the specific data trunk, field

panel, or terminal control unit to obtain value or status of any local terminal control point in the system.

- D. The terminal control unit room sensor shall come complete with a portable operator's terminal jack (additional room sensor options include: setpoint adjustment, manual override switch and temperature indication) integral to the sensor. The terminal jack shall be used for plug-in connection of a portable operator's terminal for control and monitoring of all hardware and software points associated with that terminal control unit.
- E. Terminal control valve and damper actuators shall provide complete modulating control of the terminal devices. The actuator(s) shall provide full linear position feedback for the full range of the actuator's movement. Feedback status can be monitored from the central operator's station or remote station and shall be displayed in percent open notation. Devices which provide only end switch (full open/full closed) feedback are not acceptable. The actuators shall be removable and separate devices from the terminal controller, not requiring removal or disassembly of the entire controller for service or replacement.

2.04 SENSOR/INPUT SIGNALS

- A. It shall be possible for each stand-alone control unit to monitor inputs from various types as follows:

- Analog inputs
 - 4-20 ma
 - 0-10 vDC
 - 3-15 PSI
 - thermistor
- Digital inputs
 - dry contact
 - pulse accumulator
 - flow meters

2.05 ACTUATORS/OUTPUT SIGNALS

- A. The stand-alone control unit shall directly control pneumatic and electronic actuators and control devices. Each control unit shall be capable of controlling output signals of various types as follows:

- Digital outputs
 - motor starters, sizes 0-4
 - momentary switching
 - maintained contacts
- Analog outputs
 - 3-15 PSI
 - 4-20 ma

- 0-10 vDC
- 0-135 OHM

2.06 OPERATOR INTERFACE

- A. The building control system shall permit full operator communications including: obtaining information about the performance of his/her system; allowing the operator to change the system operations; and diagnosing system malfunctions. Operator communication shall be through the use of any one of the following operator terminals:
- Printer with keyboard (located in penthouse mechanical room)
 - Monochrome CRT with keyboard (located in penthouse mechanical room)
 - Portable operator's terminal
- B. It shall be possible to have one operator's terminal at each stand-alone control unit, or to have a single operator's device which can be connected to any panel in the network. The building control system shall permit complete operation of any stand-alone control unit within the network, from any operator terminal within the system.

2.07 USER PROGRAMMABILITY

- A. All temperature control strategies and energy management routines shall be definable by the operator through any operator's terminal. It shall be possible for the operator to modify system functions independently, without intervention by the Control Contractor.
- B. Through any PC, any building operator shall be able to:
- Read the value of a measured variable (i.e. temperature)
 - Start or stop equipment
 - Monitor the status of equipment being controlled.
 - Read the set point of a control loop.
 - Determine the control signal and/or position of an actuator.
 - Set or change alarm limits.
 - Generate displays of control strategies.
- C. The system shall allow a trained operator with the ability to:
- Add control loops to the system.
 - Add points to the system.
 - Create, modify or delete control strategies.
 - Assign sensors and/or actuators to a control strategy.
 - Tune control loops through the adjustment of control loop parameters.
 - Enable to disable control strategies.
 - Generate hard copy record of control strategies on a printer.
 - Select points to be alarmable and define the alarm state(s).
 - Define system-wide points or data for use in multiple panel strategies.

2.08 PORTABLE OPERATOR'S TERMINAL

- A. A full function, portable operator's PC terminal shall be provided. The terminal must be equipped to interface with both the SCU field panels and the local Terminal Control Units. The POT shall be capable of operator readout of system variables, override control, troubleshooting, service diagnostics, adjustment of control parameters and system programming. As a minimum, the POT must contain a 56 character ASCII keyboard and eight line by 40 character display with a minimum of eight programmable function keys. The terminal must communicate in full English language with accompanying system designated engineering units of display for all inquiry, display, programming and command functions.
- B. The POT shall be available from at least one source than the Control Contractor. The POT will be a standard, unmodified product and can run on either batteries or AC line voltage. It shall not be necessary to disconnect or disable the system data communication trunk at either the SCU or the TCU or the field panel in order to plug in the POT at either device. POT shall be equivalent to a 386 laptop computer with all system software and programming software necessary for the University to direct connect into the DDC control system and access all points and be able to make programming changes.

2.09 MISCELLANEOUS

- A. Duct mounted Dampers shall be designed to operate in systems having velocities up to 3,000 FPM with a static pressure differential of 4" WG. All dampers shall be opposed blade type. The frame shall be minimum 13 gauge galvanized steel roll formed channel. Blades shall be minimum 16 gauge galvanized steel with a maximum width of 6". Shafts shall be minimum ½" diameter. Maximum damper sections size shall be 48" x 72", with larger damper installed in sections with appropriate jack shafting.
- B. Duct mounted Dampers shall be minimum leakage type equipped with blade and edge seals. Damper leakage requirement (rated for leakage less than 10 cfm per sq. ft. of damper area, at differential pressure of 4" WG when Damper is being held by torque of 50 inch-pounds, stainless steel edge seals, replaceable rubber seals on blades and nylon blade bearings.
- C. Electronic valve and damper operators shall be positive positioning, spring return. Motors shall be of the low voltage synchronous type and shall be non-overloading at a continuous stall.
- D. All water control valves to be sized for a 7.5 ft. pressure drop and all steam control valves to be sized for a pressure drop equal to 50% of the available line pressure unless noted otherwise.
- E. Provide full enclosure standard steel, finish painted cabinets as required to contain temperature controllers, relays, switches, etc.

2.10 THERMOSTATS

- A. Provide heating/cooling thermostats of modulating type, as required by sequences of operation. Provide LCD digital display of room temperature, switch from unoccupied to occupied, and settings which are clearly visible and adjustable from front of instrument. Replace all existing

thermostats with new electronic (DDC controllable type) thermostats installed in the exact same location.

- B. Duct thermostats shall be supplied with liquid filled capillaries, with the bulb of the thermostat mounted in the air flow that is being sensed and controlled. They shall be supplied with an air gauge, 1-1/2" in diameter, in each branch line. A sufficient number of main air gauges shall be supplied to indicate when main air pressure is up to operating conditions. Thermostat bulbs in mixed air and discharge air locations shall be the 8° averaging type, sensing an average temperature over the total 8° of the element. Elements shall be distributed across the air stream to sense all variations in delivered air temperature. Duct thermostats shall be readily adjustable to settings at least 5° over and under the temperature figure specified.
- C. Provide low temperature protection thermostats of manual reset type, with sensing elements 8'-0" or 20'-0" in length. Provide thermostat designed to operate in response to coldest 1'-0" length of sensing element, regardless of temperature at other parts of element. Support element properly to cover entire duct width. Provide separate thermostats for each 25 sq. ft. of coil face area or fraction thereof.

2.11 DDC INPUTS AND OUTPUTS

- A. Input/output sensors and devices shall be closely matched to the requirements of the DDCP for accurate, responsive, noise free signal input/output. Control input response shall be high sensitivity and matched to the loop gain requirements for precise and responsive control. In no case shall computer inputs be derived from pneumatic sensors.
- B. Temperature sensors shall be resistance temperature detector (RTD) type of 1000 platinum or sealed element thermistor type.
 - 1. Space temperature sensors shall be provided with blank covers, and shall be identical in appearance to the pneumatic space thermostats and room humidity sensors.
 - 2. Duct temperature sensors shall be rigid stem or averaging type as specified in the sequence of operation.
 - 3. Water sensors shall be provided with a separable copper, Monel, or stainless steel well.
 - 4. Outside air wall mounted sensors shall be provided with a sunshield.
 - 5. Temperature sensor to have an accuracy of +/- 1% at 0 Deg. C. averaging elements shall be at least 17 feet in length.
- C. Differential Pressure Switches:
 - 1. Fan proof-of-flow switches be U.L. listed adjustable setpoint and differential pressure type. Switches shall be piped to fan discharge except where fans operate at less than one inch WG, they shall be piped across the fan. For fractional horsepower and non-ducted fans, relays or auxiliary contacts may be used. Maximum pressure rating shall be at least 10 inches WG.

2. Pump proof-of-flow switches shall be U.L. listed adjustable differential pressure of flow type as specified in the sequence of operation or data point summary. Devices shall be 150 psi rated except chilled water flow switches shall be provided with totally sealed vapor-tight switch enclosure on 300 psi body. Differential pressure switches shall have valved manifold for servicing.

D. Static Pressure and Flow Sensors:

1. Air flow and static pressure analog sensors shall be high accuracy suitable for the low velocity pressures to be encountered, be selected for approximately 50% overrange, and have a 4 to 20 ma output. These air flow and pressure sensors shall be connected to the air flow measuring station with valved lines for testing and calibration, and shall have adjustments for zero and span.
2. Water flow analog sensors shall be provided complete with flow element and shall be an all solid state precision industrial type with stainless steel meter body, maximum error of no more than +/- 1% of span, and 4 to 20 ma output. Sensor shall be rated 250 psi minimum and installed in strict accordance to the manufacturer's instructions complete with three-valve manifold for calibration and maintenance.

- E. Outputs:** Control relays and analog output transducers shall be compatible with the DCP output signals. Relays shall be suitable for the loads encountered. Analog output transducers shall be designed for precision closed loop control with pneumatic repeatability error no greater than 1-1/2" percent.

- F.** Provide standard steel cabinets as required to contain temperature controllers, relays, switches, etc.; except limit controllers and other devices excluded in sequence of operation. Provide full enclosure cabinet, with painted finish.

PART 3 EXECUTION

3.01 BUILDING CONTROL FUNCTIONS

- A.** All temperature control functions shall execute within the stand-alone control unit via direct digital control algorithms. The Owner shall be able to customize control strategies and sequences of operation by defining the appropriate control loops and point data base.

3.02 OPERATING DATA BASE

- A.** It shall be possible to fully create, modify or remove control loop within a specific stand-alone control unit while it is operating and performing other control functions. Control loops within any SCU shall be able to utilize point information or control loop data from other SCU's in the network. Each control loop shall be fully user definable in terms of:

- Sensors/actuators that are part of the control strategy.
- Control mode or action.

- Value of parameters.
- Points or conditions to be included in the control loop.

B. In addition, the Owner shall be able to create customized control strategies based upon arithmetic, Boolean or time delay logic. The system shall permit the generation of job-specific control strategies that can be activated in any of the following ways:

- Continuously.
- At a particular time of day.
- On a pre-defined date.
- When a specific measured or controlled variable reads a selected value or state.
- When a piece of equipment has run for a period of time.

C. Each stand-alone control unit shall contain the capability of performing energy management routines as defined in the points list or sequence of control. Only stand-alone, memory independent panels shall be used for direct digital control functions or where modulated outputs are required.

D. Upon a loss of commercial power to any stand-alone control unit, the other panels within the network shall not be affected, and the loss of operation of that unit shall be reported at the designated operator's terminal. Upon resumption of commercial power, the control unit shall resume full operation without operator interventions.

3.03 OPERATOR'S VIDEO DISPLAY TERMINAL AND PRINTER

A. A PC terminal with keyboard shall be furnished by the owner and installed by this contractor. The PC shall display real-time data, allow operator commands, and report system activity. Locate the PC in the Maintenance Office.

B. Furnish and install a desktop printer for hard copy data printouts.

3.04 EXPANSION CAPABILITY

A. The building control system as installed shall allow the Owner to expand the system through adding new panels and control points to the existing network. Also may expand this system through the addition of a central host computer and new necessary operator terminals. The network shall be fully compatible with this additional central computer without changes to the panel hardware. Nor shall it be necessary for the operator to re-enter building data or redefine the control strategies already resident within the stand-alone control units. An upgrade to a system with a central computer will allow the following expanded operator functions:

- Support of dynamic color graphic displays.
- Hard disk storage of trending data and SCU database.
- Wider range of English language reports either predefined or Owner developed.
- Interface with data management software from independent sources.

3.05 SELF DIAGNOSTICS

- A. Each stand-alone control unit shall contain self-diagnostics that continuously monitor the proper operation of the unit. A malfunction of the unit shall be reported to the operator's terminal and inform the operator of the nature of the malfunction, and the control unit affected.

3.06 INSTALLATION REQUIREMENTS

- A. All electrical work performed in the installation of the control system as described in this specification shall be per the National Electrical Code (NEC) and per applicable state and local codes. Where exposed, conduit shall be run parallel to building lines properly supported and sized at a maximum of 40% fill. In no cases shall field installed conduit smaller than 1/2" trade size be allowed. Where conductors are concealed, cable rated for use in return air plenums shall be used.

3.07 OPERATING AMBIENTS

- A. Electronic controls mounted in unconditioned space shall be rated for ambient operating conditions from -40°F to 158°F. Controls not meeting these limits shall be mounted in an accessible location within conditioned space.

3.08 OWNER TRAINING

- A. The ATC/BMS contractor shall provide three copies of an operator's manual describing all operating and routine maintenance service procedures to be used with the temperature control and Building Management System supplied. This contractor shall instruct the owner's designated representatives in these procedures during the startup and test period. The duration of the instruction period shall be no less than 40 hours, during normal working hours.
- B. The control contractor will submit a written outline of what will be covered in the training sessions. The contractor will be responsible to furnish all reference materials for the Owner's personnel during the training sessions. The training will be divided up into three sessions as follows:
 - 1 session will include general equipment maintenance.
 - 1 session will include DDC system operation.
 - 1 session will include system hardware and programming.

3.09 CALIBRATION AND ADJUSTMENTS

- A. After completion of the installation, perform final calibrations and adjustments of the equipment provided under this contract and supply services incidental to the proper performance of the complete control system under warranty below.

3.10 ACCEPTANCE PROCEDURE

- A. Upon completion of the calibration, contractor shall startup the system and perform all necessary testing and run diagnostic tests to ensure proper operation. Contractor shall be responsible for generating all software and entering all database necessary to perform the sequence of control and specified software routines. An acceptance test in the presence of the owner's representative or engineer shall be performed.

3.11 WARRANTY

- A. All control devices and installation shall be warranted to be free from defects in workmanship and material for a period of one year from the date of job acceptance by the Owner. Any equipment, software, or labor found to be defective during this period shall be repaired or replaced without expense to the Owner. Factory authorized warranty service shall be available within 50 miles of job site.
- B. As any software updates become available for the energy management system, they shall be furnished and installed at no additional cost to the Owner during the warranty period.

3.12 CONTROL WIRING

- A. Install control wiring, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with ANSI/NFPA 70, "National Electrical Code".
- B. Install circuits over 25 volt with color coded No. 12 wire in electric metallic tubing.
- C. Install circuits under 25 volt with color coded No. 18 wire with 0.031" high temperature (105°F/41°C) plastic insulation on each conductor and plastic sheath all over.
- D. Install electronic circuits with color coded No. 22 wire with 0.023" polyethylene insulation on each conductor with plastic jacketed copper shield over all.
- E. Install low voltage circuits, located in concrete slabs and masonry walls, or exposed in occupied areas, in electric conduit.

3.13 ROOM THERMOSTATS

- A. Room thermostats shall be 24 volt and installed 5'-0" above the floor. Their range shall be 55 degrees to 75 degrees for heating only, 70 degrees to 85 degrees for cooling only, and 55 degrees to 85 degrees for both heating and cooling. Night settings shall have a 10° differential. New thermostats shall be located where the existing thermostats presently are. Other thermostats shall be located where shown on the drawings, but if no location is shown, instructions as to locations can be obtained from the Engineer. Thermostats shall not be located on outside walls, unless no other location is available, in which case they shall have insulating bases.

3.14 FINAL ADJUSTMENT OF EQUIPMENT

- A. After completion of installation, adjust thermostats, control valves, motors and similar equipment provided as work of this section.
- B. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.
- C. After complete installation of controls system for project, and after final air balance, Contractor shall test all features of control scenario in presence of Owner's representative. Contractor shall verify accuracy of controls for various operating modes for all systems including dampers and AHU shutdowns, water temperature control and laboratory hood operation.

PART 4 CONTROL SEQUENCES

4.01 ENERGY RECOVERY VENTILATOR

- A. The Energy Recovery Ventilator (ERV) fans shall operate continuously in all occupied periods. These are fans ERVF-1 and ERVF-2 that are external to the ERV. The outside air damper serving outdoor air to the ERV shall open and remain open during all occupied periods. Both ERV fans shall be de-energized and the outdoor air damper shall be closed in all unoccupied periods.
- B. ERVF-1 and ERVF-2 shall operate at the "minimum air quantity" shown on the drawings during occupied periods and shall increase speed as required by CO2 sensors. The CO2 sensors/controllers located in rooms shown on the drawings shall operate the variable frequency drives of ERVF-1 and ERVF-2 ramping up their speed from the "minimum air quantity" to the required speed to maintain a maximum of 850 ppm at any CO2 sensor.
- C. See Article 4.02 below for control of the relief fans associated with the ERV.
- D. Individual space humidistats of the fully proportional type shall operate their individual humidifiers located in the ductwork downstream of the ERV. Provide all the safety controls including but not limited to air flow proving switch, high humidity humidistat, high water limit, and an over current condition to shut down the humidifier and sound an alarm. Humidifier controls shall monitor operating history of humidifiers and display shall indicate when cartridges need replacement.
- E. Provide a 20 foot long serpentine element on the discharge side of the ERVs hot water coils to de-energize the ERV fans whenever the supply air temperature at any point along the element reaches 35 degrees and to close the outside air damper.
- F. Provide a smoke detector for each ERV fan to deenergize the fan, control arrangement per code. Provide sufficient contacts to permit connection of supervised fire alarm system.

- G. Provide a safety pressure sensor for the ERV fans. Fans shall shut down if pressure is exceeded due to over or under pressure.

4.02 FANS

- A. All new and existing exhaust fans (including the electrical room exhaust fan) shall be interlocked to be energized when the ERV fans are energized during all occupied periods. See drawings, including drawings of the existing building reissued as reference drawings, and field verify locations of existing exhaust fans.
- B. The electrical room exhaust fan shall cycle under control of a cooling-only thermostat during unoccupied periods. All other exhaust fans shall remain de-energized during unoccupied periods. Replace the existing pneumatic thermostat in the electric room with an electronic (DDC controllable type) cooling-only thermostat.
- C. RELIEF FANS CONDITION 1 (OUTDOOR AIR TEMPERATURE BELOW 20 F):
All Occupied Periods: Condenser Room intake damper shall be closed. Relief fan RF-3 shall be interlocked and energized with ERV fans during the “minimum air quantity” mode of operation. The “minimum air quantity” mode occurs during occupied periods when no CO2 sensors are calling for more outdoor air. Relief fan RF-1 shall be energized on a call from a CO2 sensor for more outdoor air and ramp up to the speed required to maintain an equal pressure in the Condenser Room. RF-1 shall be de-energized and RF-3 shall once again be energized when CO2 sensors are satisfied. There shall be rotation of run time for RF-1 and RF-2 such that the next time a CO2 sensor calls for more outdoor air then RF-2 shall be energized. Individual motorized dampers shall open with their individual relief fans.
All Unoccupied Periods: RF-1, RF-2, and RF-3 shall be de-energized and their motorized dampers shall close when below 20F outside and in the unoccupied mode.
- D. RELIEF FANS CONDITION 2 (OUTDOOR AIR TEMPERATURE ABOVE 20 F):
This is for all occupied and unoccupied periods.
 1. Condenser Room intake damper shall open.
 2. Condenser Room cooling thermostat shall override Condenser Room pressure control and shall energize and ramp up speed of RF-1, then upon more demand from the cooling thermostat, shall energize and ramp up speed of RF-2 as required to satisfy cooling thermostat setting. RF-3 shall be de-energized whenever RF-1 or RF-2 are energized. Individual motorized dampers shall open with their individual relief fans. Make the initial cooling thermostat setting at 75 F.
 3. Condenser Room heating thermostat shall override Condenser Room pressure control and shall energize and ramp up speed of RF-1, then upon more demand from the heating thermostat, shall energize and ramp up speed of RF-2 as required to satisfy heating thermostat setting. RF-3 shall be de-energized whenever RF-1 or RF-2 are energized. Individual motorized dampers shall open with their individual relief fans. Make the initial heating thermostat setting at 25 F.
- E. Provide a safety pressure sensor for all fans. Fans shall shut down if pressure is exceeded due to over or under pressure.

4.03 BOILERS AND PUMPS

- A. Energize new pump P-4 and existing system pumps and the hot water reset controller from an outdoor air temperature sensor with the initial setting of 40 degrees F.
- B. The hot water reset controller shall vary the hot water temperature in the system with the outdoor air temperature sensor. Initial setting shall be 80F water temperature with 40F outdoor air temperature, requiring warmer temperature water with cooler outdoor air temperatures. The demand for warmer system water shall stage, cycle and modulate the boilers and their boiler pumps.
- C. Provide hot water reset, staging, cycling, and modulating of boilers, boiler safety and fail safe with alarm, and rotation of run time for the boilers, boiler pumps, and existing system pumps.
- D. Provide two emergency shut off buttons, one on each side of the boiler room door.
- E. See article 4.05 below for control of pump P-5.

4.04 CITY MULTI SYSTEM

- A. Each individual City Multi thermostat shall modulate refrigerant flow to each individual indoor unit and their fans on a demand for heating and cooling.
- B. The City Multi controllers and Controls Network shall stage and modulate outdoor units refrigerant compressors and fans as required to satisfy the demands of the indoor units.

4.05 CONDENSER ROOM HEATING SYSTEM

- A. Below 20F Outside: Condenser Room heating thermostat shall cycle pump P-5 and unit heater fans to maintain the setting. Make the initial thermostat setting at 25 F.
- B. Above 20F Outside: Lock out the condenser room heating system when the outdoor air temperature rises above 20F.

END OF SECTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Refer to Section 15010 Mechanical General Provisions and Section 15050 Mechanical Basic Materials & Methods.

1.02 SCOPE OF WORK

- A. Furnish labor, equipment and materials for the complete testing and balancing of the mechanical systems:
 - 1. Hydronic systems.
 - 2. Air handling systems.

1.03 QUALIFICATIONS:

- A. Testing and balancing shall be done by an independent and certified contractor, whose business is limited to testing and balancing air and hydronic systems.

1.04 SUBMITTALS

- A. Acceptance testing must be documented as required by ASHRAE Guideline 0, Construction Phase Commissioning in a report including complete documentation of the performance tests developed and conducted. Tests must be executed and test records documented according to the procedures developed. Identify the form and detail for recoding the results of the test procedure. "The Commissioning Process" and the test documentation shall be submitted to the engineer and the building official.

1.05 DOCUMENTATION

- A. Coils: Flow rate, inlet pressure, discharge pressure.
- B. Fan Units and Pumps: Flow rate (CFM and/or GPM), RPM, pressure readings at strategic locations, power draw and BHP.
- C. Diffusers and Registers: Flow rates (CFM).
- D. All temperature readings shall be recorded.
- E. Air terminal units (VVT's/VAV's): Maximum and minimum flow rates (CFM).
- F. Include identification and types of instruments used, and their most recent calibration date.

1.06 CALIBRATION

- A. All instruments used in testing and balancing shall be calibrated prior to working on this project.

1.07 CODES AND STANDARDS

- A. NEBB Compliance: Comply with NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" as applicable to mechanical air and hydronic distribution systems, and associated equipment and apparatus.
- B. AABC Compliance: Comply with AABC's Manual MN-1 "AABC National Standards", as applicable to mechanical air and hydronic distribution systems, and associated equipment and apparatus.
- C. Test pressure piping in accordance with ANSI B31. Test natural gas piping in accordance with SBC 8029 and 8030, ANSI B31.2, and local Utility requirements. Test laboratory gas piping, including pressure, cross connection and final testing in accordance with NFPA 56F. All plumbing work, including gas piping, shall be inspected, tested and approved as required by the State and Local regulations.
- D. Industry Standards: Comply with ASHRAE recommendations pertaining to measurements, instruments, and testing, adjusting, and balancing, except as otherwise indicated.
- E. HVAC system acceptance testing shall comply with Minnesota Rules Part 1323.0672, subpart 3 of the commercial building energy code. Acceptance testing and documentation shall be completed in accordance with Sections 7.2.9, 7.2.10, 7.2.13, and 7.2.15 of ASHRAE Guideline 0-2005. The testing subcontractor and the person applying for the permit are responsible for satisfying these requirements of the building code.

1.08 JOB CONDITIONS

- A. Do not proceed with testing, adjusting, and balancing work until work has been completed and is operable. Ensure that there is no latent residual work still to be completed.
- B. Do not proceed until work scheduled for testing, adjusting, and balancing is clean and free from debris, dirt, and discarded building materials.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

- A. Except as otherwise indicated, use same products as used by original installer for patching holes in insulation, ductwork and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposes.
- B. At Tester's option, plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.

2.02 TEST INSTRUMENTS

- A. Utilize test instruments and equipment for TAB work required, of type, precision, and capacity as recommended in the following TAB standards:
 - 1. NEBB's Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
 - 2. AABC's Manual MN-1 "AABC National Standards".

PART 3 EXECUTION

3.01 TESTING PROCEDURES

- A. Tests of piping systems, except final tests of complete systems shall be made before the pipe is covered, insulated, or connected to fixtures and equipment, and before building interior finishing and backfilling commences. Provide temporary equipment for testing. Flush and clean piping and remove control devices before testing. Before tests are made, the new and existing elements of system components that might be damaged by this pressure shall be removed from the system; provide shut-off valves for isolation. Do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Test each piping system at 150% of operating pressure indicated, but not less than 25 psi test pressure.
- B. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure. Repair piping system sections which fail required piping test, by disassembly and reinstallation, using new material to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods. Drain test water from piping systems after test and repair work has been completed.
- C. All heating piping systems shall be subjected to a hydrostatic pressure of 75 psi for a period of two (2) hours. Before tests are made, the new and existing elements of system components that might be damaged by this pressure shall be removed from the system; provide shut-off valves for isolation. Do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating.
- D. All fan and pump motors under the mechanical contract shall be tested under load conditions with the RPM, CFM, GPM and amperage readings taken and listed on the required certificates. If amp draw of any motor in this contract exceeds that which is recommended, make necessary adjustments.
- E. All ventilation work shall be tested for performance, air tightness and air deliveries. After each duct system which is constructed for duct classes over 3" is completed, test for duct leakage in accordance with SMACNA HVAC Air Leakage Test Manual. Repair leaks and repeat test until total leakage is less than 1% of system design air flow.

- F. Air flow adjustment shall be done by properly setting all branch duct dampers and splitter dampers to obtain required air flow as shown on the drawings, not by restricting discharge openings with the dampers on registers and diffusers. Furnish and install any additional dampers which may be required to get proper air quantity.
- G. The Mechanical Contractor shall be responsible for changes of pulleys, belts and dampers necessary to obtain proper air quantity.
- H. All temperature control systems shall be checked out under operating conditions; temperature readings shall be taken at each control point to verify the control function.
- I. All motorized damper functions shall be verified.
- J. Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned, and is operable. Do not proceed with TAB work until unsatisfactory conditions have been corrected in a manner acceptable to Tester.
- K. Test, adjust and balance system during summer season for air conditioning systems and during winter season for heating systems, including at least period of operation at outside conditions within 5° F (3° C) wet bulb temperature of maximum summer design condition, and within 10° F (6° C) dry bulb temperature of minimum winter design condition. When seasonal operation does not permit measuring final temperatures, then take final temperature readings when seasonal operation does permit.
- L. Patch holes in insulation, ductwork, and housings, which have been cut or drilled for test purposes, in a manner recommended by the original installer.
- M. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings as completion of TAB work. Provide markings with paint or other suitable permanent identification materials.
- N. Balance flow of existing hot water heating system as well as the new sections of the hot water heating system using the existing and new balancing valves. See sheets M-3 through M-8 of the original building mechanical plans to help identify the existing balancing valves and the required flows.

END OF SECTION