SECTION 15800

HEATING, VENTILATING AND AIR CONDITIONING

DIVISION I REQUIREMENTS ARE A PART OF THIS SECTION.

PART 1 – GENERAL

General Provisions of the Contract Documents to be included but not necessarily limited to General Conditions, Supplementary Conditions and Sections of Division One of this project manual.

1.01 WORK INCLUDED

A. Furnish all labor, materials, equipment, transportation, testing and services necessary for the proper and satisfactory installation of the heating, ventilating and air conditioning systems and including the demolition and removal of certain equipment, ductwork. Piping and appurtenances all as required and indicated on the drawings and specified herein. Work, materials and equipment not indicated or specified which is necessary for the complete and proper operation of the work of this Section in accordance with the true intent and meaning of the contract documents shall be provided and incorporated at no additional cost to the Owner.

1.02 QUALITY ASSURANCE

A. Code Requirements: All work covered by this Section shall conform to the latest requirements of the following regulations:
   1. National Fire Protection Association.
   2. State Division of Industrial Safety.
   3. 2005 California Energy Code, Part 6, Title 24 C.C.R.
   4. 2007 California Mechanical Code (CMC).
   5. Uniform Fire Code with California Amendments.
   6. County Health Department.
   7. Any other legally constituted body having jurisdiction thereof.

B. Nothing in the Specifications or drawings shall be construed to permit deviation from the requirements of governing codes unless approval for said deviation has been obtained from the legally constituted authorities having jurisdiction and from the Owner's representative.

1.03 DRAWINGS

A. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings and accessories, which may be required. The Contractor shall carefully investigate the conditions surrounding the installation of his work, furnishing the necessary ductwork and fittings, which may be required to complete the installation. (See requirement hereinafter for 1/4" scale drawings.) The Contractor shall verify that adequate space is available for the installation of the ductwork as indicated, prior to detailing and fabrication.

B. The general arrangement indicated on the drawings shall be followed as closely as possible. Coordinate with the Architectural, Structural, Plumbing, Fire Protection and Electrical Drawings prior to installation of ductwork, piping and equipment to verify adequate space is available for installation of the work shown. In the event a field condition arises which makes it impossible to install the work as indicated, submit, in writing, the proposed departures to the Architect for his acceptance prior to the installation. Only when Architect's acceptance is given, in writing, shall Contractor proceed with installation of the work.

C. Special Note: Should the Contractor make changes in the installation differing from what is indicated on the contract drawings and not necessitated due to field conditions as indicated hereinabove, the Contractor shall be required to re-install the work to comply with what has been indicated on the contract drawings. Should it be impossible to re-install the work and the installation is in accordance with all governing authorities, the Architect may permit the installation to remain. However, all costs incurred to revise the contract drawings by the Engineer for resubmittal to the building department indicating the as-installed condition shall become the responsibility of the Contractor.

D. In case of a difference in the specifications between the specifications and the drawings or in the drawings, the contractor shall include the cost of the most expensive alternate in the bid proposal. The contractor shall secure direction from architect before the start of any construction.

1.04 PERMITS, INSPECTIONS AND LICENSES

A. All permits, inspections and licenses required by the legally constituted authorities for installation of the work according to the plans and specifications shall be obtained and paid as a part of the work of this Section.

1.05 EXAMINATION OF PREMISES

A. Before bidding on this work, Contractors shall make a careful examination of the premises and shall thoroughly familiarize themselves with the requirements of the contract. By the act of submitting a proposal for the work included in this contract, the Contractor shall be deemed to have made such study and examination, and that he is familiar with and accepts all conditions of the site.

1.06 PROTECTION

A. All work, equipment and materials shall be protected at all times. Contractor shall make good all damage caused either directly or indirectly by his own workmen. Contractor shall also protect his own work from damage. He shall close all duct and pipe openings with caps or plugs during installation. He shall protect all his equipment and materials against dirt, water, chemical and mechanical injury. Upon completion, all work shall be thoroughly cleaned and delivered in a new condition.

B. Contractor shall be held responsible for all damage to equipment and materials until he has received written notice from the Architect that his work has been accepted.

1.07 LOCATIONS

A. The locations of apparatus, ductwork, and equipment indicated on the drawings are approximate. Ducts, piping, and equipment shall be installed in such a manner as to avoid all obstructions, preserve headroom, and keep openings and passages clear. The locations of all diffusers, registers and grilles shall be coordinated with the architectural reflected ceiling plans and room elevations.

B. Clearance and Openings: Contractor shall cooperate and coordinate his work with all other trades to avoid conflict and permit for a neat and orderly appearance of the entire installation. The Contractor shall, in advance of the work, furnish instructions to the General Contractor as to his requirements for equipment and material installation of any kind, whether or not specifically mentioned on drawings or in the specifications, and shall include recesses, chases in walls, and all required openings in the structure. Should furnishing this

information be neglected, delayed or incorrect and additional cuttings are found to be required, the cost of the same shall be charged to this Contractor.

1.08 UNINSPECTED WORK

A. Contractor shall not allow or cause any of his work to be covered up before it has been duly inspected, tested and accepted by the Owner, Architect or any other authorized inspectors having legal jurisdiction over his work. Should he fail to observe the above, he shall uncover the work and, after it has been inspected, tested and accepted, recover it at his own expense.

1.09 SUBMITTAL DATA (Also see Division I)

A. Furnish, all at one time, prior to any installation, within the time noted below, six (6) bound copies of valid submittal data on all material, equipment and devices. Each submitted item shall be indexed and referenced to these specifications and have identification numbers as noted on the equipment schedules. Submittals not complying with this paragraph shall be rejected.

B. Manufacturer's submittal literature and shop drawings are required on all items to ensure the latest and most complete Manufacturer's data is available for review. Requirements of the submittals and Engineer's submittal notes are a part of the work of this Division except that Engineer's notes may not be used as a means of increasing the scope of work of this Division.

C. Submittals will be checked for general conformance with the design concept of the project but the review does not guarantee quantities shown and does not supersede requirements of this Division to properly install work.

D. A list of names is not a valid submittal. To be valid, all submittals must:
   1. Be delivered to the Architect's office in accordance with Division I requirements.
   2. Include all pertinent construction, installation, performance and technical data.
   3. Have all copies marked to indicate clearly the individual items being submitted.
   4. Have each item cross-referenced to the corresponding specified item and be marked to show how differences will be accommodated.
   5. Contain calculations and other detailed data justifying how the item was selected for proposal. Data must be completed enough to permit detailed comparison of every significant characteristic for which the specified item was analyzed during design.
   6. Include, for every item, which differs in size, configuration, connections, service, accessibility, or any other significant way, a drawing to the same (or larger) scale as to the pertinent portions of the contract drawings. In this drawing show a complete layout of the system except that which is identical to the contract drawings, unless the unchanged portions must be shown to indicate such things as clearances. This drawing, together with the contract design drawings must show the complete system as revised to accommodate the proposed alternate.
   7. In addition to the material and equipment submittals, the Contractor shall provide shop drawings for the items listed below.
      a. 1/4" scale drawings of ductwork necessary for contractor to coordinate clearance available with all other trades. Indicate all required offsets, transitions, etc., as required. Photo reproduced copies of the design drawings are not acceptable.
      b. Equipment support and lateral restraint details.
      c. Refrigerant piping diagram.
      d. Exposed outdoor piping support details.
      e. Duct hanger supports. Type provided with test data.

f. Automatic temperature control diagrams with sequence of operation.
g. Range hood and exhaust system.
h. Certified letter from Equipment Manufacturer for factory start-up as called for hereinafter.
i. Certified letter from Test & Balance Co. regarding excessive vibration of all mechanical equipment. See "Testing".

These shop drawings must be reviewed and accepted by the Architect before the start of said items.

1.10 SUBSTITUTIONS (Also see Division I)

A. The Contractor assumes full responsibility that alternate items and procedures will meet the job requirements and is responsible for cost of redesign and of modifications to this and other parts of work caused by the use of any equipment other than what is scheduled on the drawings. In view of these responsibilities, it is the purpose of these specifications to establish procedures, which ensure that the Contractor has considered all the ramifications of proposed alternates before submitting them for review. Submittals which do not comply with the requirements of these specifications or which indicate proposed alternates were selected without proper regard to the requirements of the job, will not be approved. No more than one proposed alternate will be considered for each item.

B. Alternate items installed without Engineer's review and acceptance will be replaced with specified items at Contractor's expense.

C. Provide or perform tests required by Engineer for purpose of judging acceptability of proposed substitutions.

D. This Contractor is responsible to provide sufficient information to allow the Engineer to analyze any proposed alternate. If inadequate information is provided, the proposal will not be accepted and resubmittal will not be allowed.

E. Certification: The Contractor shall arrange for and pay for the services of a certified representative of each of the Air Conditioning Unit Manufacturers, who shall review and sign as acceptable to the Manufacturer, all shop drawings essential to the installation of the air conditioning units. The shop drawings shall be reviewed and signed by this representative, prior to submittal to the Architect for acceptance. Shop drawings shall include such items as control diagrams arrangement and type of vibration isolation base, and safety controls.
1. Any change in controls, or installation procedures required by the Unit Manufacturer, shall be made by the Contractor at no additional cost to the Owner.
2. All changes to mechanical and electrical drawings required by the Manufacturer shall be made, provided these changes do not reduce the scope of the work, which shall be considered as a minimum requirement.
3. If during the progress of the installation, the Manufacturer's representative required additions to, or changes to the work of the installation of the air conditioning units, wiring, controls, all such additional changes shall be made without cost to the Owner.
4. The completed installation shall be checked and tested by the Air Conditioning Units Manufacturer's representative, who shall submit a written report that the installation in all respects is acceptable to the Manufacturer in and conformance with accepted drawings

F. The Architect or his authorized representative shall be the sole judge as to the quality and suitability of proposed alternate equipment, fixtures or materials and decisions of the Architect or that of his representative shall be final and conclusive.

1.11 RECORD DRAWINGS (Also see Division I)

A. Contractor shall provide and keep up-to-date a complete "as-built" record set of prints, which shall show every change from the original drawings and the exact "as-built" locations, and sizes of the work provided under this Section of the specifications. On completion of the work, all "as-built" information will be delivered to the Architect.

1.12 WEATHERPROOFING

A. All equipment, ductwork, controls, motors, bearings, V-belt, or other materials requiring protection from weather when located outside of building shall be provided with adequate weatherproof protection. Protection provided shall have acceptance of the Architect prior to installation. Weatherproof protection shall be constructed to prohibit water from standing or puddling on equipment and ductwork. Where applicable, the weatherproofing of equipment and accessories shall be by the manufacturer of the equipment.

1.13 GUARANTEES (Also see Division I)

A. Contractor shall guarantee the entire heating, ventilating and air conditioning systems unconditionally for a minimum period of one (1) year after final acceptance by Owner except where noted otherwise. If, during this period, any materials, equipment, or any part of the systems fail to function properly, Contractor shall make good the defects promptly and without any expense to the Owner. Contractor shall also guarantee before final acceptance that the specific quantities of air on the drawings shall be supplied as indicated; also that each apparatus shall deliver the capacities specified. The size of all equipment, valves, duct supply outlets, return and exhaust grilles, etc., are a minimum and the Contractor shall not decrease them in any way.

B. The work shall be installed of such materials and equipment and in such manner that the operation of all parts of the systems covered by the plans and specifications shall be noiseless to the extent that no sound of operation will be heard inside the rooms served by the system's equipment.

C. All equipment shall carry Manufacturer's warranty against defective parts or poor workmanship, and shall not be less than one (1) year. See specific equipment specification for extended warranty requirements.

D. Contractor shall be responsible for all damage to any part of the premises caused by equipment furnished and installed under this section of the specifications for a period of one (1) year after date of acceptance of his work.

E. The Contractor shall agree to provide for emergency repair service within 24 hours of call during the one year guarantee period. Should the contractor not respond within the 24 hour period, the Owner at its own discretion, may order the necessary work to be done and pass on the cost to the Contractor and not impair the one year guarantee requirement. The Contractor shall provide a phone number for emergency calls.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT - (Also See Schedules on Drawings)

A. General: Provide all materials and equipment as specified or required in the work, new and free from defects and imperfections.

2.02 DUCTWORK AND FITTINGS

A. The Contractor shall furnish and install all ductwork indicated on the drawings. All ductwork (except where specified otherwise) shall be galvanized steel complying with ASTM A653, lock forming with a minimum coating of 1.25 ounces per square foot and shall conform to specifications for zinc-coated galvanized steel sheets meeting the requirements of CMC Section 602, Standard No. 2-2. All ductwork shall be fabricated and installed in full compliance with Sections 601, 602, 603, Tables 6-1, 6-2, 6-5 and 6-8 of the California Mechanical Code, and as specified hereinafter or as detailed on the drawings. Ductwork to be exposed in occupied spaces shall be free from visual imperfections, including pitting, seam marks, roller marks, stains, discolorations and other imperfections, including those, which would impair painting. Where indicated on drawings, provide stainless steel duct complying with ASTM AS167 type 316L with No.4 finish. Protect finished surface with mil applied adhesive protection paper, maintained through fabrication and installation.

B. Thickness of metal for air ducts and duct support requirements shall comply with schedules as indicated hereinafter. The partitions and the ceilings forming all plenums, housing and connections for air intakes, the filters, etc., and other portions of the ductwork where so noted on the drawings shall be made with minimum 20 gauge, GI, with standing lock seams. They shall be fitted with 1-1/2" x 1-1/2" x 3/16" stiffening angles on all sides of the housing spaced a minimum 34" center to center being located between the seams.

C. Take-offs from main and branch ducts, unless otherwise noted on the drawings, shall be made with either spin-in connectors or 45 degree taps and provided with volume dampers. All panels shall be either cross-broken or beaded 12" on center to ensure rigidity. The internal ends of all slip joints shall be installed in the direction of flow. All braces, stiffeners and hangers shall be placed outside of the ducts. All longitudinal duct, seams and transverse joints shall comply with the California Mechanical Code Sections as listed hereinbefore except that all exposed duct located in occupied areas shall have transverse joints made with "DUCTMATE" system.

D. All changes in direction of the ducts shall be made possible with inside radius not less than one and one-half (1-1/2) times the width of the duct. Where, due to space limitations, it is necessary to use elbows of less radius; or where indicated on the drawings, elbows having turning vanes shall be used. These turning vanes shall be as hereinafter specified.

E. All ducts shall be installed true to line and grade. All concealed horizontal ducts shall be installed to leave the greatest possible furring space under them, or as indicated on the drawings. Where necessary, changes of elevation in the ducts shall be made to secure this result, but not without acceptance of the Architect.

F. Changes in the shape of the ducts shall be made at small angles. Sides of the ducts shall diverge or converge at an angle not greater than 30 degrees.

G. Where required, sheet metal connections shall be made to building structure by means of galvanized angles anchored to the structure and the sheet metal bolted to the angles.

H. Sheet metal gauges shall conform to the following requirements:

Largest Duct Dimension (inches)	Maximum Duct Diameter (inches)*	U.S. Standard Gauge - Galv.
Up thru 12	Up thru 14	26
14 thru 30	15 thru 23	24
32 thru 54	24 thru 36	22
55 thru 84		20
85 and over		18

* All galvanized round duct shall be of spiral lockseam construction. All plenums where indicated on drawings shall be constructed of 20 gauge.

I. Round Duct and Fittings: Round and oval ductwork where indicated on drawings shall be spiral lock seam low pressure type as manufactured by United McGill Corporation or approved equal, and shall be constructed of galvanized steel meeting ASTM-A653 requirements. Round duct shall be of gauge thickness as indicated on schedule and all fittings shall have a wall thickness not less than specified for straight duct (minimum 24 gauge). Reducers shall be formed type. 90 degree elbows shall be four (4) piece type. 45 degree elbows shall be three (3) piece type. Fittings shall have seams and joints spot welded or riveted and sealed airtight with duct sealant. All circumferential joints shall be duct to duct couplings, mechanically fastened with sheet metal screws, minimum four (4) per fitting and not to exceed 12" on centers.

J. Flexible Duct and Fittings: (Above furred ceilings only) Flexible ductwork between sheet metal ducts and air outlets shall not exceed 6'-0" in length and shall be Casco L181 or approved equal, factory fabricated assembly consisting of a galvanized spring steel wire helix covered with a continuous, non-perforated interior air seal liner and wrapped with a 1" barrier jacket, factory sealed at both ends of each section. The flexible duct shall conform to the requirements of NFPA Bulletin No. 90A & 90B and shall be labeled by Underwriters' Laboratories, Inc. (UL) in accordance with standard 181 as a Class I air duct. Insulation shall have a flame spread of not more than 25 and a smoke density not exceeding 50 per CMC Section 605. Flexible ductwork takeoffs from main and branch ducts shall be made with a sheet metal pressure tap-in, combination unit, having adjustable damper and extractor hardware. Connections to sheet metal collars shall be with high pressure duct sealer applied to the interior of the flexible duct for a minimum of 3" wrap with 2" wide U.L. 181 B-FX tape and secured in place over the collar with 1/2" wide positive locking steel or vinyl straps.

K. Restrooms With Shower Exhaust System: All ductwork shall be aluminum construction, two gauges heavier than required for galvanized ductwork.

L. Range Exhaust Ductwork: No. 16 gauge steel, all exterior welded construction. Horizontal duct shall pitch in accordance with CMC Chapter 5.

2.03 DUCT SUPPORT

A. Sheet Metal Duct Supports:

1.

Max. Diameter Diameter	Minimum Support Material	Maximum Distance
20"	22 ga. GI strap	8'-0" O.C.

a. Refer to SMACNA HVAC Duct Construction Standards – Second Edition, Table 4-2 for duck sizes not shown.

Max Sides of Rectangular Duct

Max. one side	Max. other Side	Minimum Support Material	Maximum Distance
18"	12"	22 ga. GI strap, 1" wide	8'-0" O.C.
48"	24"	20 ga. GI strap, 1" wide	8'-0" O.C.
60"	36"	18 ga. GI strap, 1" wide	8'-0" O.C.
Above 60"	Above 36"	16 ga. GI strap, 1-1/2" wide	6'-0" O.C.

a. Refer to SMACNA HVAC Duct Construction Standards – Second Edition, Table 4-1 for wire and rod hanger requirements for sizes and spacing shown.

3. Vertical duct supports 1-1/2 x 1-1/2 x 1/8 shall be installed on two (2) opposite sides of each duct and shall be riveted, bolted or metal screwed to each side of the duct at not more than 12" intervals. The angle iron supports shall project beyond the opening in the floor.
4. Hanger straps to turn under bottom of rectangular ducts and shall attach with sheet metal screws at this point as well as minimum two (2) additional screws into sides of duct for sizes 18" and under three (3) screws for sizes above 18" (typical for each strap). Ducts in sizes above 48" shall run continuous under bottom of duct. Straps for round duct shall run completely around underside of duct and shall be secured in place with minimum of two (2) sheet metal screws each side.
5. Exposed ducts within the building shall be supported with steel rods attached to a 16 gauge, 2" wide sheet metal strap secured to the duct with sheet metal screws. Provide one rod for round duct and two rods for rectangular ducts. Rods shall have eye bolt connector for attachment to sheet metal straps. Use side beam connectors attached to framing to receive rods. Where necessary, span beams with angle iron to provide for rod attachment.

B. Flexible Ducts: Support flexible ductwork 4'-0" on centers with 1-1/2" wide 24 gauge galvanized metal band with hemmed edges and 22 gauge sheet metal strap, 1" wide. Secure flexible duct to connectors with 1/2" wide positive locking steel or vinyl straps and high pressure duct sealer as specified hereinbefore.

C. Strap Installation: In general, provide in accordance with SMACNA Duct Construction Standards Chapter 4. Contractor may request approval of alternate support methods to type specified. Shop drawings will be required.

1. Concrete: Secure supports to concrete with concrete inserts. Branch ductwork in sizes 18" and smaller may be secured by power actuated fasteners. For existing concrete construction provide expansion shields. Contractor shall submit sizes and maximum loading data.
2. Steel and Wood Framing: Provide beam clamps as manufactured by Grinnel, Tolco or approved equal. Where necessary, span beams with angle iron to provide support. Submit test data for size hangers provided.
3. Brace all ductwork laterally to structural framing to prevent swaying or lateral movement in accordance with SMACNA "Guidelines for Seismic Restraints of Mechanical Systems Chapter". Where guidelines do not address the smaller size ducts and flexible ducts, the Contractor shall provide sway bracing consisting of

sheet metal straps or angle iron that will restrict any swaying to within 2" in any direction.

D. Access Doors:

1. Where required or indicated on drawings, airtight sheet metal access doors shall be installed in ducts and plenum casings. Doors shall be of sizes shown, or as directed where no sizes are shown. All doors shall be constructed per SMACNA Duct Construction Standards Chapter 6 of at least the same weight as the duct or casing. Reinforcing shall be installed, where required, to prevent distortion and vibration. All doors shall be fitted with felt strips to ensure air tightness.
2. Each door shall be hung on two (2) or more hinges. Doors shall be provided with Ventlok No. 100 latches, or approved equivalent.
3. Ceiling Access: Where no means of access are provided, the Contractor shall furnish and install Pottorff metal access doors and frames, of sufficient size to permit easy access to fire dampers, valves, and other furred equipment, which require access to same. Adjustable volume dampers located above ceilings shall be provided with remote damper controls as specified hereinafter. Doors in concealed spline acoustic ceilings shall be acoustic tile type with screwdriver operated spring loaded latches. Other doors shall be minimum 16" x 16" by Pottorff model HAD or approved equivalent.

E. Extractors: Shall be Anemostat, Titus, Air Factors or approved equivalent with adjustment made from register or diffuser face.

F. Turning Vanes: All elbows having a centerline radius less than the width of the duct shall be square elbows with turning vanes of proper radius and spacing. These turning vanes shall be multi-vane type and shall be carefully installed in accordance with the Manufacturer's instructions. Contractor may submit for approval shop fabricated vanes conforming to SMACNA Duct Design Manual Standard Chapter 5. Where required or indicated on drawings, provide acoustic turning vanes constructed of air foil shaped aluminum extrusion with perforated faces and fiberglass fill.

G. Flexible Duct Connections: Shall be provided where indicated as required and shall be "Vent-glass" or Duro-Dyne Durolan super metal-fab or equivalent. Provide 20 ga. galvanized steel weather cover for top and sides of flexible duct connections installed at all outdoor units secured to 6" on center unit flange with # 10 sheet metal screws

2.04 DUCT TAPE AND SEALER

(Meet requirements of California Title 24, Section 124, Requirements for Air Distribution System Ducts and Plenums)

A. All longitudinal snap lock joints shall be made airtight with high pressure duct sealant TREMCO J.S. 773, GREY A.F., or Foster 1042, and transverse joints sealed with Hard cast AFG No. 1402 printed foil grip instant tape sealant for rectangular ducts and round ducts, all Underwriter's Laboratory (UL) classified with NFPA 90A rating of a flame spread not exceeding 25 and a smoke developed rating not to exceed 50. At Contractor's option, all round duct transverse joints may be made with MIRACLE D-619 water based, duct sealant UL classified as manufactured by MIRACLE ADHESIVES CORP., Foster or Ductmate.

B. Sealant Standards:

1. Metal Ducts: UL 723.
2. Flexible Ducts: UL 181 B-M.

C. Exposed outdoor ductwork shall be sealed as described herein and, in addition, all transverse joints shall be covered with Glenkote "Seal-Flex".

D. Ductwork exposed in occupied areas shall have transverse joints sealed with Miracle D-619 sealant and all joints wiped clean after application.

2.05 DAMPERS (Also See Details On Drawing)

A. General (Conform to C.M.C. 508.5, 606.0, Chapter 17 and UL555, 555C, 555S):

1. Smoke Dampers- Smoke dampers complying with recognized standards in the C.M.C. 2007 ED Part II, shall be installed in accordance with approved Manufacturer's installation instructions when required by Chapters 7 and 9 of the C.B.C. 2007 ED and shall be provided with BELIMO AIR CONTROLS FSNF 120 actuator or approved equivalent. Actuator operating time shall be 15 seconds or less to drive open or spring closed from 32° F. to 350° F. and have UL 555S listing. Actuator shall draw no more than 27 VA running or 10 VA holding for 70 in.-#of torque. Actuator shall carry a manufacturer's 5-year warranty. Smoke dampers shall be labeled by an approved agency. Mfg. to provide non-fusible toggle switch on the damper sleeve for power disconnect.
2. Fire Dampers- Fire dampers complying with recognized standards in the C.M.C. 2007 ED, Part II, shall be installed in accordance with approved Manufacturer's installation instructions when required by Chapter 7 of the C.B.C. 2007 ED Fire dampers shall be curtain type with blades removed from the air stream to allow for maximum free area. Fire dampers shall have been tested for closure under airflow conditions and shall be labeled for both maximum airflow permitted and direction of flow. When more that one damper is installed at a point in a single air path, the entire airflow shall be assumed to be passing through the smallest damper area. Fire dampers shall be labeled by an approved agency. Only fire dampers labeled for use in dynamic systems shall be installed in heating, ventilation and air-conditioning systems, which are intended to operate with fans "on" during a fire. See C.B.C. Section 716.3. Ductwork shall be connected to damper sleeves or assemblies in such a way that collapse of the ductwork will not dislodge the damper or impair its proper operation. Damper shall be Pottorff Model VFD-10-ISB in systems equipped with Smoke Detector for fan shut down and Pottorff Model VFD-10D-ISB for all others. (CSFM No. 3225-0368:101) or approved equivalent.
3. Ceiling Dampers- Ceiling dampers complying with recognized standards in the C.M.C. 2007 ED, Part II, shall be installed in accordance with Manufacturer's approved installation instructions in the fire-resistive ceiling element of floor-ceiling and roof-ceiling assemblies when required by Chapter 7 of the C.B.C. 2007 ED. Fire dampers not meeting the temperature limitation of ceiling dampers shall not be used as substitutes. Ceiling dampers shall be labeled by an approved agency. Damper shall be Pottorff Model CFD-15-ES (CSFM No. 3225-0368:104) or approved equivalent.
4. Multiple Arrangements- When size requires the use of multiple dampers, the installation shall be framed in an approved manner to ensure that the dampers remain in place.
5. Access and Identification- Dampers shall be provided with an approved means of access, large enough to permit inspection and maintenance of the damper and its operating parts. The access shall not impair fire-resistive construction. Access shall not require the use of tools, keys or special knowledge. Access points shall be permanently identified on the exterior by a label with letters not less 1/2" (13mm) in height reading: COMBINATION FIRE/SMOKE DAMPER, SMOKE DAMPER or FIRE DAMPER. Access doors in ducts shall be tight-fitting and suitable for the required duct construction, Pottorff model FD.

6. Freedom from Interference- Dampers shall be installed in a manner to ensure positive closing or opening as required by function. Interior liners or insulation shall be held back from portions of a damper, its sleeve or an adjoining duct, which would interfere with the damper's proper operation. Exterior materials shall be installed so as to avoid interference with the operation or maintenance of external operating devices needed for proper function.
7. Temperature Classification of Operating Elements- Fusible links, thermal sensors, and pneumatic or electric operators shall have a temperature rating or classification as required by the C.B.C.
8. Fusible link fire dampers shall be provided in all ducts passing through fire separations in accordance with governing authorities. Fire dampers shall be "Style B" out of air stream. Provide a 12" x 12" access panel in ductwork 6" from fire damper for resetting the fusible link whenever the damper is inaccessible from grille or register. Dampers shall be as manufactured by Pottorff or Ruskin Manufacturing Company, and shall be California State Fire Marshal approved, designed, and constructed in accordance with NFPA 90A and UL Standard 555 and bear label on damper showing compliance. Dampers in smoke detector controlled systems shall be labeled "STATIC". Dampers in systems without smoke detectors shall be labeled "DYNAMIC".
9. Combination Fire and Smoke Dampers:
   a. Provide BELIMO AIR CONTROLS FSNF 120 actuator or approved equivalent. Actuator operating time shall be 15 seconds or less to drive open or spring closed from 32° F. to 350° F. and have UL 555S listing. Actuator shall draw no more than 27 VA running or 10 VA holding for 70 in.- # torque. Actuator shall carry a manufacturers 5-year warranty. Motor must reopen damper fully even if power failed for less than 2 seconds. Inexpensive stall motors will not be accepted.
   b. For Wall and Concrete Floor Installations:
      1) Combination fire and smoke dampers will be louver bladed type. Dampers must be tested and listed under both UL 555 and UL 555S. Units must be factory supplied assemblies that consist of damper, sleeve and 1 cycle/year actuator. Dampers must have a minimum class II leakage and dynamic closure rating under UL 555S. Provide units as power-open unless otherwise noted. Actuators to have a minimum operating temperature of 350° F. Seals shall be neoprene gasket. Dual temperature thermal switches (DRS-30) rated for 212° F and 350° F, unless in the City of Los Angeles, provide DRS-10 rated for 212° F. Install in accordance with manufacturer's installation instructions provided with units. Provide suitable access for inspection and servicing of each damper. Motor actuators must be by ISO 9001 recognized control manufacturer and certified by ETL laboratories for <u>1 year continuous power applications</u> such as Belimo, damper and motor shall have minimum 5 year warranty, thermal switches shall be equipped with auxiliary contacts for remote annunciation. Pottorff model FSD 142. (CSFM No. 3225-0368:110 & 3230-368:111) or approved equivalent. Mfg. to provide non-fusible toggle switch on the damper sleeve for power disconnect.
   c. For Corridor Ceiling Applications:
      1) Dampers shall be of similar construction to those above except in tunnel corridor construction (where the ceiling construction is similar to that of the wall) provide dampers that have been specifically tested and listed for horizontal mounting as "corridor dampers" under UL 555 and UL 555S. Damper shall be Pottorff

Model FSD 172, (CSFM No. 3225-0368:110 and 3230-0368:111) or approved equivalent. Dampers that are installed in corridor ceilings, where construction is ceiling-floor or ceiling-roof assemblies that require radiation protection will be radiation dampers that have been tested and listed under both UL 555 and UL 555S. The dampers will have a minimum Class II leakage rating. The dampers will be equipped with power open Belimo actuator that responds to a signal from a smoke detector and shall require manual reset if closed by fire. Dampers shall be Pottorff Model CFD20SD142 (CSFM No. 3225-0368:104 and 3230-0368:111) or approved equivalent. Mfg. to provide non-fusible toggle switch on the damper sleeve for power disconnect.

10. Automatic Dampers:
    a. Ruskin Model CD 30 VGI, Pottorff CD 42 opposed blade for rectangular ducts and Ruskin CDR25, Pottorff CD-25R or approved equivalent round control damper.
    b. Dampers shall be installed and coordinated with the Control Manufacturer to facilitate the addition of the damper motors and linkage. Mfg. to provide non-fusible toggle switch on the damper sleeve for power disconnect.
11. Volume Dampers:
    a. Volume dampers shall be provided and installed on all supply, return and exhaust ducts as indicated on the drawings and as required for proper balancing of the system. Dampers shall be fabricated of same material as duct system served.
    b. Single blade volume dampers shall be provided in all round ducts and in rectangular ducts not exceeding 8" in depth. Damper blades shall be constructed of not less than 20 gauge galvanized steel. Dampers shall be complete with galvanized steel frame, blades, control shaft, hand quadrant and bearings. Dampers shall be Ruskin Model #MD25, Pottorff CD-10 or approved equivalent for rectangular and Ruskin Model #MDRS 25, Pottorff CD-10R or approved equivalent for round.
    c. Volume dampers provided in rectangular ducts exceeding 8" in depth shall be factory made, opposed action multi-blade type, Ruskin Model MD-35, Pottorff CD-40, or approved equivalent. Provide Duro-Dyne or Ventlok, heavy duty locking quadrant, dial type damper regulator set or approved equivalent.
    d. Remote Cable Control Systems:
        1) Manual volume dampers, round or rectangular, with cable control or manual quadrant, Pottorff model RCS-213/215, or equivalent.
        2) General: All volume dampers above inaccessible ceilings shall be provided with remote cable controls as manufactured by Pottorff or Young Regulator Co. (no known third equivalent). Dampers mounted in diffuser inlets or requiring ceiling access panels for adjustment are not acceptable.
        3) Construction: The remote control cable assembly will be factory attached to the damper to eliminate any field assembly. The opening in the ceiling/wall for remote adjustment will not exceed one (1) inch in diameter and will be provided with finishing cover.
        4) Manual Quadrant: Manual quadrant shall be commercial quality, locking type for 3/8" square or ½" round shaft and shall be available on an extended base for externally insulated ductwork.
12. Back draft Dampers:
    a. General: Provide back draft dampers of types and sizes required. Construct casings of 0.090 thickness aluminum with mitered corners.

b. Blades, 0.025" formed aluminum with extruded vinyl edge seals. Bearings: Zytel. Linkage 1/8" x 1/8" aluminum tie bars concealed in frame.

c. Counterbalance: Zinc plated bar on blades (except top blade) adjustable for final setting. Mill finish.

d. Counterbalanced Relief Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to relieve at indicated static pressure. Construct blades of 16-ga aluminum, diameter steel axles spaced on 9" centers. Construct frame of 2" x 1/2" x 1/8" steel channel for face areas 25 sq. ft. and under; 4" x 1-1/2" x 16-ga channel for face areas over 25 sq. ft. Provide galvanized steel finish on frame with aluminum touch-up.

e. Where indicated on drawings, provide motor operated 2 position dampers.

2.06 REGISTERS, DIFFUSERS AND GRILLES (Anemostat or approved equivalent by Price or Krueger):

A. Provide diffusers, registers and grilles to sizes indicated on drawings. Sound levels shall not exceed NC25 for air quantities indicated. Outlet Manufacturer's representative shall be responsible for a complete review of all outlets as indicated on the drawings and shall provide outlets that have as minimum temperature and velocity transverses, throw and drop, and noise criteria ratings for each size device as listed in Manufacturer's current data that will meet the required conditions as indicated on the drawings. Diffusers shall be tested in accordance with ASHRAE STD. 70-1991.

B. Rectangular ceiling diffusers shall be Anemostat model SMD complete with seismic hanging tabs opposed blade volume damper and air flow equalizer with filler panel assembly for suspended T-bar ceiling or Surface mount for plaster ceilings. The diffusers shall have a baked white enamel finish.

C. Ceiling mounted return air and exhaust air registers shall be Anemostat model XGC, with opposed blade damper for registers. Provide type as required for either a suspended T-bar ceiling or plaster ceiling.

D. Supply air registers for sidewall and exposed duct application shall be two sets of individually adjustable louvers of extruded aluminum in a extruded aluminum frame Anemostat model X20H, double deflection horizontal throw 3/4 inch louver spacing adjustable supply registers with opposed blade volume damper and extractor.

E. Sidewall and exposed duct return air and exhaust air registers shall be Anemostat model X30HD, made of curved fins of extruded aluminum with fixed horizontal 3/4 inch center with opposed blade volume damper.

F. Rectangular ceiling diffusers and return registers located in suspended <u>integrated</u> ceiling systems shall be provided and installed by the Ceiling Contractor, including plenum and collar. Connection to collar shall be by the Mechanical Contractor.

G. Rectangular ceiling diffusers to be installed in other than <u>integrated</u> ceiling systems shall be Anemostat model SMD steel modular core diffuser. Diffuser core shall consist of fixed louver directional modules each module shall be removable. Diffuser shall be complete with seismic hanging tabs opposed blade volume damper in neck and air flow equalizer with filler panel assembly for suspended T-bar ceiling or surface mounted for plaster ceilings. The diffusers shall have a baked white enamel finish.

H. Ceiling mounted return air and exhaust air registers and grilles to be installed in other

than an integrated ceiling system shall be Anemostat model XGC with opposed blade damper for registers. Provide type as required for either a suspended T-bar ceiling or plaster ceiling.

I. Ceiling and wall transfer air grilles shall be Anemostat model S30HD.

J. Round Ceiling Diffusers shall be Anemostat model C27, complete with adjustable cones, extractor and volume control. The diffusers shall have a baked white enamel finish.

K. Secure all ceiling supply, return and exhaust air outlets to ceiling grid system and overhead framing per State Building Code Section 2501A.5.9.

L. The Contractor shall coordinate the ceiling diffusers or return register assembly design and installation requirements with the T-bar ceiling suspension system furnished.

2.07 PIPING MATERIALS

A. Heating Hot Water: Piping 2-1/2" and larger Schedule 40 seamless black steel pipe per ASTM A-53 standards, with welded joints using Schedule 40 seamless steel long radius fittings. Piping 2" and smaller Schedule 40 black steel pipe, ASTM A-53 standards with 150-lb., malleable iron screwed fittings. At the Contractor's option, copper Type "L" hard temper with wrought copper fittings may be used for piping up to 2-1/2" diameter in lieu of steel piping. Connections to equipment, apparatus and valves shall be made with (85%) red brass pipe, IPS screwed. Adapters shall be used where copper connects to brass pipe. Fittings for brass pipe shall be 125 lb. brass screwed. The Contractor at his option may use Victaulic or Gruvlock by Anvil zero deflection grooved piping couplings in lieu of welded or flanged joints and at valves in exposed areas. Victaulic couplings shall be selected for proper pressure and temperature range and shall be installed using manufacturer's recommendations as shown in their latest General Catalog and Piping Design Manual. Contractor shall submit for approval prior to any installation.

B. Refrigeration Piping: Type "K" hard temper copper tubing with wrought copper fittings, silver brazed, suitable for 400 psi working pressure.

C. Vents and Relief Valve Discharge: Schedule 40, galvanized steel, ASTM A-53, with 150 lb. galvanized malleable iron, screwed fittings.

D. Cold Water Make-Up: Type "L" hard temper copper tubing, hard temper with wrought copper, solder joint type fittings.

E. Indirect Drains Including Equipment Drains and Air Vent Drains: Type "L" hard temper copper, solder joint type fittings.

2.08 UNIONS AND FLANGES

Furnished and installed at each threaded or flanged connection to all equipment or valves. Locate unions or flanges so that the piping can be easily disconnected for removal of the equipment or valve, and be of the type specified in the following schedule:

A. Unions:
   1. Black Steel Pipe, 2" and Smaller: 250 lb. screwed black malleable iron, ground joint, brass to iron seat.
   2. Screwed Black or Galvanized Pipe, 2-1/2" and Larger: 150 lb. cast iron screwed flanged union, flat faced, full faced gasket.

3. Copper Pipe, 2-1/2" and Smaller: 150 lb. cast bronze or copper, ground joint, non-ferrous seat with ends. Walseal, NIBCO, Mueller or Flagg-Flow.

B. Flanges: Raised face 150 lb. class forged steel, weld, neck or slip-on type conforming to ASA B16.5 and ASTM A181. For copper piping systems, provide flanges conforming to ANSI B16.24, the faces of the flanges being connected to be alike in all cases. Locate flanges so that the piping can be easily disconnected for removal of the equipment or valve. Gasket material shall be of material suiting the service of the opening system in which installed and which conforms to its respective ANSI standard (A21.11, B16-20 or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.09 VALVES

A. General:

1. Piping systems shall be supplied with valves so arranged as to give complete and regulating control of piping systems throughout the building and located so all parts are easily accessible and maintained.
2. Valve Design: Rising stem or rising outside screw and yoke stems. Non-rising stem valves may be used where headroom prevents full extension of rising stems.
3. Pressure and Temperature Ratings: As scheduled and required to suit system pressures and temperatures.
4. Operators: Provide the following special operator features:
   a. Hand wheels, fastened to valve stem for valves other than quarter turn.
   b. Lever handles, on quarter turn valves 6" and smaller, except plug valves. Provide plug valves with square heads; provide wrench for each valve.
   c. Chain-wheel operators for valves 2-1/2" and larger, installed 72" or higher above finished floor elevation. Extend chains to an elevation of 5'-0" above finished floor elevation.
   d. Gear drive operators, on quarter-turn valves 8" and larger.
5. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
6. End Connections: 2" and smaller shall be threaded, 2-1/2" and larger shall be flanged.
   a. Threads: Comply with ANSI B1.20.1
   b. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.

B. Approved Manufacturers:

Hammond
Stockham
NIBCO
Nordstrom
Apollo
Milwaukee

1. Provide Class 150 or better valves meeting the valve specifications.

C. Gate Valves:

1. Gate Valves, 2" and Smaller: Hammond IB638, MSS SP-80, Class 150, body and union bonnet of ASTM B62 cast bronze; with threaded ends, solid wedge disc, B-62 stem material, brass packing gland, non-asbestos malleable iron handwheel.

2. Gate Valves, 2-1/2" and Larger: Hammond IR1140, MSS SP.70; Class 125, iron body, bolted bonnet, flanged ends, non-rising stem, solid wedge, bronze trim replaceable seat rings, malleable iron hand wheel.

D. Ball Valves:

1. Ball Valves, 2" and Smaller: Hammond 8501, rated for 150 psi saturated stem pressure, 600 psi WOG pressure; two or three-piece construction; with threaded ends, bronze body, single reduce bore or better, chrome-plated solid brass ball, "Teflon" seats and seals separate adjustable packing gland and nut, blowout-proof stem, and vinyl covered steel handle.

E. Plug Valves: (Walworth)

1. Plug Valves, 2-1/2" and Larger: Walworth 1797 MSS SP-67; rated at 200 psi WOG; lubricated plug type, with cast iron body, single gland, wrench operated, and flanged ends.

F. Globe Valves:

1. Globe Valves (Hammond IB 423), 2" and Smaller: MSS SP-80; Class 150; body and screwed bonnet of ASTM B62 cast bronze; with threaded ends, brass or replaceable composition disc, B-62 stem material, brass packing gland, non asbestos packing, and malleable iron handwheel.
2. Globe Valves, (Hammond IR 116), 2-1/2" and Larger: MSS SP-85; Class 150 iron body and bolted bonnet conforming to ASTM A126, Class B; with outside screw and yoke, bronze mounted, flanged ends, non asbestos packing, and two-piece backing gland assembly.

G. Butterfly Valves Hammond: (2" to 6" 6201-01, 8" to 24" 6201-03):

1. MSS SP-67; rated 200 psi; cast-iron body conforming to ASTM A1265, Class B. Provide lug valves with field replaceable phenolic backed EPDM sleeve, nickel-plated ductile iron disc (except aluminum bronze disc for ductile iron disc (except aluminum bronze disc for valves installed in condenser water piping and/or copper piping systems), stainless steel stem, and EPDM) - ring stem seals. Provide lever operators with locks for sizes 2" through 6" and gear operators with position indicator for sizes 8" through 24".

H. Check Valves:

1. Swing Check Valves, (Hammond IB 944), 2" and Smaller: MSS SP-80; Class 150, cast-bronze body and cap conforming to ASTM B62, with horizontal swing, Y-pattern, and bronze disc; and having threaded ends.
2. Swing Check Valves, (Hammond IR 322), 2-1/2" and Larger: MSS SP-71; Class 250, cast iron body and bolted cap conforming to ASTM A126, Class B; horizontal disc ring; and flanged ends.
3. Lift Check Valves (Hammond IB 940), 2" and Smaller: Class 125; cast-bronze body and cap conforming to ASTM B62; horizontal or angle pattern, lift-type valve, with stainless steel hinge pin, bronze disc holder with renewable "Teflon" disc, and threaded ends.
4. Non-Slam Check Valves: (Hammond IR 9354), 2-1/2" and Larger: Provide non-slam check valves mounted on the discharge of the pumps. Check valves to be silent closing, 150 lb. iron body, bronze mounted spring leaded center guide, Miller No. 162 or equal by Williams Hager, CPV or Smolensky.

I. Refrigeration Valves and Accessories: The following accessories may be factory furnished with equipment or field installed.

1. Strainers shall have 500 psig maximum working pressure; forged brass body with monel 80-mesh screen, and screwed cleanout plug; Y-pattern, with solder and connections, Mueller or Henry.
2. Sight glass indicators shall have forged brass body, with replaceable polished optical viewing window with cap, Sporlan or ALCO.
3. Filter driers with 3 valve by-pass shall be complete with replaceable filter-drier core kit, including gaskets. Standard capacity desiccant sieves to provide micronic filtration, Sporlan or Henry.
4. Flexible connectors shall have 500 psig maximum operating pressure; seamless tin bronze or stainless steel core, high tensile bronze braid covering, solder connections, and synthetic covering; dehydrated, pressure tested, minimum 7" in length.
5. Complete valve assembly and refrigerant piping specialty assembly shall be UL-listed and designed to conform to ARI 760.
6. Shut-off valve shall have cast bronze body with cast bronze or forged brass wing cap and bolted bonnet; replaceable resilient seat disc; plated steel stem. Valve shall be straight through or angle pattern, with solder-end connections.
7. Check Valves Smaller than 7/8": 450 psig maximum operating pressure, 300° F maximum operating temperature; cast bronze body, with cast bronze or forged brass bolted bonnet; floating piston with mechanically retained Teflon sat disc. Valve shall be straight through or angle pattern, with solder-end connections.
8. Check Valves - 7/8" and Larger: 450 psig maximum operating pressure, 300° F maximum operating temperature; cast bronze body, with cast bronze or forged bass bolted bonnet; floating piston with mechanically retained Teflon seat disc. Valve shall be straight through or angle pattern, with solder-end connections.
9. Solenoid Valves: Jackes-Evans or ASCO, 250° F temperature rating, 400 psig working pressure; forged brass, with Teflon valve seat, two-way straight through pattern, with solder end connections. Furnish complete with NEMA 1 solenoid enclosure with 1/2" conduit adapter, ASCO or Jackes-Evans.
10. Thermal Expansion Valves: Sporlan or ASCO, thermostatic adjustable, modulating type; size as required for specific evaporator requirements, and factory set for proper evaporator superheat requirements. Valves shall have copper fittings for solder end connections; complete with sensing bulb, a distributor having a side connection for hot gas bypass line when required, and an external equalizer line, Sporlan or ASCO.
11. Hot Gas By-Pass Regulator: Sporlan or ASCO.
12. Liquid & Hot Gas By-Pass Solenoid Valve: Jackes-Evans or ASCO adjustable type, sized to provide capacity reduction beyond the last step of compressor unloading; and wrought copper fittings for solder end connections.
13. Charging Valve: Henry or approved equal.

J. Miscellaneous Pipe Accessories:
1. Air Vents: Hoffman No. 78 or equal by Amtrol and Crane. The discharge of all vents shall be piped to a floor sink or drain. Install air vents at the high point of chilled and hot water piping. Provide Crane No. 12228 bronze fitted, iron body, square head type plug cock between air vent and piping.
2. Strainers: Strong, Sarco, Kecly with No. 20 mesh monel screen. Provide plug valves for strainer outlets.
3. Mercury-In-Glass Thermometers (Ashcroft or Weiss):
   a. Case: Die cast, aluminum finished, in baked epoxy enamel, glass front, spring secured, 9" long.
   b. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plans, 360-degree adjustment in horizontal plane, with locking device.
   c. Tube: Red reading, mercury filled, magnifying lens.

d. Scale: Satin-faced, non-reflective aluminum, with permanently etched markings.
e. Stem: Copper-plated steel aluminum or brass, for separable socket, length or suit installation.
f. Thermostat Wells: Brass or stainless steel, pressure rated to match piping system design pressure; with 2" extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

4. Pressure Gauges (Ashcroft or Weiss):
   a. Type: General use, ASME B40.1 Grade A, phosper bronze bourdon-tube type, bottom connection.
   b. Case: Drawn steel or brass, glass lens, 4-1/2" diameter.
   c. Connector: Brass, 1/4" NPS.
   d. Scale: White coated aluminum, with permanently etched markings.
   e. Accuracy: Plus or minus 1% or angle span.
   f. Range: (As required) with 1 psi graduation.
   g. Pressure Gauge Accessories (install as required):
      1) Syphon: 1/4" NPS straight coil constructed of brass tubing with threads on each end.
      2) Snubber: 1/4" NPS bras bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.
5. Cold water make-up assembly shall consist of a combination B&G Model F-3TU pressure reducing valve with a built-in check valve, strainer, fill valve and pressure relief valve. All valves shall be bronze construction with brass parts. Provide pressure gauge on equipment side of assembly.
6. Combo Valve: Shall be a Griswold combination shut-off valve including ball valve, union, strainer and "Pete's" plug. Install at all coils. Furnish one Pete's plug kit with thermometer and pressure gauge to Owner.
7. Flow Controllers: Pressure compensating, constant flow type by Griswold for flow capacities as indicated on drawings. Provide as part of installation, one (1) Pressure Monitoring Kit.
8. Flexible Pipe Connections: Provide suction and discharge of all water circulating pumps pipe size Hyspan series 5500 bellow pipe connector or Mason "Safe flex" SFDEJ Peroxide cured EPDM flexible connectors.
9. Provide dielectric unions, or flanges at all connections between dissimilar materials. Dielectric flanges to be used on 1" and larger piping. Fittings to be Vallett "F" line or Epco, Maloney or Capitol.
10. Access Doors: See Paragraph as specified hereinbefore.
11. Plates: Provide polished chrome plated cast brass set screw flanges where pipes pass through walls, floors, ceilings and partitions in exposed portions of the buildings.
12. Refrigerant valves and accessories shall be of commercial quality as manufactured by Henry or Sporlan.
    a. Refrigerant Valves for Soldered Connections: Standard pattern pack less globe valves with seal caps suitable for refrigerant used as manufactured by the Kero-test Manufacturing Company or approved equivalent.
    b. Filter-Driers: Sporlan Catch-All replaceable core type sized in accordance with the Manufacturer's recommendations and designed for use with the refrigerant specified, complete with 3-valve bypass.
    c. Sight Glasses: Sporlan/See-All lion size with sweat connections.
13. Pete's Plugs: Provide where indicated on the drawings a Peterson Equipment Co. Inc., "Pete's Plug" 1/4 MPT fitting to receive either a temperature or pressure probe 1/8 O.D. Fitting shall be solid brass with two valve cores of Neoprene or Nordel, fitted with a color-coded and marked cap with gasket and shall be rated at 1000

psig at 140 degrees. Supply to the Owner upon completion of testing, a Peterson Equipment Co. Inc. Series 1500 Test Kit. The kit shall consist of a 0-100 psi, 0-230 ft. of water pressure gauge with No. 500 gauge adapter attached, a 25° F to 125° F pocket testing thermometer, a 0° F to 220° F pocket testing thermometer, a No. 500 gauge adapter and a protective carrying case.

2.10 PIPE SUPPORTS - Unless otherwise indicated on the drawings shall be as follows:

A. The Contractor shall furnish and install all miscellaneous iron work including angles, channels, etc., required to appropriately support the various piping systems. The hanger spacing and location shall conform to California Mechanical and Plumbing Code requirements.

B. All horizontal runs of piping within the building to be supported from the structural framing with steel rods and split ring hangers, B-line, Grinnel Company, Tolco, or approved equal. Steel rods shall be secured to overhead framing with side beam connectors. Where necessary, install angle iron between framing to accommodate hanger rods. Where several pipes are running together, unistrut channels with clamps may be used in lieu of individual pipe hangers, and supported from structure as herein specified. Submit test data for type of hanger supports to be provided. For support conditions other than specified herein, the Contractor shall submit method of support for approval prior to any installation.

C. Contractor shall provide a frame constructed of angle iron or unistrut channel complete with pipe clamps to properly support the refrigerant piping, valves and accessories at the cooling coil. The supporting frame shall be secured to minimum 6" X 6" redwood blocking when on roof. Where required, piping along roof shall be secured to unistrut channel with pipe clamps on top of 6" X 6" redwood blocking. Individual pipe risers may be supported by pipe stancheons and saddle recurred to 6" X 6" redwood block. All redwood blocking to be set in mastic.

D. Horizontal Piping Hangers and Supports:
   1. General: Provide factory fabricated horizontal hangers and support, complying with one of the following MSS types listed to suit horizontal-piping systems, in accordance with MSS-SP-69 and Manufacturer's published product information. Select size of hangers and supports to exactly fit pipe size for bare piping and to exactly fit around piping insulation with shield for insulate piping. Provide copper-plated hangers and supports for copper-piping systems.
      a. Adjustable Steel Clevis Hangers: (MSS-SP-69, Type 1) B-Line B3100.
      b. Adjustable Swivel Pipe Rings: (MSS-SP-69, Type 5) B-Line B3690.
      c. Split Ring: MSS-SP-69, Type II.

E. Vertical-Piping Clamps:
   1. General: Provide factory fabricated vertical-piping clamps complying with the type listed to suit vertical piping systems, in accordance with MSS SP-69 and Manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.
   2. Two-Bolt Riser Clamps: (MSS-SP-69, Type 8) B-Line B3373.

F. Hanger-Rod Attachments:
   1. General: Provide factory fabricated hanger-rod attachments, Tolco, B-line, or approved equal, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-58 and Manufacturer's published product information. Select size of hanger rod attachment to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.

2. Side beam eye socket, Tolco Fig. 57 for rod sizes 3/8" dia. and Tolco Item No. 25-30-251 for rod sizes 1/2" dia.

G. Building Attachments:
1. General: Provide factory fabricated building attachments selected by Installer to suit building structural framing conditions, in accordance with MSS SP-069 and Manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper-piping systems.
2. For existing concrete construction provide expansion shields.

H. Hanger rods and spacing shall conform to the following table:

Pipe Sizes	Spacing	Rods
2" and Smaller	6'	3/8"
2½" to 3"	8'	1/2"
4" and Larger	8'	5/8"

I. Hangers and supports shall be adequate to maintain alignment and prevent sagging and shall be placed within 18" of joint. Support shall be provided at each horizontal branch connection.

J. Anchors: Anchors shall be installed to properly regulate direction of expansion of piping systems and shall be separate and independent from all hangers and supports. All anchors shall be of heavy angle iron construction and suitable in every way for the work, and shall be installed where necessary. Shop drawings showing anchor construction shall be submitted to the Architect for approval.

K. Stanchions: Horizontal pipe located along equipment floor, at grade, or roof shall be supported by pipe stanchions and saddle or secured to adjacent walls with unistrut.

L. Submit shop drawings. Provide lateral bracing as manufactured by B-line or approved equal for all piping to prevent swaying or movement in accordance with SMACNA "Guidelines for Seismic Restraints of Piping Systems". Piping smaller than indicated in the guidelines shall be provided with bracing as specified for the smallest size indicated. The entire water distribution system shall be properly braced and will not move due to the action of quick closing of valves.

M. Miscellaneous Supports, Wall Brackets Etc: Provide where required in accordance with the best standard practices of the trade. Submit shop drawings for all fabricated supports.

N. Isolators: All non-insulated piping shall be installed with a manufactured type isolator. Isolators shall be Super Strut, Stoneman "Trisolator", or approved equal. Piping shall be installed and supported in a manner to provide for expansion without strains. Guides shall be properly installed to ensure this requirement.

O. Shields:
1. General: Provide 18 gauge galvanized metal protective shields 6" long at piping hangers and supports, factory-fabricated, for all insulated piping. Size shields for exact fit to mate with pipe insulation.
2. Protection Shields: Pre-insulated pipe supports "Pipe Shields Inc.", MSS Type 40; provide high density insert of same thickness of insulation or equal 100-psi average compressive strength, waterproofed calcium silicate, encased with a sheet metal

shield. Insert and shield shall cover entire circumference of the pipe and shall be of length indicated by Manufacturer for pipe size and thickness of insulation.

2.11 INSULATION

Insulation of ducts, plenums and air handling boxes shall meet the requirements of California Title 24, Section 124, Requirements for Air Distribution System Ducts and Plenums, and UL-181.

A. Ductwork shall be insulated as hereinafter specified. Insulation shall be as manufactured by Johns Manville, Owens-Corning or CertainTeed.

B. Concealed Ductwork with Exterior Insulation: Indoor concealed supply and return ductwork shall be insulated with Johns Manville Microlite Type 150 or approved equivalent minimum 3" thick, 3/4-lb. per cubic foot density glass fiber flexible duct insulation with vapor barrier jacket FSK, aluminum foil faced reinforced with fiberglass scrim laminated to UL rated Kraft paper. Installed R-value per the 2005 CEC Energy Efficiency Standards for indoors. The insulation shall be firmly wrapped around the ducts with all joints lapped a minimum of 2". Securely fasten insulation in place with 16 gauge soft annealed black or galvanized wire spaced not more than 12" on centers for straight runs and 3" on centers for elbows and fittings. Insulation shall have a flame spread of not more than 25 and a smoke density not exceeding 50 per C.M.C. Sec. 605, and UL-181.

C. Exposed Ductwork with Exterior Insulation: All supply and return air ducts and plenums located within equipment rooms shall be insulated on the outside with Johns Manville Type 814 Spin-Glas or approved equal, 2" thick, 3 lb. density, rigid board fiberglass with foil faced vapor barrier. The insulation shall be applied in accordance with the Manufacturer's recommendations, utilizing proper adhesives and mechanical pin fasteners. The insulation shall be taped at all joints to provide a complete vapor proof installation. A field applied jacket shall be installed in accordance with manufacturer's recommendation. The insulation shall be covered with 8 oz. fiberglass cloth dipped with CP50 mastic or approved equal and after installation another coat of CP50 mastic shall be applied. Insulation shall have a flame spread of not more than 25 and a smoke density not exceeding 50 per C.M.C. Section 605, and UL-181.

D. Faced insulation intended for installation on the exterior of ducts shall be legibly printed with the name of the manufacturer, nominal thickness of insulation and the flame-spread and smoke developed ratings of the composite materials.

E. Ductwork with exterior insulation located outdoor shall be weatherproofed with Childers aluminum jacketing or equal. Jacketing is to be manufactured from 1100, 3105 or 5010 aluminum alloy with 3/16" corrugations. All jacketing shall have an integrally bonded moisture barrier over entire surface in contact with insulation. A minimum thickness of 0.020 is to be used.

F. Where indicated on drawings, all rectangular outdoor ductwork, all supply and return air plenums, and rectangular ductwork shall be lined with Johns Manville Permacote "Linacoustic R-300" rigid fiberglass plenum liner board or approved equivalent with pre-applied edge coated material, minimum 2" thick for outdoors and indoors, 3.0 lb. density. The insulation shall have a minimum noise reduction coefficient (NRC) of .80 for 1" and 1.05 for 2" determined on Type "A" mounting when tested as per ASTM C423-90. The insulation shall not exceed K = .23 at a mean temperature of 75° F. Per the 2005 CEC Energy Efficiency Standards, a thermal resistance (R-value) not less than 8.0 for outdoors (without exterior wrap insulation) and a total equivalent R-value not less than 8.0 for ductwork installed in unconditioned spaces indoors achieved through 1" thick interior liner (R= 4.3) and 1-1/2" thick, ¾-lb per cubic foot density exterior wrap (R=4.2) as specified

above (J/M Microlite Type 75 or equivalent). Maximum velocity on coated air side 6,000 ft./min. (8.0 M/sec). Adhesive: UL listed waterproof type. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened and installed in accordance with Manufacturer's recommendations. The lining shall have a flame spread of not more than 25 and a smoke developed rating of not more than 50 per C.M.C. 605. All joints and seams shall be coated with adhesive to ensure an approved erosion resistant coating in the air stream throughout the entire length of insulation.

G Internally Lined Rigid Sheet Metal Round Duct: Casco "Circliner II" or United McGill "ACOUSTIC-LINE" factory installed fiberglass insulation, 1" thick (minimum R4.3). All round lined ductwork shall additionally be provided with 1-1/2" thick, ¾-lb. Per cubic foot density exterior wrap (R=4.2) as specified above (J/M Microlite Type 75 or equivalent) for a total minimum installed R-value of 8.0 per 2005 CEC Energy Efficiency Standards requirements.

H. Provide sheet metal nose guards for lining at each fan discharge and downstream of fire dampers.

I. Pipe Insulation: Insulation and covering on pipe and tubing shall have flame spread rating not to exceed 25 and a smoke density not to exceed 50 when tested in accordance with CMC 1201.2.1.8 or 1201.3.1.3 and FHC 25/50 per ASTM E 84, UL 723, NFPA 255.

1. All heating hot water, supply and return lines and branches thereof to be insulated with Johns Manville Micro-Lok fiberglass pipe insulation, 1-1/2" thick for indoor and 2" thick for outdoors with factory furnished fiberglass jacket. Insulate fittings to a thickness equal to adjoining pipe insulation and finish with pre-molded one (1) piece PVC insulation fitting as manufactured by Zeston, Inc. or equal.
2. All indoor exposed insulated piping shall have a field applied jacket installed over the insulation in accordance with insulation manufacturer's recommendations. The insulation shall be covered with 8 oz fiberglass cloth dipped with CP50 mastic or approved equal and after installation another coat of CP50 mastic shall be applied.
3. Insulate refrigerant piping with Armstrong Armaflex Foam, 3/4" thick. Install per Manufacturer's recommendations for a vapor barrier proof installation. Where necessary at valves, fittings, etc.., provide anti-sweat tape, double wrap.
4. Aluminum Jacket: All outdoor insulated piping to be protected by covering with 0.020" thick Childers aluminum weather-proof jacket in strict accordance with Manufacturer's recommendations.
   a. All 90 and 45 degree insulated elbows having a nominal iron pipe size of 1/2" to 8" shall be protected with Childers aluminum Ell-Jacs insulation covers, or approved equal, manufactured from 110 aluminum alloy of same thickness as pipe covering. Insulated elbows having a nominal pipe size of 10" thru 18" shall be protected by Childers 4-piece aluminum Ell-Jacs.
   b. All Tees, Flanges, and Valve Insulation in Conjunction with Aluminum Jacketing: Use Childers Aluminum Special Fabrications Insulation Covers as manufactured by Childers Products Company.
5. Shields: Provide insulated shields for insulated piping at hanger or support locations. See "Pipe Supports" as specified hereinbefore.
6. Adhesives: Adhesives shall be acceptable to the State Fire Marshal. Submit name, type and method of application for review.

2.12 EQUIPMENT (Also See Schedules on Drawings):

A. The Manufacturer of the heating and air conditioning equipment as specified herein other than what is called for on the schedule shall certify that the equipment furnished can be installed within the areas designated on the drawings without exceeding the overall width, length, height and weight, and shall be fully responsible for any modifications necessary to

the structural framing, and associated openings through the roof. These shall be provided for by coordinating with the Contractor who shall obtain approval of the Architect prior to proceeding with any work. Any additional cost shall be the responsibility of the Contractor. The Contractor shall also be responsible for any additional costs that may be incurred by the Electrical Contractor should the equipment proposed exceed the electrical design capabilities.

B. The HVAC equipment manufacturer shall coordinate with the Energy Management Control Contractor to provide the required terminals, relays, etc., for each unit as necessary to permit for automatic control of the unit by the Energy Management System.

C. Packaged Roof Top Gas/Electric Units:

1. Single Zone Roof Mounted Air Conditioning Units: Units shall be of the manufacturer, model, size, capacities, SEER & EER as indicated on the drawings or approved equivalent. Units shall be rated in accordance with ARI Std. 210/240 and 270/370 ANSI/ASHRAE 15-Safety Code for Mechanical Refrigeration California Energy Commission Administrative Code Title 20/24 for minimum efficiency requirements (minimum 13.0 SEER) and designed in accordance with U.L. Std. 564. Units shall be combination electric cooling/gas heating type completely factory assembled, wired and tested. Units shall be complete with centrifugal supply fan, complete with motor and belt drive, motor starters, copper tube evaporator with aluminum fins, air cooled condensing section with copper tube and aluminum fin coil, complete refrigerant system with all piping and accessories, refrigerant charge, filter frames to accommodate replaceable media, 2" thick filters as specified hereinafter, all operating and safety controls, galvanized steel foil faced insulated weatherproof housing and factory supplied condenser coil hail guards. Provide factory wired 24 volt control circuit with control transformer. Units shall be provided with multi-stage heating and cooling capability as indicated on equipment schedule. The compressor or multiple compressors as indicated on equipment schedule with dual refrigerant circuits with each compressor resiliently mounted and equipped with positive crankshaft lubrication, crank case heater, drier, manual reset high pressure switches, automatic reset on low pressure switches, oil level sight glass, charging valve, sight glass, discharge and suction service valves, accessible gauge ports, discharge temperature limited, current and temperature sensing motor overloads, factory installed indoor evaporator defrost control to prevent compressor slugging by interrupting compressor operation, five minute compressor timed-off cycle and shall be unconditionally guaranteed for five (5) years. Heating section shall include an aluminized steel heat exchanger, aluminized steel burner, side outlet flue automatic gas controls, electronic spark ignitor for 100% safety, induced draft blower, fan and limit controls. Heat exchanger shall have a ten year warranty. Each unit where indicated on equipment schedule shall be provided with enthalpy controlled modulating, 100% fresh outdoor air economy cycle feature with power exhaust centrifugal fan and roof mounting frame. Supply and return ductwork from unit shall drop through the roof within the factory fabricated roof mounting frame. Provide a room thermostat that shall be capable of providing automatic cooling/heating switch over and shall be wired for continuous fan operation. Power exhaust fan assemblies field mounted shall be supported with angle iron steel. Coordinate supports with General Contractor and submit shop drawings for approval prior to installation.

2. Factory Start-Up: Contractor shall provide for the Equipment Manufacturer to supervise start-up, check, test and start the unit. Units that are equipped with modulating economizer section with centrifugal power exhaust accessory shall have the manufacturer or their representative provide supervision of start-up, check, test & commissioning of the device (including controls & programming of

the fan drives). A report by each Manufacturer shall be furnished to the Engineer for review.

3. Where indicated on equipment schedule provide a spring isolation roof mounting curb as manufactured by Can Fab with 2 inch static deflection spring isolators and earthquake restraints complete with base curb, isolator frame and perimeter flashing. Isolation curb shall be State of California OSHPD approved.

D. Split System (Heat Pump Under Two Tons):

1. General: Units shall be of the split system design of the type, model and capacities as shown on the drawings or approved equal as manufactured by EMI, Carrier, or Mitsubishi Electric Corporation. Ship unit factory assembled, with pre-charged Type "L" copper refrigerant piping and wired ready for installation. Test operate each unit at factory and rate in accordance with ARI Standard 210. Provide UL approved unit.
2. Outdoor Condensing Unit: The compressor shall be scroll type or hermetically sealed with built-in protection, suction, cooled and overload protected. Unit shall include coil with copper tubes and aluminum, or dipped and baked phenolic coated fins, efficient outdoor fan, suction line accumulator, reversing valve, expansion valve, crankcase, thermostat, high pressure switch, timed off control, refrigerant line connections, electrical connections, and all required refrigeration and oil system service valves. Compressor shall carry unconditional 5-year guarantee.
3. Indoor Fan Coil Unit: Enclose unit within a foil faced insulated steel cabinet complete with indoor blower, filters, drain pan, condensate lift pump, refrigerant coil with copper tubes and aluminum fins, expansion valve kit, and all required controls, including microprocessor remote control and thermostat with attached cable and mounting bracket.
4. Controls: Provide a remote room thermostat to actuate the unit automatically to maintain the desired room temperature. Run supply fan continuously when system lever is in the "AUTO" position and fan lever is in "ON" position. Thermostat shall be attached to wall within as vandal-proof enclosure, BEKO or equal.
5. Piping: As specified hereinbefore or field installed piping with field charge of refrigerant. All piping shall be sized and installed in strict accordance with Unit Manufacturer's instructions.
6. Valves: Provide as required for service of equipment.
7. Factory Start-Up: Provide for Equipment Manufacturer to supervise start-up, check, test and start the units. A report by the manufacturer shall be furnished to the engineer for review

E. Condensing Unit

1. General
   a. Outdoor-mounted, air cooled condensing unit suitable for rooftop installation as manufactured by Carrier or approved equal by Trane or McQuay. Unit shall have 2 independent refrigeration circuits and shall consist of multiple semi-hermetic reciprocating or scroll compressors, air-cooled coils, propeller-type condenser fans, and a control box. Unit shall discharge supply air upward as shown on contract drawings. Unit shall be used in refrigeration circuit matched with remote air handling unit direct-expansion coils. See schedule on drawing for size and capacity.
   b. Unit performance shall be rated in accordance with ARI Standard 365, latest edition.
   c. Unit construction shall comply with latest edition of ASHRAE and with NEC.
   d. Base unit shall be constructed in accordance with UL standards and shall carry the UL label of approval. Unit shall have CSA approval.
   e. Unit cabinet shall be capable of withstanding Federal Test Method Standard No. 141 (Method 6061) 500-hour salt-spray test.

f. Air-cooled condenser coils shall be leak tested at 150 psig and pressure tested at 450 psig.

g. Warranty shall be one-year parts and labor except five years for compressors.

2. Equipment:

a. Factory assembled, air-cooled condensing unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressors, holding charge (R-22), and special features required prior to field start-up.

b. Unit Cabinet:

1) Unit cabinet shall be constructed of galvanized steel, bonderized, and coated with a pre-painted, baked enamel finish.

2) Unit access panels shall be hinged for control box service access.

3) Lifting holes shall be provided to facilitate rigging.

c. Fans:

1) Condenser fans shall be direct-drive propeller type, discharging air vertically upward.

2) Condenser fan motors shall be 3-phase type with Class B insulation and permanently lubricated bearings. Motors shall be drip proof with sealed bearings.

3) Shafts shall be inherent corrosion resistant.

4) Fan blades shall be statically and dynamically balanced.

5) Condenser-fan openings shall be equipped with PVC-coated steel wire safety guards.

d. Compressors:

1) Compressors shall be serviceable, scroll, or reciprocating, semi-hermetic type.

2) Compressors shall be equipped with an automatically reversible oil pump, operating oil charge, suction and discharge shutoff valves, and an insert-type factory-sized crankcase heater to control oil dilution.

3) Compressors shall be mounted on spring vibration isolators with an isolation efficiency of no less that 95%.

4) Compressor speed shall not exceed 1750 rpm.

5) Lead compressors on each circuit shall unload using suction cutoff unloading.

e. Condenser Coils:

1) Condenser coils shall be air cooled and circulated for integral sub-cooler.

2) Coil shall meet ARI Std. 410 and shall be constructed of aluminum or dipped and baked phenolic coated fins mechanically bonded to internally grooved, seamless copper tubes which are then cleaned, dehydrated, and sealed. Copper sins shall be available as an option.

f. Refrigeration Components: Refrigeration circuit components shall include hot gas muffler, suction line accumulator, hot gas bypass tubes, high-side pressure relief device, liquid line shut-off valve, suction and discharge shutoff valves, and holding charge of refrigerant R-22.

g. Controls and Safeties:

1) Minimum control functions shall include:

a) Power and control terminal blocks.

b) Five-minute time guard protection to prevent compressor shot-cycling.

c) Lockout on auto-reset safety until reset from thermostat.

d) Capacity control on the lead compressor shall be by suction cutoff unloaders in response to compressor suction pressure.

e) Head pressure control for mild ambient temperature operation through fan cycling. Condenser fans (except fans 1 and 2) shall be cycled by discharge pressure to maintain proper head pressure.

2) Minimum safety devices shall include:

a) Automatic reset (after resetting first at thermostat)

(1) High discharge temperature cutoff

(2) Low suction pressure cutoff

(3) Condenser-fan motors protected against overloads or single-phase condition by internal overloads.

(4) Low oil pressure cutout.

b) Manual reset at the unit

(1) Electrical overload protection through the use of definite-purpose contactors and calibrated, ambient compensated, magnetic trip circuit breakers. Circuit breakers shall open all 3 phases in the event of an overload in any one of the phase or a single-phase condition.

(2) High discharge-pressure cutout.

h. Operating Characteristics: (See schedule on drawing)

i. Sound-Reduction Kit: Kit shall contain specially designed fan propellers and stacks to lower sound emitted from the unit and shall be compatible with the Motormaster III control.

3. Factory Start-Up: Provide for Equipment Manufacturer to supervise start-up, check, test and start the units. A report by the manufacturer shall be furnished to the engineer for review

I. VAV Units:

1. General: The roof top VAV package units shall be designed specifically for outside roof top application. They shall include weatherproof cabinet, air handling system, air-cooled refrigeration system, filter system and all operating controls and safety controls, all as furnished by the Unit Manufacturer. The unit shall be capable of providing natural cooling with 100% outside air by use of a power return air fan system. Unit shall be as manufactured by Carrier or Governair.

2. At the Contractor's option, a split system may be provided in lieu of the package unit as described herein. The split system shall not exceed the total unit weights as indicated on the schedules or the platform areas sizes as indicated on the drawings. The units required to be shipped in multiple pieces shall be designed to permit interconnecting of the units in the field after units have been installed in place. Interconnecting of units including refrigerant piping and electrical wiring and conduit shall be in accordance with Manufacturer's instruction. Refrigerant and oil shall be field charged as specified herein and as required. The split system shall be capable of providing the temperature control as described hereinafter as provided within the single package units. The split system shall be as manufactured by Carrier or Governair.

3. All wiring shall be in accordance with ARI STD. 360 and design in accordance with UL STD 1995 and tested and certified by ETL in accordance with ANSI Z21.47 STD. national Electrical Code and all other governing authorities. All units shall be furnished with non-fused disconnect switch; short fuse protection of all internal electrical components and all necessary motor starters, contactors, and over-current protection. A 120 volt convenience outlet shall be installed in each cabinet.

Each unit shall bear an ETL or UL label or shall be field inspected and approved by the Los Angeles County Electrical Laboratory.

4. The Unit Manufacturer shall furnish the services of an authorized factory service representative to test check and start up each unit. The check, test and start of each unit shall be in accordance with Manufacturer's printed instructions, and a copy of the complete check, test and start report for each unit shall be provided to the Engineer.
5. The unit cabinet shall be constructed of heavy gauge, pre-painted galvanized steel or aluminum having mill applied pastel beige finish.
6. The top panels shall interlock with each other to provide a standing waterproof seam. The top panels shall also be pitched to both sides for drainage and they shall be reinforced from within with a structural ridge beam.
7. The base of the cabinet shall be designed to mate and seal with a roof mounting curb. A resilient sealant gasket shall be factory installed in base recess so as to provide a positive seal when the unit is installed on the curb.
8. All interior surfaces of the cabinet shall be insulated with foil faced 1" thickness, 1-1/2 lb. density glass fiber insulation as approved by the National Board of Fire Underwriters.
9. All exterior panels shall be removable. Man sized access doors shall be provided with hinges and Ventlok No.333 latches for filter, drain pan, compressor and fan sections.
10. All dampers shall be tight closing and be gasketed at all four edges to assure tight close off. Return air, outside air and exhaust air dampers shall be of reinforced blade construction with all four edges gasketed to assure tight close-off. Dampers shall be the equivalent of Ruskin CD-35 with a certified leakage rate of 6 CFM per square foot at 4" W. C. differential pressure.
11. Supply fan shall be double width double inlet or air foil plug type statically and dynamically balanced. Fan ratings shall be in accordance with ARI Standard 430-78. The fan shaft shall be solid steel coated to prevent excessive oxidation. Maximum operating rpm shall be 20% below first critical speed. Bearing shall be self-aligning, grease lubricated ball type, selected for 200,000 hour average life. Drives shall be cast iron heavy-duty type. V-belts shall be static free and sized for 150% of BHP. Belt guards shall meet OSHA Standards. Motor bases shall be adjustable. Motors shall be Reliance "XE", Marathon XRI or Siemens-Allers PE-21 High Efficiency. A return fan section shall be used to provide building static pressure balance. Blower assemblies shall be mounted on spring isolation with seismic restraint. Centrifugal fans shall be belt-driven and designed for low tip speed. Fan motors shall be NEMA design ball bearing type with electrical characteristics and horsepower as specified.
12. Condenser fan shall be direct propeller type, corrosion resistant, static and dynamic balanced.
13. All fan motors shall be high efficiency type, Gould E-plus, Reliance XE or approved equal and mounted on a heavy steel motor base. Compressor motors shall be cooled by suction gas passing over motor windings and shall have line break thermal and current overload protection. Condenser fan motors shall be totally enclosed with permanently lubricated ball bearings and internal automatic reset thermal overload protection. Indoor blower motor shall be ball bearing type.
14. Supply & Return Air Fan Drives: Unit shall be equipped with Variable Frequency Drive (VFD) Inverter one each for both supply and return air fan drives. The VFD shall be provided with a metal enclosure and shall be factory mounted, wired and tested. The VFD shall control motor speeds to maintain set point static pressure at the sensor tube locations of the pressure transducer (transducer is factory provided and installed; sensor tube must be field routed). The VFD may be field adjusted to maintain supply duct static pressure at points from 0-in. wg. to 3.5 in. wg. The variable speed drive shall include the following features:

a. Full digital control.
b. Insulated GATE BI-POLAR Transistors (IGBT) used to produce the output pulse width modulated (PWM) waveform, allowing for quiet motor operation.
c. Inverters capable of operation at a frequency of 8KHZ, so no acoustic noise shall be produced by the motor.
d. NEMA I metal enclosure for reduction of RFI (radio frequency interference).
e. Self diagnostics.
f. Personal lockout code for additional security.
g. Critical frequency avoidance.
h. PID set point control.
i. RS23 2C/RS485 capability (accessory card source required).
j. Electronic thermal overload protection.

15. Refrigeration System:
a. Unit shall incorporate an integral direct expansion refrigeration system which shall be factory charged with full operating charge and tested. Compressors shall be fully warranted for five (5) years by the Manufacturer.
b. The refrigeration system shall include multiple accessible, hermetic compressors, which shall be isolated from the base unit and refrigerant piping. Capacity reductions shall be accomplished by electric cylinder unloading, and hot gas bypass and shall be controlled by a cold plenum control.
c. The refrigeration controls shall provide for control of head pressures to prevent short cycling of the compressor during light load conditions.
d. The compressors shall be equipped with a positive pressure; forced lubrication system; crankcase heater; and high and low pressure cutouts, control and gauge panel.
e. Each refrigeration piping system shall include thermal expansion valve, full flow replaceable filter-dryer, sight glass, moisture indicator, suction line accumulator, liquid line solenoid.
f. Coils shall meet ARI Std. 410 and shall be constructed of 1/2" O.D. seamless copper tubing, with rippled-leading edge die-formed "V" waffle pattern aluminum fins. Fin tube holes shall be formed with extruded collars and shall be in full contact with and completely enclose the tubing between fins. Tubes shall be arranged in a staggered pattern in the airflow. Tubes shall be mechanically expanded into the fin throughout the length of each tube. Headers shall be of heavy wall, seamless copper construction. Casting shall be of not less than 16 gauge steel mill-galvanized to ASTM A-525 Code G-90 or better, for maximum structure life. All coils shall be vapor degreased to assure cleanliness and after final assembly, shall be leak tested under water with 350 psi dry air and promptly sealed. Lower test pressures will not be acceptable. Coils shall be split by rows to meet variable load conditions.
g. Drain Pan: Drain pan shall be zinc-coated steel construction. Drain pan shall have threaded drain line connections on each side of the unit.
h. Condenser coil shall be seamless copper tubing mechanically bonded to heavy duty aluminum fins as described hereinabove. Aluminum tubes will not be approved.
i. With multiple compressors each refrigerant circuit shall be equipped with a back seating liquid line service access valve.
j. Refrigeration system shall be capable of starting and operating down to 50° F ambient.

k. Condenser fans shall be staged unloading. Condenser fans shall be furnished with backdraft dampers to prevent backflow for fans not in operation.

16. The units shall be equipped with filter section. The filter section shall be furnished with filters as called for in the equipment schedule. Provide one extra set of filters.

17. Controls:

a. All controls necessary for the operation of the AC unit (with the exception of the static pressure controls, VAV box controls and the room thermostats) shall be furnished, installed and wired by the Unit Manufacturer. The room thermostats shall be furnished under temperature controls.

b. The control system shall be sensitive to space demand. The cold deck supply air temperature shall be a function of the cooling demand and mechanical cooling will only be activated when the warmest zone cannot be satisfied with natural cooling.

c. Mechanical cooling shall be locked out whenever the outside ambient is below 55° F. During full mechanical refrigeration, exhaust air dampers shall be positioned for minimum outside air.

d. Economizer controls shall provide for the introduction of outside air as required for minimum ventilation and natural cooling cycle. When system shuts down, outside air dampers shall be fully closed. An enthalpy control shall override the economy cycle to maintain required humidity.

e. Condensing unit and cold deck controls and outside return air mixture controls shall all be provided by the Unit Manufacturer.

f. The controls shall cause the exhaust damper to remain closed and the exhaust fan to remain off unit the outside air dampers being to open past minimum position. At this point, the exhaust air damper shall begin to modulate open under control of mixed air temperature controller and the exhaust fan shall start.

g. The controls shall include a warm-up cycle, which shall cause the outside air, and exhaust damper to remain closed until at least one zone has come up to temperature. Upon completion of warm-up cycle outside air damper, return air damper, and exhaust air damper shall be modulated under control of mixed air temperature controller to maintain 54° F cold deck temperature.

18. The controls shall include the following safeties:

a. Compressor over temperature and over current.

b. High and low pressure switches.

c. Loss of charge.

d. Time delay relays on compressors.

e. Freeze protection.

19. The unit shall have full diagnostic with LED display.

20. The unit shall have the same communication bus with the VAV box controllers.

21. Unit shall operate at temperature of 125° F without unloading. Operating lower than 125° F is not acceptable.

22. Factory Start-Up: Provide for Equipment Manufacturer to supervise start-up, check, test and start the units. A report by the manufacturer shall be furnished to the engineer for review

J. Variable Air Volume (Terminal Units):

1. Provide Pottorff, or approved equal by Kruger, Tuttle and Bailey or Titus, single duct variable volume terminals as herein specified with capacities as scheduled on drawings. Terminals to be constructed of 24 gauge zinc-coated steel casings, lined with 1" density foil faced fiberglass insulation, meeting NFPA 90-A requirements for flame and smoke. Casing and damper leakage shall not exceed 2% of maximum terminal capacity at 6" wg. Dampers shall be 16 gauge zinc-coated steel with

twenty (20) gauge zinc-coated steel seat. Damper shafts shall be sealed with felt gaskets each side of damper blade. All metal hardware components shall be rust resistant, and terminals shall be complete with inlet and outlet collars.

2. Controls: Provide actuator(s) and controllers(s) for system pressure independent operation sequence as shown on drawings.
3. Box shall be factory set for the air volume range specified. Air flow at maximum, minimum or any intermediate setting shall be maintained without any changes of pressure upstream or downstream of the box.
4. Boxes to accommodate terminal hot water heating coils shall be constructed of heavy gauge galvanized steel sheet metal. Unit shall have a matching collar to accommodate air box. Box shall be lined with 1/2" thick, 3/4 lb. coated fiberglass. Heating coil shall be a minimum of two (2) rows, with 1-1/2" O.D. copper tubes 1-1/2" on center, and aluminum fins. See schedule on drawings for coil rows, fins per inch, and minimum face area.
5. Factory Start-Up: Provide for Equipment Manufacturer to supervise start-up, check, test and start the units. A report by the manufacturer shall be furnished to the engineer for review

K. Hot Water Boiler:

1. Contractor shall supply and install Raypack Raytherm (or engineer approved alternate) hot water boiler. The boiler will be of low emission type and will be pre-certified by SCAQMD in compliance with Rule 1146.2 Contractor will submit to owner evidence of the precertification compliance of the boiler at time of submittal.
2. Boiler Design:
   a. The boiler shall be design certified and tested with a minimum thermal efficiency of 82%, and shall bear the ASME stamp and be inspected and approved by the National Board for 160 PSIG working pressure complete with Manufacturer's Data Report.
   b. The boiler shall be equipped with a pressure relief valve, piped by the installer to an approved drain, and a temperature and pressure gauge.
   c. The water tube heat exchanger of the boiler shall be of the single bank, horizontal grid design with integral copper fin tubes, each end of which is rolled into an ASME boiler quality steel tube sheet and sealed to 160 PSIG rated headers with Silicone "O" rings, having a temperature rating over 500°F. The low water volume heat exchanger shall be explosion proof on the water side and shall bear a 20 year Warranty against "Thermal Shock" caused by boiler operation with large changes, not exceeding 150° F. between the water temperature at the boiler inlet and the boiler outlet temperature up to 230°.F. maximum. The headers shall be secured to the tube sheet by stud bolts with flange nuts to permit inspection and maintenance without removing external piping connections. The heat exchanger shall incorporate "V" Baffles, between the tubes, to insure complete contact of the external tube surfaces with the products of combustion.
   d. The boiler(s) shall be capable of operating down to 105°F without condensation.
   e. The lightweight, high temperature, interlocking castable combustion chamber liner shall reduce standby radiation losses. The corrosion resistant galvanized steel jackets shall be finished with a baked on powder finish, suitable for outdoor installation, and shall incorporate louvers, in the outer panels, to divert air used for combustion, past heated surfaces reducing jacket losses and increasing unit efficiency.
   f. The stainless steel alloy burners shall be of the raised port design with fixed primary air ports, capable of quiet ignition and extinction without

flashback at the orifice at firing rates between 20% and 100%, and mounted in a slide out burner drawer for ease of inspection.

g. The boiler(s) shall have a floor loading of 70 lbs/square foot or less.

h. The boiler(s) shall be completely assembled and fire tested prior to shipment from the factory.

3. Pilot Control System

a. The boiler shall be equipped with a 100% safety shutdown on loss of pilot flame. The pilot ignition shall be an electronic intermittent ignition system with electronic flame supervision having a nominal 0.8 second flame response time.

4. Firing Mode

a. The boiler shall be equipped to:

1) Provide full modulation of the gas input to any load condition as low as 20% of the full rating of the boiler (5:1 ratio) without flashback, burning at orifices or improper combustion. Or

2) Provide two stage control of the gas input to the boiler. Or

3) Provide on/off control of the gas input to the boiler. In addition, all gas control trains must have a redundant safety shut off feature, main gas regulation, shut off cock and plugged pressure tapping to meet the requirements of ANSI Z21.13.

5. Boiler Control

a. The boiler shall be equipped with an operating temperature control and high limit control.

b. A flow switch, mounted and wired shall be provided as standard.

c. An energy saving pump control relay (Economaster II), mounted and wired shall be provided for system efficiency.

d. Additional controls.

L. Flue: Flues shall be U.L. listed and AGA approved. Provide Metal-Fab Inc. Model PIC or Selkirk Metalbestos Model PS with CISPI No. 304 stainless steel, double wall flue for heating equipment of sizes indicated on drawings. Flue and associated breeching and flue cap shall be factory built, laboratory tested and listed by Underwriters Laboratories Inc. The double wall flue shall have an inner gas carrying pipe and outer jacket constructed of type 304 stainless steel. Provide all required supports, flue supports at roof penetration, flashing, storm collar, ventilated thimble, and flue cap. Complete installation shall be in accordance with manufacturer's recommendations.

M. Expansion Tank:

1. General: Expansion tank shall be pressured diaphragm type of the model size and capacity as scheduled and shall be as manufactured by B & G, AMTROL or approved equal.

2. Construction: The expansion tank shall be electrically welded from steel in accordance with ASME requirements and shall bear the label of ASME for 150 lb. operation.

3. The tank shall be fitted with air and water connections and air charging valve.

N. Chemical Treatment

1. Provide a pot feeder in bypass piping around hot water pump to control corrosion in hot water system. Feeder shall be J.L. Wingert Co. or approved equal, for 125 psi working pressure. Use a # 2 up to 200 gallon capacity, a # 5 for 750 gallon capacity and greater. Installation shall be complete with all piping, valves, and fittings.

2. Prior to operation, hot water shall be cleaned to remove oil, grease, and rust oxides using following procedures:

a. Flood system with a solution containing cleaning compound.

b. Circulate system 150 – 180 °F. for a period of not less than 12 hours and not in excess of 24 hours. If heat cannot be provided, dosage should be double and circulated for 2 days.

c. Cleaning solutions shall be drained and flushed with clean water until stable PH is obtained. Refill with treated water to stabilize water in system.

O. Exhaust Fans:

1 Power Roof Exhausters: Curb mounted fans shall be Cook, Carnes, Greenheck or Breidert, of the sizes and capacities indicated on the drawings, complete with backward curve non-overloading blower wheel, motor, belt drive, disconnect switch, birdscreen, back draft dampers, extruded aluminum weather-proof housing, UL label and shall be tested and rated in accordance with the applicable AMCA codes and shall bear the AMCA label.

2. Ceiling Mounted Exhaust Fans: Cook, Greenheck, Carnes or Breidert of the sizes and capacities indicated on the drawings, complete with direct drive blower, motor, grille, housing, back draft damper, mounting frame, roof jack or wall cap discharge, UL label and shall be tested and rated in accordance with the applicable AMCA Codes.

P. Fly fans shall be Mars, Berner or approved equal with capacities indicated on drawings, complete with direct drive fans, adjustable discharge nozzles, washable air filter screen. Totally enclosed motor, micro switch and/or three speed fan switch and cabinet for one piece molded, high density polycarbonate.

Q. Air Filters (See Drawings for Size and Number Required):

1. Replaceable (Throwaway) Panel Filters: Provide factory fabricated, viscous-coated, Farr 30/30, or equivalent, pleated panel type replaceable air filters with holding frames with 2" thick UL Class 2 throwaway cotton and synthetic non-fiberglass media material. Where required or as indicated on drawing, construct holding frames of 20 ga. galvanized steel, capable of holding media and media frame in place and gasketed to prevent unfiltered air bypassing between media frames and holding members.

2. Air filters shall be a State Fire Marshal approved and listed type. Preformed filters having combustible framing shall be tested as a complete assembly. Air filters in all occupancies shall be Class 2 or better, (as shown in the State Fire Marshal listing).

3. Installation: Pleated Filters shall be factory or field installed at each air handling unit. Refer to item # 5 her-in-after.

4. Air Filter Gauge: Provide a Dwyer Series 2000 magnehelic or a Dwyer Series 450AF inclined manometer type gauge with range as required for the service. Install at each central station air handling unit and where indicated on drawings.

5. Provide two (2) sets of filters for each air handling unit. Utilize one (1) set for start-up, test and balance and provide Owner with second set.

R. Miscellaneous Equipment:

1. V-belt drives for fans shall be Gates, Browning or approved equal, with grooved, cast iron sheaves, adjustable pitch. Drive shall be rated at the H.P. of the motor, plus fifty per (50%). Not less than two (2) belts on all motors one (1) H.P. and larger.

S. Variable Frequency Drives (VFD's)

1. General: The manufacturer of variable frequency drives shall provide, coordinate and start-up a variable speed drive system to ensure proper application of equipment to the driven load. The variable frequency drive shall be manufactured by Reliance Electric Company, Square D or Allen-Bradley and shall be FCC labeled.

a. VFD shall have a factory warranty for a period of at least 2 years from date of start-up.

b. VFD shall be current rated at 8 kHz carrier frequency for VFD's 1-60 HP and 4 kHz for VFD's 75-400 HP. All HP ratings shall meet or exceed Table 430-150 of the National Electric Code. Three phase motor full load currents, HP, maximum current, and rated voltage shall appear on the drive nameplate. No derating of the VFD shall be required due to increasing the switching frequency for motor noise reduction. All drives designed at greater than 8 kHz carrier frequency (regardless of kHz rating level of VFD) shall include an output voltage rise time reduction device as part of the VFD.

c. Variable frequency drives (VFD) shall be compatible with the motors served.

d. VFD and options shall be UL 508 listed.

2. Quality Assurance: Each drive shall be subjected to the following test and quality control procedures.

a. Every VFD shall be functionally tested under motor load. During this load test the VFD shall be monitored for correct phase current, phase voltages, and motor speed. Correct current limit operation shall be verified by simulating a motor overload.

b. Verification of proper factory presets by scrolling through all parameters shall be performed to ensure proper microprocessor settings. The computer port should also verify that the proper factory settings are loaded correctly in the drive.

c. All options shall be functionally tested including operation of a motor in the bypass mode. Proper heater coil installation in motor overload, if supplied, shall be verified.

3. Service: The VFD manufacturer shall maintain and staff world-wide service centers. The manufacturers shall have the ability to test the drives in these service centers.

a. Start-up shall be included for each VFD provided.

b. Service engineers shall be employed by the manufacturer or be certified by the manufacturer and provide start-up service including physical inspection of drive and connected wiring and final adjustments to meet specified performance requirements.

4. Drive Functions: The VFD shall have the following basic features.

a. An electronic overload circuit designed to protect an A-C motor operated by the VFD output from extended overload operation on an inverse time basis. This electronic overload shall be UL™ and NEC recognized as adequate motor protection. No additional hardware such as motor overload relays or motor thermostats shall be required.

b. An LED display mounted on the door of the cabinet that digitally indicates:

1) Frequency output
2) Voltage output
3) Current output
4) Motor RPM
5) Input kW
6) Elapsed time
7) Time stamped fault indication
8) DC Bus volts

c. The VFD shall have the capability of riding through power dips up to 10 seconds without a controller trip depending on load and operating condition. In this extended ride through, the drive shall use the energy generated by the rotating fan as a power source for all electronic circuits.

d. RS232 Port and Windows based software for configuration, control and monitoring.

e. An isolated 0-20mA, 4-20mA or 0-4, 0-8, 0-10 volt analog speed input follower.

f. An isolated 0-10 volt or 4-20mA output signal proportional to speed or load.

5. Protective Circuits And Features: The VFD shall include the following protective circuits and features:

a. Motor current exceeds 200% of drive continuous current rating.

b. Output phase-to-phase short circuit condition.

c. Total ground fault under any operating condition.

d. High input line voltage.

e. Low input line voltage.

f. Loss of input or output phase.

g. External fault (this protective circuit shall permit wiring of remote N.C. safety contact to shutdown the drive). User supplied end switches, thermal switches, fire stats, freeze stats inputs will be connected to this VFD supplied circuit.

h. Metal oxide varistors for surge suppression shall be provided at the VFD input terminals.

6. General Options And Modifications: The following options shall be included as specified in the document:

a. Complete contactor bypass shall be provided to allow motor to be safely transferred from VFD output to the A-C line, or from the A-C line to the VFD, while the motor is at zero speed. The contactor bypass shall utilize two motor contactors electrically interlocked. One contactor is to open and close the connection between the VFD output and the motor. The other contactor will open and close the connection between the bypass power line and the motor, providing "across the line" starting. Motor protection is to be provided in the "bypass" mode by a bi-metallic Class 20 Smart Motor Protection adjustable overload relay. Relay control logic shall also be included within the VFD enclosure to allow the same "Start/Stop" command to operate the motor in either mode. The relay logic shall be 115 volts. The bypass circuit shall include a second disconnect installed in the VFD to provide the ability to safely troubleshoot and test the controller, both energized and de-energized, while the motor is running in the "bypass" mode. A contact closure shall be provided to indicate that the drive is in the "bypass" mode. A remove/local selector switch shall also be provided to transfer control from the keypad to user wired signals. Form "C" normally open and normally closed contacts shall be provided for both run and IET/drive stopped. The entire bypass option shall be packaged with the controller enclosure and be mechanically isolated from the VFD.

b. Input line fuses shall provide protection for the input rectification circuit using Class J fuses with interrupting rating of 200,000 AIC. The series interrupting rating of the VFD and fuses shall be a minimum of 30,000 AIC and shall be stated in the VFD instruction manual as required by UL.

c. A main input disconnect shall mount within the standard NEMA 1 enclosure for positive power disconnect of the VFD. It shall have the capability for door padlocking.

T. Indoor Air Quality Sensor: Controls shall have the ability to provide demand ventilation and exhaust capability to maintain indoor air quality (IAQ) through the economizer with an indoor air quality sensor. The sensor shall measure the amount of carbon monoxide CO^2 present and control the amount of outside air entering the conditioned space and the amount of air to be exhausted. The IAQ sequence shall provide high and low temperature lockout, space temperature reset, adjustable delay for alarm notification, IAQ alarm notification and

adjustable economizer delay. The IAQ sensor shall be available in duct mount, wall mount and wall mount with LED display of CO^2 in parts per million The set point shall have adjustment capability.

U. Automatic control systems

1. General requirements

a. Furnishing & installing automatic controls for the air conditioning heating & ventilating systems as indicated and as specified here-in. Work shall include but not be limited to the following:

1) Provide and install complete automatic systems for the proper operation and control of the heating, ventilating and air conditioning system. The work shall be complete with all remote interlocks and controls, all remote wiring between system control circuits, and, as required for a complete and properly operating control system.

2) The contractor shall be responsible for the proper coordination of all control work and electrical work in connection herewith. The contractor shall be responsible for the proper operation of the entire system.

b. Installation and Commissioning: All work described in this section shall be installed under the supervision of factory trained engineers and mechanics qualified for this work and in the regular employ of the system contractor. Engineering, programming, testing, calibration and checkout shall be performed by qualified employees of the contractor.

c. Codes and Approvals: (1) All components of the system shall be approved and listed by UL listed and labeled and submitted in submittals, (2) equipment shall conform to the requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled, (3) manufactured to ISO 9001 quality standard (4) and California Title 24 Standard.

d. Controls

1) Equipment Unitary Controllers (EUC): AC units, Fan Coil/Condensing units (split systems).

a) Controls shall be microprocessor based and furnished as integral part of equipment manufacturer.

b) Controls shall be operated by internal sequence of operations and with space mounted thermostat or sensors.

2) Thermostats: Thermostats shall be seven days programmable and manufacturer and model number as indicated on drawings.

3) Relays:

a) Control relays shall be UL listed plug-in type with dust cover. Contact rating, and coil voltage suitable for application.

b) Time delay relays shall be UL listed solid state plug-in type with adjustable time delay. Delay shall be adjustable and suitable for application. Contact rating, configuration, and coil voltage suitable for application.

4) Transformers:

a) Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 Service.

5) Wire and Conduit: Electrical wiring, wiring connection and conduits required for the installation of the building control

systems shall be provided by the control contractor unless shown on the drawings called for in the specifications to be under Electrical Division. All wiring and conduits shall comply with the requirements of Division 16000 and the local and national electrical codes. Communications and sensor cable may be installed without conduit in the ceiling spaces where permitted by code. No conductors smaller than No. 14 AWG shall be used on low voltage wiring below 30 volts. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.

6) Local Control Panels:
   a) All indoor control cabinets shall be fully enclosed NEMA 1 type construction with hinged door, key lock latch, a single key shall common to all field panels.
   b) Provide on/off power with over-current protection for control power sources to each panel.

e. Sequence Of Operations
   1) Package AC Units:
      a) Temperature Control: The Gas fired package air conditioning or cooling only units are controlled by a EUC located at the units. The controller receives a signal proportional to the room temperature from a wall sensor or thermostat and controls the AC unit to maintain space temperature.
      b) Schedule Control: The units are scheduled for operation only during occupied periods. A unit can be overridden at the wall or sensor for adjustable period.
   2) Split System Air Conditioning Unit:
      a) Temperature Control: The split system air conditioning units are controlled by a EUC controller located in the indoor unit. The controller receives a signal proportional to the space temperature from a wall mounted sensor or thermostat and controls the unit accordingly.
      b) Schedule Control: The air conditioning systems serves electrical rooms, computer, data processing rooms, and communication rooms shall operate continuously seven days a week to maintain room temperatures between 65 and 85 ° F (adjustable).
   3) Exhaust Fans
      a) Units serving main toilet rooms are scheduled to operation only during occupied mode. See drawings where indicated on drawings.
      b) Units serving staff and custodial rooms operate by time delay switch and room light (interlocked light and fan).
      c) Units serving electrical rooms with local thermostats to maintain space temperature shall be activated by thermostat.
      d) Units interlocked with AC units shall be energized when AC units activated.

V. Fabric Duct
   1. Description of Work:

a. Extent of non-metal ductwork is indicated on drawings and by requirements of this section.

b. Types of non-metal ductwork required for this project include the following:

1) Fabric Air Dispersion Products.

2. Quality Assurance:

a. Building Codes and Standards:

1) Product must be Classified by Underwriter's Laboratories in accordance with the 25/50 flame spread / smoke developed requirements of NFPA 90-A and are also classified in accordance with ICC Evaluation Service AC167 and UL2518.

2) All product sections must be labeled with the logo and classification marking of Underwriter's Laboratories.

3) Product must be treated with an EPA registered antimicrobial agent.

4) Green Product: Product must be constructed of a minimum 55% recycled content
(80% post-industrial and 20% post-consumer).

5) Fabrics shall meet minimum criteria or use in ISO Class 3 application as defined by ISO 14644-1.

b. Design & Quality Control

1) Manufacturer must have documented design support information including duct sizing, vent and orifice location, vent and orifice sizing, length, and suspension. Parameters for design, including maximum air temperature, velocity, pressure and fabric permeability, shall be considered and documented.

3. Submittals:

a. Product Data: Submit manufacturer's specifications on materials and manufactured products used for work of this section.

b. Building Code Data: Submit UL file number under which product is Classified by Underwriter's Laboratories for NFPA 90-A, ICC AC167 and UL2518.

4. Warranty

a. Manufacturer must provide a 10 Year Product Warranty for products supplied for the fabric portion of this system as well as a Design and Performance Warranty.

5. Delivery, Storage and Handling:

a. Protect fabric air dispersion systems from damage during shipping, storage and handling.

b. Where possible, store products inside and protect from weather. Where necessary to store outside, store above grade and enclose with a vented waterproof wrapping.

6. Manufacturer:

a. Subject to compliance with requirements, choose one of the following:
DuctSox® Corporation
Phone: (866) DUCTSOX or (563) 589-2777
FAX: (866) 398-1646 or (563) 589-2754
www.ductsox.com

7. Fabric Air Dispersion System:

a. Sedona-Xm Fabric: Air diffusers shall be constructed of a woven fire retardant fabric complying with the following physical characteristics:

1) Fabric Construction: Fabric shall be constructed of a polyester that includes 55% recycled content (80% post-industrial and 20% post-consumer), treated with a machine wash-able anti-microbial

agent by the fabric manufacturer, of a non-linting filament yarn to meet the requirements of ISO Class 3 environment, and 100% flame retardant.

2) Weight: 6.8 oz. /yd^2 per ASTM D3776
3) Color: (Standard: blue, natural white, tan, red, green, gray, black or custom)
4) Fabric Porosity: 2 (+2/-1) cfm/ft^2 per ASTM D737, Frazier
5) Temperature Range: 0 degrees F to 180 degrees F
6) Fire Retardancy: Classified by Underwriters Laboratories in accordance with the flame spread/smoke developed requirements NFPA 90, ICC AC167 and UL 2518.
7) Antimicrobial agent shall be proven 99% effective after 10 laundry cycles per AATCC Test Method 100.

b. Systems Fabrication Requirements:

1) Air dispersion accomplished by linear vent and permeable fabric. Linear vents must be sized in 1 CFM per linear foot increments (based on .5" SP), starting a 1 CFM through 90 CFM per linear foot. Linear vent is to consist of an array of open orifices rather than a mesh style vent to reduce maintenance requirements of mesh style vents. Linear vents should also be designed to minimize dusting on fabric surface.
2) Size of vent openings and location of linear vents to be specified and approved by manufacturer.
3) Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches to be secured to metal duct via. zip screw fastener – supplied by contractor.
4) Inlet connection includes zipper for easy removal / maintenance.
5) Lengths to include required zippers as specified by manufacturer.
6) System to include Adjustable Flow Devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 – 0.60 in w.g. static pressure.
7) End cap includes zipper for easy maintenance.
8) Fabric system shall include connectors to accommodate suspension system listed below.
9) Any deviation from a straight run shall be made using a gored elbow or an efficiency tee. Normal 90 degree elbows are 5 gores and the radius of the elbow is 1.5 times the diameter of the DuctSox.

c. Design Parameters:

1) Use fabric diffusers only for positive pressure air distribution components of the mechanical ventilation system.
2) Do not use fabric diffusers in concealed locations.
3) Fabric diffusers shall be designed from 0.25" water gage minimum to 3.0" maximum, with 0.5" as the standard.
4) Fabric air diffusers shall be limited to design temperatures between 0 degrees F and 180 degrees F (-17.8 degrees C and 82 degrees C).
5) Design CFM, static pressure and diffuser length shall be designed or approved by the manufacturer.

d. Suspension Hardware: (include applicable components only)

1) Suspended H-Track: System shall include a single (1 Row) or double (2 Row) runs of aluminum H-Track system located 1.5" above top-dead-center (1 Row) or 1.5" above the 10 and 2

o'clock (2 Row) locations of DuctSox system. 2 Row supports are required for systems of 32" diameter and larger. Hardware to include 10' sections of track, splice connectors, track end caps and vertical cable support kits – consisting of a length of cable with a locking stud end and Gripple quick cable connectors. Radius aluminum track must be included for all radius sections.

2) Fabric / Track attachment

a) Track tabs are a detachable tab positioned every 24" along the length of the system (all diameters).

8. Installation of Fabric Air Dispersion System:

a. Install chosen suspension system in accordance with the requirements of the manufacturer. Instructions for installation shall be provided by the manufacturer with product.

9. Cleaning and Protection:

a. Clean air handling unit and ductwork prior to the DuctSox system unit-by-unit as it is installed. Clean external surfaces of foreign substance which may cause corrosive deterioration of facing.

b. Temporary Closure: At ends of ducts which are not connected to equipment or distribution devices at time of ductwork installation, cover with polyethylene film or other covering which will keep the system clean until installation is completed.

c. If DuctSox systems become soiled during installation, they should be removed and cleaned following the manufacturers standard terms of laundry.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment Installation:

1. All equipment provided under this section of the specifications shall be installed in strict accordance with the Manufacturer's recommendations.
2. Should the drawings or specifications indicate the equipment is to be installed in a manner not in accordance with the Manufacturer's recommendations, the Contractor shall obtain direction from the Engineer prior to proceeding with the installation. If the Contractor proceeds with the installation without obtaining direction from the Engineer, the Contractor shall be required to make all required corrections to the installation at no additional cost to the contract.
3. Space Consideration: Certain equipment and ductwork will have to be installed within the limited space available as indicated on the drawings. Exact field measurements of existing conditions will be the responsibility of this Contractor to assure that the equipment and ductwork to be installed under this Section of the specifications can be installed as indicated. Contractor shall submit shop drawings for approval prior to installation. These field verified dimensions shall be made prior to purchase of equipment or fabrication of ductwork.

B. Roof and Wall Flashings: Ducts penetrating roof shall have 22 gauge sheet metal flashing with a minimum of 10" of the base extended on to the roof, or roof curb, as indicated on the drawings. Ducts through walls shall be sealed with galvanized angle iron on all sides. Where required or indicated, a weather hood constructed of galvanized sheet metal with galvanized birdscreen shall be provided.

C. Piping Through Roof: Piping penetrating roof to be provided with Stoneman four (4) pound seamless lead flashing with 6" shirt and reinforced steel boot, 915 multi-flash, or approved

equal, counterflashed with cast iron counter flashing sleeve. Seal joint between flashing and pipe with waterproof compound.

D. Openings through Walls and Roof:

1. Framed openings in walls and roof for ductwork to be coordinated in advance of the work. Installer shall furnish shop drawings showing the correct dimensions and locations of the required openings.
2. The Contractor shall provide and install "line-seals" where pipes pass through masonry walls or floors.
3. All pipes passing through walls, floors, ceilings, and partitions in finished portions of the buildings shall be provided with chromium plated, cast brass, set screw plates.
4. Where sleeves and plates are installed around insulated pipes, they shall be of sufficient size to allow the insulation to go through them, presenting a neat finish.

E. Piping Installation:

1. The piping installation is defined to include all pipe, fittings, valves and accessories.
2. Install all piping to provide rapid and positive drainage of water and venting of air. The entire piping system must be neat with respect to workmanship and arrangement.
3. All changes in size of piping shall be made through the use of reducing fittings. No bushings will be permitted.
4. Flanges or unions shall be installed on the branch side of all gate valves and at all equipment to allow easy removal.
5. All runs of piping to be made of full lengths of pipe of lengths cut to fit. No coupling shall be used except where the length or run requires more than (1) length of pipe. In such cases, the short length shall be installed at the end of the run.
6. Street elbows, running thread and bullhead tees shall not be installed in piping systems. All offsets shall be made with fittings. Piping shall not be bent at any time.
7. Welded Joints: All welding shall be performed by welders certified as passing ASME Boiler and Pressure Vessel Code (Section IX) and shall comply with ASME Std. B31.1.0 and the American Welding Society, Welding Handbook.
8. Brazing and Soldering: Conform to ANSI B9.1 Standard Safety Code for Mechanical Refrigeration.
9. Before installing automatic control valves and control devices, completely flush out the various piping systems using city water pressure to remove all dirt, grit, metal chips, pipe dope and other foreign particles. Repeat this procedure until systems are flowing with clear water and all strainers are free of all foreign substance.
10. In general, make all solder joints with 95-5 silver in accordance with Manufacturer's recommendations. Joints in threaded pipe shall be made with teflon tape.
11. Where incompatible materials come in contact, isolate from each other with materials to be isolated. Dielectric couplings for connecting piping or non-compatible materials shall be standard commercial design and shall be Hexter Corrosion Control Products.
13. Contraction and Expansion: Install all work in such a manner that its contraction and expansion will not do any damage to the pipes, pipe fittings, the connected equipment, or the building. Install offsets, swing joints, anchors, and other devices as required to prevent excessive strains in the pipe work. All supports shall be installed to permit the materials to contract and expand freely without putting any strain or stress on any part of the system. Provide anchors as necessary.
14. Cleaning System: Hot water, chilled water, steam and condensate systems shall be flushed with clear water until all piping and all strainers are entirely free of all foreign substances.

F. Painting: The interior of all sheet metal duct connections to supply, return and exhaust air outlets shall be painted black. Refer to architectural specifications for type of material to be used.

G. Sleeves and Seals: (Provide for pipes passing through walls or floor slabs).
1. Sheet-Metal Sleeves (above grade): 22 gauge, galvanized sheet metal.
2. Steel Sleeves (below grade): Where pipes pass through concrete foundation walls provide schedule 40 galvanized steel pipe or 10 gauge, galvanized sheet metal, round tube closed with welded longitudinal joint.
3. Mechanical Sleeve Seals (install where indicated on drawings): Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
4. Isolate pipes through ground floor sleeves with double wrap Kraft paper.
5. Pack space between pipe and sleeves with ceramic fiber rope so as to be absolutely watertight.
6. All penetrations of sleeves through fire rated walls and other fire rated assemblies shall be protected and sealed per UL Fire Resistance System No. WL 1001 for uninsulated pipe and No. WL 5039 for insulated pipe. See architectural plans for evocations of rated walls and other fire rated assemblies.
7. Hanger rods required to pass through fire rated finished ceilings shall be protected as specified here-in-above and an escutcheon plate provided at face of penetration.

3.02 TESTING

A. General: The Contractor shall perform all tests to the entire satisfaction of the Architect.

B. Piping - General: Perform all tests in the presence of the Architect, Engineer or the Owner's representative.
1. Refrigeration Piping:
a. Field Quality Control: Prior to initial operation examine and inspect piping system for conformance to plans and specifications and ASME B31.5. Equipment, material, or work rejected because of defects or nonconformance with plans and specifications shall be corrected as required. All piping shall meet applicable ANSI codes for pressure testing.
b. Field Tests:
1) After completion of piping installation and prior to initial operation, conduct test on piping system according to ASME B31.5. Furnish materials and equipment required for tests. If the test fails, correct defects and perform the test again until it is satisfactorily done and all joints are proved tight.
a) Every refrigerant-containing parts of the system that is erected on site, except compressors, condensers, evaporators, safety devices, pressure gages, control mechanisms and systems that are factory tested, shall be tested and proved tight after complete installation, and before operation.
b) The high and low pressure sides of each system shall be tested and proved tight at not less than the lower of the design pressure or the setting of the pressure-relief device protecting the high or low side of the system, respectively, except systems erected on site using nontoxic and nonflammable Group A1 refrigerants with copper tubing not exceeding 16 mm (0.62 in) O.D. may

be tested by means of the refrigerant charged into the system at the saturated vapor pressure of the refrigerant at 20 degrees C (68 degrees F) minimum.

2) Pressure Test Medium: A suitable dry gas such as nitrogen or approved compatible refrigerant shall be used for pressure testing (do not use oxygen or acetylene to develop pressure when checking for leaks). Before using nitrogen to test the system, obtain recommended testing pressure from unit nameplate. If pressures are not known, do not exceed 170 psig pressure when testing all or part of the refrigeration system. The means used to build up test pressure shall have either a pressure-limiting device or pressure-reducing device with a pressure-relief device and a gauge on the outlet side. The pressure relief device shall be set above the test pressure but low enough to preventing permanent deformation of the system components.

c. System Test and Charging:

1) System Test and Charging (new installation): As recommended by the equipment manufacturer or as follows:

a) The same refrigerant that will be used in operation is first charged into the system in vapor form to create a low pressure (20 to 50 psi or 240 to 450 KPa). Close valves and disconnect refrigerant drum. Test system for leaks with halide test torch or other approved method suitable for the test gas used. Repair all leaking joints and retest.

b) When all leaks have been repaired, recover the refrigerant charge to an EPA approved containment cylinder prior to pressurizing with nitrogen. A hand shut-off valve, pressure regulator, pressure gauge and pressure relief valve in the nitrogen charging line are required to pressurize with nitrogen. Connect a drum of dry nitrogen to charging valve and bring test pressure to design pressure for low side and for high side. The relief valve should be adjusted to open 1 to 2 psi above the test pressure (see Pressure Test Medium paragraph above). Test entire system again for leaks. After pressures are built-up in the system piping, rap each brazed and mechanical joint with a rubber mallet to assure joints will be leak proof under operating conditions. If no leaks are detected, leave the nitrogen pressures in the system for between four (4) and twenty-four (24) hours (no of hours depends on the system size, smaller size means shorter hours). With nitrogen, the soap bubble test is used to check for leaks. If refrigerant is mixed with nitrogen, the halide torch or electronic leak detector can be used. If leaks are detected, repair the leak and repeat the above procedure.

c) When no leaks are detected at the pressures established, check further by producing vacuum (29" – 30" HG using the compound gauge reading) on the entire system. If this vacuum is maintained for the same time period used for nitrogen testing above, the installation is ready to be charged. Break the vacuum with the refrigerant to be charged and charge with the proper volume of refrigerant.

d) Refrigerant and Oil: Upon satisfactory completion of the tests, the system shall be charged with refrigerant. Any loss of refrigerant or oil during the first year of operation due to system leaks shall be replenished as necessary to maintain a full charge on the system by the Contractor at no added cost to the Owner

e) All equipment which would be subject to damage at test pressure shall be isolated from the system.

f) Refrigerant piping system, including its safety and automatic control instruments, shall be started and initially operated for not less than eight hours.

C. Testing, Regulating and Adjusting of HVAC Systems:

1. Before testing and balancing is started, the Contractor shall adjust belts and sheaves, align all parts, lubricate bearings in accordance with manufacturer's instructions, clean exterior surfaces of coil tubes and fins, adjust all dampers for proper operation, and verify all thermostats and other control devices are operating properly and controlling the correct devices.

2. Contractor shall provide 2 sets of disposable filters for use during start up and test and balance. Upon completion of test and balance the construction filters shall be replaced with new filters of the type and quantity hereinbefore specified.

3. The Contractor shall be responsible for certifying, in writing, to the Engineer and Test & Balance Agency, that the systems, as scheduled for balancing are operational and complete, the fans, pumps, refrigeration machines, boilers, and other devices are installed properly and are in good working order, and that the full load performance has been preliminarily tested.

4. The Contractor shall retain the services of an experienced, independent balancing and testing agency certified as a member of the Associated Air Balancing Council (AABC), (approved AABC test and balance contractors are Penn Air Control Inc., American Air Balance Co. Inc., Los Angeles Air Balance Co. Inc., Precision Air Balance Co., Inc. and Winaire, Inc.) the Testing, Adjusting and Balancing Bureau (TABB) or approved equivalent specializing in heating, ventilating and air conditioning system balancing and testing to test, regulate, adjust and completely balance the systems to deliver the flows and volumes indicated on the drawings. The Test and Balance Agency shall adjust and readjust the systems until the operation complies with the requirements of the drawings and specifications. Sample testing forms shall be submitted for review.

5. The Contractor shall install any sound traps, acoustical duct liners, dampers and other items that may be required; change the fan pulleys as may be found necessary (all at no additional cost to the contract); and make a complete test of the systems after final adjustment to demonstrate the operation of the system. Per prior paragraphs of this section of these specifications, the contractor shall provide volume dampers in all supply, return and exhaust air branch ducts for adjusting and balancing the air distribution systems. Volume dampers provided with the air outlets are to be used for final adjustment only as required to achieve airflows within ± 10% of the design airflows. No volume dampers shall be set so as to generate noise in the area served. The contractor shall provide balancing valves or other devices in the water piping systems to achieve the water flows within ± 10% of the design flows.

6. Ongoing Inspection: The test and balance agency shall visit the job site on a monthly basis during the early stages of fabrication to inspect duct installation. A report shall be submitted to the Mechanical Engineer listing any deficiencies found and making recommendations for work to be performed or devices to be added to allow for proper balancing.

7. The Test and Balance Agency shall submit six (6) copies of the test and balance reports for each system to the Architect for approval. The reports shall be complete with all test data. The data shall be in tabulated form.
8. Air Systems Balancing Procedure:
   a. Measure and adjust all supply, return, and exhaust fan speeds to the system requirements. Record all fan speeds.
   b. Measure and record all motor full load amperes. The full load amperes shall not exceed nameplate ratings.
   c. Make pitot tube transverses of main supply, return and exhaust ducts. Adjust fan drives to obtain design airflows (CFM) at fans. Measure and record the final airflows
   d. Measure and record the suction, discharge and total static pressures for each system after the design airflows have been obtained.
   e. Adjust each system for design outside air airflows (CFM). Measure and record the airflows.
   f. Measure and record entering and leaving air temperatures (D.B. and W.B. for cooling), (D.B. for heating) at each air coil after design airflow have been obtained and at design conditions.
   g. Adjust all main supply and return air ducts to provide the design airflow (CFM).
   h. Adjust all zones to provide the design supply and return airflows (CFM).
   i. Test, balance, and adjust each diffuser, grille, and register for not less than 10% of the air quantity shown on the drawings and not greater than 10% of that quantity. Measure and record the final airflows.
      1) Each grille, diffuser and register shall be identified as to location and areas.
      2) Test, balance, and adjust each fume hood for required exhaust airflow. Indicate height of the hood opening at 100 fpm face velocities.
      3) Size, type and manufacturer of diffusers, grilles, registers, and all tested equipment shall be identified and listed. Manufacturer's ratings on all equipment shall be used to make required calculations.
      4) Readings and tests of diffusers, grilles, and registers shall include required air velocity (FPM) and final resultant air velocity, required airflow (CFM) and test resultant airflow (CFM) after adjustments.
      5) Measure and record sound pressure level (DB) in each occupied room with all normal mechanical equipment running. Include DB level in final report.
      6) Sound Test Procedures:
         a) Sound level measurements shall be taken at times when the building is occupied, or when activity in surrounding areas and background noise levels in areas tested are at a minimum and relatively free from sudden changes in noise levels.
         b) Measurements shall be taken with all equipment secured, except that being tested.
         c) The required sound levels shall be measured at any point within a room not less than six (6) feet from the air terminal or room unit, and not closer than three (3) feet from any floor, wall or ceiling surface.
         d) Sound levels shall be measured with the General Radio Model 1982-9720 Sound Analysis System 30-140 DB Octave Band Analyzer. The "A" scale shall be used to measure overall sound levels. The specified octave band

levels shall be determined with the above sound meter set on "A".

9. Hydronic Systems Balancing Procedure:
   a. Open all water valves to full open position. Close coil bypass stop valves. Set mixing valves to full-flow through the coils.
   b. Remove and clean all strainer screens.
   c. Verify all systems have been cleaned and flushed and provided with the specified water treatment. Clean, flush, and treat as required.
   d. Check pumps for the proper rotation. Adjust for proper rotation as required. Measure and record the running full load amperage. Record the nameplate full load amperage.
   e. Check expansion tanks to determine that each system is completely full of water and is not air bound. Fill and vent as required. Adjust the system static pressure to exceed the static head above the circulating pumps.
   f. Verify air vents are provided at the high points of water systems. Install air vents as required. Determine the vents operating freely. Vent all air from the systems.
   g. Test, balance, and adjust the water flow (GPM) at each boiler, chiller, cooling tower, heat exchanger, coil, and other devices for the design quantities. Measure and record the water flows. Measure and record the pressure drop at each device. Set water pumps to proper gallons per minute delivery.
   h. Set the water pumps for the design water flows. Measure and record the water flows. Measure and record pressure differential across each pump and the simultaneous motor amp readings.
   i. Measure and record the entering and leaving water temperatures at each boiler, chiller, cooling tower, heat exchanger, coil, and other devices at design conditions.
   j. Upon completion of checks previously mentioned, submit a written report that the entire system is operating properly and in full conformance to system specifications.
10. Vibration: Immediately upon mechanical equipment becoming operable, this Contractor shall inspect for excessive vibration. A report regarding this Contractor's findings shall be sent directly to the Engineer by Certified Mail. This information shall be made available to the Engineer in advance of the final Test and Balance Report.
11. Reports:
   a. The test and balance agency shall prepare and submit six (6) copies of the test and balance analysis report to the owner <u>within five (5) working days of completion</u>.
      1) This report shall contain, at a minimum:
         a) Project cover sheet.
         b) Project summary/general comments.
         c) Log, data and reference records.
         d) Calibration certificates for all test equipment used on project including model and serial number.
         e) Drawings. The air balance agency shall prepare a complete set of full scale drawings showing actual duct runs and outlet/inlet locations. Drawings shall be keyed to and furnished with the air balance report. The mechanical plans are not acceptable for this purpose. Drawings shall be in AutoCAD version 14 format.
         f) AABC National performance guaranty.

3.03 CUTTING & PATCHING (See Division I)

A. The cutting and patching of existing construction shall be coordinated in advance of the work.

B. Where required to remove, cut or core drill existing building walls, partitions, floors, ceilings and roof and outdoor paved and landscaped areas in order to install the work as indicated, the Contractor shall cut and patch existing construction to match adjacent areas in a manner that will not result in visual evidence of any cutting or patching. The materials, finishes and methods of installation shall match the existing adjacent surfaces and shall be in accordance with the requirements of other applicable sections of these specifications.

C. Unless specified on structural drawings, any alterations or modifications to a structural element by cutting, drilling, boring, bracing, welding, etc., shall have written approval by Structural Engineer of record prior to start of work.

3.04 JOB COMPLETION

A. Equipment Identification:
   1. All equipment furnished under this section shall be provided with the Manufacturer's metal identification labels securely attached and showing all pertinent data, including performance characteristics, size, model, and serial number. Labels shall not be obscured in any manner.
   2. Identification name plates shall be provided on all equipment and control components, including room thermostat numbers coded to their respective automatic zone damper, valve, or air conditioning unit. Name plates shall be constructed of black bakelite with white center engraved letters 3/16" high and shall be cemented to equipment with an epoxy resin. The Contractor shall submit to the Architect, a complete list of name plate titles for acceptance prior to installation.
   3. Valve tags shall be 3/32" thick plastic, 2" x 2" stamped to indicate service and valve number, 1/4" lettering, chain hanger. Provide valve list and include in maintenance manual.

B. Plastic Duct Markers:
   1. General: Provide Manufacturer's standard laminated plastic, color-coded duct markers. Conform to the following color code.
      a. Green: Cold air
      b. Yellow: Hot air.
      c. Yellow/Green: Supply air.
      d. Blue: Exhaust, outside, return and mixed air.
      e. For hazardous exhausts, use colors and designs recommended by ANSI A13.1
   2. Nomenclature: Include the following:
      a. Direction of air flow.
      b. Duct service (supply, return, exhaust, etc.).

C. Pipe Markings: Self-sticking pipe marker tape with written legend, color coded background and flow arrow, all in accordance with ANSI A13.1. Letters to reflect drawing legend descriptions. Seton or Brady.

D. Final Operation: Upon completion of the installation of the equipment and after all systems have been tested, cleaned, the Contractor shall place a competent person in charge who shall operate the equipment for a schedule instruction period as submitted by the contractor and approved by the District per Division I requirements. Video tape each instruction session and provide the District with two (2) copies of each session. During this period of operation, all safety and operating controls shall be actuated to demonstrate proper operation. During

this operating period, the Owner's representative shall be instructed in all details of operation and maintenance. All required instructions from the Equipment Manufacturer's representative shall be given during the period.

E. Operation Instructions:

1. Prepare a diagram of the entire control system with a full description of the heating, ventilating and air conditioning systems.
2. After acceptance by the Engineer, the control diagram and complete operating instructions shall be mounted under plastic and installed where directed.
3. Prepare two (2) maintenance manuals, which shall include all the necessary or pertinent data, such as:
   a. Names, addresses and emergency phone numbers of all suppliers and manufacturers.
   b. Part numbers of all replaceable items.
   c. Oiling and lubrication instructions.
   d. Air balance report.
   e. Control diagram and operation sequence, together with labeling of controls and instruments to match the diagram.
   f. A maintenance schedule which shall list all required maintenance on all equipment furnished under this section of the specifications and the intervals of which the items are to be performed.
4. An identification chart indicating valve operating in the piping system shall be installed as located by the Owner. Identification charts shall be mounted behind plastic in a frame.

E. Clean-Up:

1. After all heating, ventilating and air conditioning work has been tested and accepted, the Contractor shall thoroughly clean all parts of the equipment installation. Exposed parts to be painted are to be thoroughly cleaned of cement plaster and other materials and all greases and oil spots removed with solvent. Exposed rough metal work to be carefully brushed down with steel brushes to remove rust and other spots and left in proper condition to receive painter's finish.
2. Remove all debris from the job site, all cartons, boxes, packing crates, excess materials not used occasioned by the work and to the satisfaction of the Owner.
3. If the above requirements of clean-up are not to the satisfaction of the Owner, the Owner reserves the right to order the work done and the cost of which shall be borne by the Contractor.
4. The Contractor shall remove on a daily basis all debris from the job site, to the satisfaction of the Owner.
5. If the above requirements of clean-up are not to the satisfaction of the Owner, the Owner reserves the right to order the work done by a third party and the cost of which shall be borne by the Contractor.

END OF SECTION