SECTION - AIR CONDITIONING, HEATING AND VENTILATING SYSTEMS

MS5 - 01. SCOPE: The work covered by this section of the specifications consists of furnishing all labor, equipment, materials, supplies, cartage, services, etc., and performing all operations necessary for completing the installation of air conditioning, heating, and ventilating systems in strict accordance with this section of the specifications and the applicable drawings, and subject to the terms and conditions of the contract.

MS5 - 02. APPLICABLE PUBLICATIONS: The following publications form a part of this specification.

(a) Federal Specifications.

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<tr>
<th>Symbol</th>
<th>Date</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>HH-I-562</td>
<td>28 Dec 51</td>
<td>Insulation, Thermal, Mineral Wool, Block or Board and Pipe Insulation (Molded Type).</td>
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<td>&amp; Int.</td>
<td>10 Jan 58</td>
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<td>28 Mar 58</td>
<td>Aluminum-Alloy Plate and Sheet 3003.</td>
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<td>QQ-S-00766c</td>
<td>24 Sep 59</td>
<td>Steel Plates, Sheets and Strip-Corrosion Resisting.</td>
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<td>Screening, Wire Insect.</td>
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<td>22 Jul 59</td>
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<td>30 Mar 60</td>
<td>Varnish; Asphalt.</td>
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<tr>
<td>CCC-C-419</td>
<td>30 Jul 56</td>
<td>Cloth, Cotton, Duck, Unbleached, Plied-Yarn,(Army and Numbered).</td>
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<tr>
<td>&amp; Amend. 1</td>
<td>4 Mar 57</td>
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(b) Military Specifications.


(c) Air Conditioning and Refrigerating Institute.

Standards 1958.

(d) American Society of Refrigerating Engineers Standards.


(e) American Standards Association Standard.


(f) Air Moving and Conditioning Associations.

No. 110 Standards, Definitions, Terms and Test Codes for Centrifugal, Axial and Propeller Fans (1950).

(g) National Board of Fire Underwriters Pamphlet.

No. 90A Air Conditioning and Ventilating Systems Other than Residential Type - June 1957, with June 1958 Amendments.

No. 91 Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying (Nov. 1949).

(h) Tubular Exchange Manufacturer's Association Publications.

Standards (1952).

(i) American Welding Society Standard.


(j) National Bureau of Standards.

Dust Spot Method Using Cottrell Precipitate.

MS5 - 03. GENERAL: The contract drawings indicate the extent and general arrangement of the air conditioning, heating and ventilating systems. If any departures from the contract drawings are deemed necessary by the Contractor, details of such departures and the reasons therefor shall be submitted as soon as practicable to the Contracting Officer for approval. No such departures shall be made without prior written approval of the Contracting Officer. The air conditioning equipment and installations shall conform to the Air Conditioning and Refrigerating Machinery Association, Inc. Equipment Standards and American Society of Refrigerating Engineers' Standard No. 15, and ventilating equipment and installation shall conform to National Board of Fire Underwriters Pamphlet No. 91. The air conditioning system shall conform to Pamphlet No. 90A of the National Board of Fire Underwriters.
All work shall conform to the applicable State of California safety orders, and local codes and ordinances. The dimensions of the mechanical-equipment room are as indicated on the drawings. Equipment and piping arrangements shall provide adequate and acceptable clearances for entry, servicing, and maintenance.

(a) **Standard Products.** The equipment to be furnished under this specification shall be essentially the standard product of the manufacturer. Where 2 or more units of the same class of equipment are required, these units shall be products of a single manufacturer; however, the component parts of the system need not be the products of the same manufacturer.

(b) **Approval of Materials and Equipment.** As soon as practicable and within 30 days after award of contract and before any materials or equipment are purchased, a plan and necessary elevations of the equipment room layout showing the proposed air conditioning, heating and ventilating equipment, ductwork, and all applicable appurtenances therefor, with clearances, together with a complete schedule of the materials and equipment proposed for installation shall be submitted in quintuplicate for the approval of the Contracting Officer. The schedule shall include catalogs, cuts, diagrams, drawings, and other such descriptive data as may be required by the Contracting Officer. No consideration will be given to partial lists submitted from time to time. Approval of equipment under this provision shall not be construed as authorizing any deviations from the specification, unless the attention of the Contracting Officer has been directed to the specific deviations. Approval of materials and equipment will be based on manufacturers published data considered in conjunction with referenced standards. Any materials or equipment listed which are not in accordance with the
specifications requirements will be subject to rejection. The product of any reputable manufacturer regularly engaged in the commercial production of this equipment will not be excluded on the basis of minor differences providing all essential requirements of this specification relative to materials, capacity, and performance are met. The Contractor shall furnish a statement, in quintuplicate, giving a complete description of all points wherein the equipment he proposes to furnish does not comply with the specifications and drawings. Failure to furnish such a statement will be interpreted to mean that the equipment meets all requirements of the specifications. If the equipment offered under this provision is, in the opinion of the Contracting Officer, equal to or better than that specified, it will be given consideration.

(c) **Shop Drawings.** As soon as practicable after award of contract and prior to purchase, complete shop drawings of the equipment layout, showing all refrigerant, water, and vent connections, shall be submitted to the Contracting Officer for approval in accordance with the "Special Conditions".

(d) **Capacity Information.** Prior to installation, the Contractor shall furnish the Contracting Officer with manufacturer's published capacity information, including tables, curves, and other data that may be required in order to determine the capacity of the equipment under the design conditions indicated on the drawings.

**MS5 - 04. MATERIALS AND EQUIPMENT:** The following materials and equipment shall conform to the respective specifications and other requirements specified below:

(a) **Aluminum Sheets.** Federal Specifications QQ-A-359d, quarter-hard condition.

(b) **Asphalt Varnish.** Federal Specification TT-V-5lc.

(c) **Cotton Duck.** Federal Specification CCC-C-419, Type III, weight as hereinafter specified or best suited for the work.
(d) **Cork Insulation.** Federal Specification HH-P-381, "Pipe
Covering; Cork Molded".

(e) **Electrical Materials and Appliances.** Section "Electrical
Work", of these specifications.

(f) **Glass Insulation.** Federal Specification HH-I-551a, "Insulation
Block and Pipe Covering, Thermal Cellular Glass".

(g) **Iron and Steel Sheets (Galvanized).** Federal Specification
QQ-S-775a, "Steel, Sheets, Carbon, Zinc-Coated," Class D1, unless otherwise
specified.

(h) **Iron and Steel Sheets (Uncoated, black).** Federal Specification
QQ-S-636, "Steel; Carbon (Low Carbon), Sheets and Strips," composition, and
finish best suited to the end use.

(i) **Mechanical Equipment.** Major items of mechanical equipment shall
be of the best quality used for the purpose in commercial practice, and
shall be the products of a reputable manufacturer. Each major component
of the equipment shall have the manufacturer's name, address, and catalog
number on a nameplate securely affixed in a conspicuous place. The name
plate of a distributing agent only will not be acceptable. Belts, pulleys,
chains, gears, couplings, projecting set screws, keys, and other rotating
parts located so that any person may come in close proximity thereto shall
be fully enclosed or properly guarded.

(j) **Mineral Wool Insulation.** Federal Specification HH-I-562,
"Insulation, Thermal, Mineral Wool, Block or Board and Pipe Insulation
(Molded Type), Type I, Class 2, for ducts.

(k) **Pipe Materials and Workmanship.** Sections "Piping" and "Plumbing",
of these specifications.

(l) **Steel Sheets (Corrosive Resisting).** Federal Specification QQ-S-
00766c, Type 316.

(m) **Welding.** Welding shall conform to American Standard B31.1,Section 6.
(n) Wire Screening. Federal Specification RR-S-114a, "Screening, Wire, Insert", Type VI.

MS5 - 05. WORKMANSHIP. Equipment shall be installed in accordance with the recommendations of the manufacturer and the best standard practice for this type of work.

MS5 - 06. PREVENTION OF RUST: All surfaces of ferrous sheet metal not otherwise specified shall be given a rust-inhibiting treatment. Unless otherwise approved by the Contracting Officer, the rust-inhibiting treatment shall consist of hot-dip-galvanizing after fabrication, or bonderizing followed by the application of a suitable rust-inhibiting primer and finish paint.

MS5 - 07. DESIGN CONDITIONS: (a) Outside.

(1) Summer - 90°F., DB; 68°F., WB
(2) Winter - 35°F., DB
(3) Wind - 15 mph

(b) Inside.

<table>
<thead>
<tr>
<th>ZONES</th>
<th>Room, Area and Equipment</th>
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</thead>
<tbody>
<tr>
<td>1 through 4</td>
<td>73°F. DB min, 10°F above Ambient Max.</td>
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<tr>
<td>5</td>
<td>High Bay Area (Test)</td>
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<tr>
<td>6</td>
<td>First Floor Entrance</td>
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<tr>
<td>6</td>
<td>First Floor Offices</td>
</tr>
<tr>
<td>6</td>
<td>First Floor Fabrication and Storage</td>
</tr>
<tr>
<td>8</td>
<td>First Floor Cold Test and Aluminum Spray</td>
</tr>
<tr>
<td>9</td>
<td>First Floor Final Assembly</td>
</tr>
<tr>
<td>13 through 21</td>
<td>Second Floor Light Laboratories</td>
</tr>
<tr>
<td>22</td>
<td>First Floor Chemical Laboratories &amp; WestBlast</td>
</tr>
<tr>
<td>10</td>
<td>First Floor Furnace Area</td>
</tr>
<tr>
<td>11</td>
<td>First Floor Process Area</td>
</tr>
<tr>
<td>12</td>
<td>First Floor Storage Area</td>
</tr>
</tbody>
</table>

- 6 -
Room, Area and Equipment

15°F Above Ambient Max.

23
Mechanical Equipment Room
68°F ± 2°F DB Year Around, 45RH ± 5%

24
General Assembly

25
Ceramic Room, Metal Spray, Cathode Spray
Cathode Assembly Room, Air Lock

MS5 - 08. CONDENSING UNIT: (a) General. Condensing unit shall consist generally of a compressor, electric-motor drive, motor starter, scale trap, suction strainer, suction and discharge valves, safety guards, condenser, filter drier and other recommended standard equipment and accessories as listed in Air Conditioning and Refrigeration Institute Standard 5-21. The compressor unit shall be tested and rated in accordance with American Society of Refrigerating Engineers Standard 23-R.

(b) Reciprocating Compressor. Reciprocating compressor shall be of the open reciprocating type, of vertical, V, or radial design, designed specifically for Freon-22. Compressor shall have integrally cast housing of close-grained iron with oil-level bull's-eye, cast cylinder heads, cast aluminum or iron-alloy automotive-type piston, cast-aluminum or forged-steel connecting rods, and cast-iron or forged-steel crankshaft. Main bearings shall be babbitt-lined-sleeve insert type. Lubrication system shall be of the forced-feed-positive-displacement type with oil strainer. Shaft seal shall be mechanical type. Suction and discharge valves shall be flange-connected, wrench-operated, rising-stem, with cap. Rotating parts shall be statically and dynamically balanced at factory to eliminate vibration. Thermostatically controlled crankcase-oil heaters shall be provided, electrically interlocked to operate only when the compressor is not running. Piston speed shall not exceed manufacturer's recommendation or 875 feet per minute whichever is less.
(1) **Drive.** Drive for reciprocating compressors shall be direct by an electric motor, at a speed not in excess of that for which the compressor is designed. Motors shall be induction type with continuous-duty rating, low-starting-current and high-starting-torque type, unless the compressor starts at not over 1/3 load, in which case motors may be low-starting-current and normal starting-torque type. V-belt drives designed for not less than 50 per cent overload capacity. Motor shall be provided with belt tightening devices. Direct-drive units shall be connected by means of a flexible coupling that does not require lubrication.

(2) **Controls and Gages.** Compressors shall be provided with automatic capacity controls, actuated by either pressure or temperature to provide multistep capacity reduction and cylinder unloading at start-up, low-oil pressure cut-out, oil sight glass, high and low-pressure cutout, and suction, discharges, and oil pressure gages. Pressure cutouts and gages shall be factory mounted on a gage board.

(3) **Base.** The units shall be mounted on all-welded structural steel bases complete with vibration isolators.

(c) **Water-Cooled Condensers.** Water-cooled condensers shall be of the shell and straight tube type, and may also serve as a receiver if standard with the manufacturer. The condenser shall consist of steel shell with integral finned copper tubes rolled into heavy tube sheets. Water circuit shall be designed for 100 psig working pressure. Corrosive resisting steel or cast iron water boxes shall be furnished on each end with removable covers for inspection and/or cleaning of tubes without dismantling water piping. Condensing gas shall be on shell side. Condenser capacity shall be not less than that indicated and shall be adequate to condense the vaporized refrigerant, when supplied with 85 degree F. condensing water, as indicated.
Each condenser shall be equipped with necessary accessories such as fittings and valves. Condenser capacities shall be based on fouling factor of .001.

Suitable tappings shall be provided in the water boxes for thermometers, control bulbs and gages. Water boxes shall be designed for maximum working pressure in conformance with the 1959 ASME Boiler and Pressure Vessel Code and ASRE Standard 15-58.

MS5 - 09. RECEIVERS: Liquid receivers shall be constructed of steel, with welded seams. The inner surfaces shall be thoroughly cleaned by sandblasting or by other suitable means. Each receiver shall be suitably supported, and shall be equipped with inlet, outlet, drain, charging valve, ASME relief valve, purge valve, and safety connections. An approved liquid-level indicator shall be provided in connection with water-cooled equipment. Each liquid receiver shall have a storage capacity not less than 25 per cent in excess of that required for the fully charged system.

MS5 - 10. COILS: Coils shall be of the extended-surface type, arranged in a rectangular form to suit the space requirements within the duct of air handling unit. All coils shall be properly supported by means of suitable frames constructed of galvanized-steel angles, or other approved devices.

(a) Direct Expansion Cooling Coils. Direct expansion cooling coils shall be constructed entirely of nonferrous alloys with the fins securely bonded to the tubes. The cooling coils shall be designed for use with Refrigerant 12, or Refrigerant 22, and shall have sufficient surface to provide the capacity to chill air in quantity and to the temperature indicated on the equipment list under the specified operating conditions. Cooling coils shall be tested pneumatically and proved tight under a gage pressure of 300 psi.
Individual cooling coils shall be dehydrated and sealed at the factory. Each cooling coil shall be provided with an equal number of liquid and suction connections. Cooling coils shall be provided with a suitable condensation gutter and a drainage line installed as indicated on the drawings or as directed by the Contracting Officer.

(b) Hot Water Heating Coils. Hot water heating coils shall be of the extended-surface, nonferrous alloy construction, with the fins securely bonded to the tubes. The coils shall have been tested hydrostatically and proved tight under a gage pressure of 150 psi. The coils shall be properly pitched to permit complete drainage and shall be encased in a metal frame. The coils shall have capacity not less than that indicated on the equipment list when supplied with hot water at the temperature indicated, and with the other established operating conditions.

MS5-11. FANS: (a) Propeller-Type Fans. Propeller-type fans shall be installed where shown on the drawings. The fans and motor shall be supported on heavy metal frames designed for as shown. Fan housings or covers exposed to the outside atmosphere shall be of corrosive resisting steel. In general, fans less than 24 inches in diameter or directly connected to the motor, and fans 24 inches in diameter or larger shall be connected to the motor by a V-belt drive designed for 50 percent overload capacity. The motor speed for direct-driven fans with capacities of 3,000 cfm or more shall not exceed 1,200 rpm. Motors and fans shall be mounted on resilient supports. The motors shall be designed to suit the characteristics of the available electric service. Thermal-overload protection shall be provided in the starter or integral with the motor. The fans shall be rated in accordance with Bulletin No. 110 of the Air Moving and Conditioning Association. Each unit shall have a capacity not less than that shown on the equipment list. Decibel rating shall not be more than 62.
(b) Centrifugal-Type Fans. Centrifugal-type fans complete with motors, drive equipment, and vibration-isolation supports, shall be installed where shown on the drawings. The fans shall have air capacities not less than those shown on the equipment list when operating against the static pressures indicated, and shall be rated and constructed in accordance with Bulletin No. 110 of the Air Moving and Conditioning Association. The impeller wheels shall be of the multi-blade type, with curved blades, shall be heavily and rigidly constructed, accurately balanced both statically and dynamically, and free from objectionable vibration or noise. Fans with wheels over 36 inches in diameter shall have overhung pulleys and a bearing on each side of the wheel. Fans with wheels 36 inches or less in diameter may have one extra long bearing between the fan wheel and the drive. The bearings shall be self-aligning and self-oiling, with adequate oil reservoirs. The fan shafts shall be of steel, and shall be provided with key seats and keys for the impeller hubs and fan pulleys. Each fan outlet shall be of ample proportions and shall be equipped with removable angles and bolts for attaching canvas or other flexible connections. Fans with wheel diameters of 12 inches or less may be directly connected to the driving motor, and fans of larger wheel diameter shall be indirectly connected by means of an approved multiple V-belt drive designed for at least 50 percent overload capacity. Where indirect drives are employed, motors shall be equipped with adjustable bases or with rails. Each motor shall be designed to suit the characteristics of the available electric service and shall conform to section "Electrical Work".

(c) Cabinet-Type Fan Units. Where indicated on the drawings, circulating fans shall be housed in a casing constructed of steel sheets not less than 0.0178 inch in thickness (18 gage). The cabinet shall be adequately re-
inforced and stiffened with steel angles or other structural members, and shall be provided with all necessary interior panels, supports for equipment, access openings, and dampers. Cabinet openings connected to ducts shall be equipped with removable angles and bolts for attaching canvas or other flexible connections. All interior surfaces at the cabinet shall be rendered rust resistant in the manner hereinbefore specified. All exterior surfaces of the cabinet shall have an enamel or other approved finish. Removable panels on the casing shall provide easy access to all parts for lubrication and servicing. Fans, motors, and drives for cabinet units shall be as specified hereinbefore, except that forward curve type fans may be used if standard with the manufacturer. Cabinets for supplying conditioned air shall be constructed to house the circulating systems cooling coils and shall be complete with a cooling drain pan adequately sloped to insure positive drainage. The cabinet shall be insulated on the inside with not less than \( \frac{1}{2} \) inch of moisture resistant, moldproof, verminproof, termiteproof insulation. Drain pan shall be insulated with not less than \( \frac{1}{2} \) inch rigid moisture resistant, moldproof, verminproof, termiteproof insulation cemented in place and covered with a mastic waterproof sealer.

Cabinets for supplying heated air shall be constructed to house the hot water heating coils. Heating and cooling coils shall be as previously described. Where so specified cabinets shall be furnished with filter boxes and air mixing boxes. Filter boxes shall be designed for use with filters as herein described. Mixing boxes shall be designed to suit the connecting Hützwork as shown and shall be furnished with dampers to control the flow of air as required.

The contractor shall submit printed catalog evidence showing that the fan is certified for quiet operation at the rated speed and capacity and conforms to the requirements.
MS5 - 12. **VIBRATION-ABSORBING FOUNDATIONS:** All items of mechanical equipment including compressors, fans, and pumps, shall be properly isolated from the building structure by means of approved vibration-absorbing foundations. Each foundation shall include an adequate number of standard isolation units. Each unit shall consist of machine and floor or foundation fastenings, together with intermediate isolation material. The isolation units shall be standard catalog products with printed loading ratings. Complete data for the foundations for each piece of equipment shall be submitted to the Contracting Officer for approval.

MS5 - 13. **BELT GUARDS and MOTOR HOUSINGS.** Each "V" belt drive shall be provided with a guard conforming to the requirements of the State of California Industrial Safety Orders. Hinged access doors not less than 6" by 6" shall be provided for access to motor and fan shafts for service and test purposes. Motors and drives, located outdoors or exposed to the weather shall be covered with a weatherproof sheet metal housing of galvanized sheet metal not lighter than No. 22 gage. Housing shall be adequately ventilated.

MS5 - 14. **AIR FILTERS:** (a) Throw-Away Medium Filters. Panel air filters of the throw-away medium type shall be installed in suitable dust-tight corrosive resisting steel racks at the suction side of the supply air fans. The filter sections shall be a standard commercial size as indicated on the drawings, 2 inches in thickness and shall have, when clean, a resistance not in excess of .17 inch of water when handling 2 cubic feet of air per square inch of face area. Filters shall be suitable for the use when installed with velocities as shown on the equipment list. Each filter section shall be composed of a fibrous glass filter medium held in a corrosive resisting steel holding frame. Holding racks shall be fabricated by the filter manufacturer when possible. Contractor shall furnish one set operating filters, and one complete spare set of filter replacement medium shall be provided and stored on the job as directed by the Contracting Officer.
(b) **High Efficiency Type Medium Filters.** Filters shall be installed in corrosive resisting steel holding frames and racks as hereinbefore specified. The size shall be as indicated on the equipment list. Filter medium shall be spunglass and shall have a minimum efficiency of 90 percent based on National Bureau of Standards Dust Spot Method Test. Initial filter resistance and velocity shall be as indicated. Contractor shall furnish one complete set of operating filters and one complete spare set of filter replacement cartridges shall be provided and stored on the job as directed by the Contracting Officer.

(c) **Absolute Type Medium Filters.** The final stage shall be installed in corrosive resisting steel holding frames and racks as hereinbefore specified. The size shall be as indicated. Filter shall be furnished with aluminum separators, rubber base sealer and cadmium plated steel frame. Filter medium shall be pleated glass-asbestos and shall have a minimum efficiency of 99.95 percent when tested by the D. O. P. Smoke Test. Initial filter resistance and velocity shall be as indicated on the equipment list. Contractor shall furnish one complete set of operating filters and one complete spare set of filters shall be provided and stored on the job as directed by the Contracting Officer.

**MS5 - 15. BACK-DRAFT DAMPERS:** Back-draft dampers consisting of a set of delicately balanced louvers that open automatically when the fan starts and shut by gravity when the fan stops, shall be installed where shown on the drawings. The louvers shall be constructed of corrosive resisting steel weighing not less than 0.90625 pound per square foot, or of sheet aluminum of adequate thickness. The edges of the blades shall be provided with felt strips to prevent rattling. The damper blades shall be supported on metal frames designed for wall-mounting. The dampers shall be standard catalog products of a reputable manufacturer.
MS5 - 16. **Propeller Type Unit Heaters:** Propeller type unit heaters shall have capacities not less than those shown on the drawings. The unit heaters shall be rated in accordance with the code of the American Society of Heating Refrigeration and Air Conditioning Engineers and shall have a Btu capacity not in excess of 125 percent of that specified. Orifice plates may be provided to reduce the Btu output where required. The noise level of each unit heater shall be appropriate for the space in which the heater is installed. Upon completion of the installation unit heaters that are considered by the Contracting Officer to be objectionably noisy shall be replaced with acceptable heaters at no additional cost to the Government. Unit heaters shall be designed for suspension and arranged for vertical discharge of air. The casings shall be of study, rigid construction of furniture grade steel and shall be finished with baked enamel over a rust protective coating or treatment. Adjustable diffusers shall be furnished consisting of cones and radial louver blades. Heating elements shall be copper tube and non-ferrous radiating fins and contracts in the casing with proper pitch for drainage. The elements shall be tested under a hydrostatic pressure of 200 psig or greater and a certified report of the test shall be delivered to the Contracting Officer. Motors shall be supported on a vibration isolation mounting and shall be of adequate size and speed to operate the fans at their specified capacities.

MS5 - 17. **Roof Ventilators:** Roof ventilator fans shall be of the propeller or centrifugal type, and shall have capacities not less than those shown on the equipment list. Fans shall be installed in a vertical or horizontal position within the housing as indicated. The motors shall be of an approved type and shall be provided with thrust bearings if installation is in the vertical position. Motors shall be designed to suit the characteristics of the available current and shall conform to section "Electrical Work". Where so indicated motors shall be mounted out of the air stream. Ventilators shall be constructed of corrosive resisting steel sheets weighing not less
Roof ventilators designated as having a protective coating shall have all portions of the fan and housing in contact with the air stream covered with six coats of air dried synthetic vinyl plastic applied in alternate colors and inspected between coats, or other approved corrosion protection.

MS5 - 18. GRAVITY ROOF VENTILATORS: Gravity roof ventilators shall be installed as shown on the drawings. Ventilators shall be self-supporting rectangular, weatherproof, low silhouette type, having approximately 40 percent free area. Units shall be constructed of galvanized steel, with 16 gage curbs and a minimum weight of 22 gage for end caps, baffles, gutters and other sheet metal parts. Dampers shall be one piece construction with continuous pivot rod. Bearings shall be nylon. Dampers shall be arranged to open in case of fire by the parting of 212°F fusible link. Operation shall be automatic or manual as indicated. Manually operated units shall be furnished with remote crank, pulleys, and stainless steel cable for operation from floor. Automatic operation shall be by pneumatic motor with linkage and shall function as described in the sequence of operation. Bird screen shall be two-mesh, 0.01 galvanized steel.

MS5 - 19. GOOSENECKS AND RAIN HOODS: Goosenecks and rain hoods shall be constructed of corrosion resisting steel sheets of approved weight, and shall be rigidly reinforced and braced, and flashed in an approved manner.

MS5 - 20. SCREENS: Removable bird and insect screens shall be installed in the goosenecks, air intakes, exhausts, and rain hoods indicated on the drawings. Insect screens shall be 16-mesh wire corrosive resisting screening, and bird screens shall be ½ inch mesh corrosion resistant hardware cloth.

MS5 - 21. INSTRUMENT AIR DRYER: An instrument air filtering and dehydrating unit shall be installed as indicated on the drawings. Unit shall be connected to the compressed air system with a three valve bypass as
recommended by the manufacturer. The dehydrator shall be the refrigeration type and shall be complete with a one-half horsepower 115 volt, 60 cycle, single phase air cooled refrigeration unit, heat exchanger, condenser, mechanical cartridge type filter of radial fin construction and an automatic condensate discharge valve. Pressure vessel shall be designed for a 200 psig operating pressure in accordance with the A.S.M.E. Code.

Dehydrator shall have capacity to continuously reduce the dewpoint of 100 scfm of saturated air at 100 psig and 100°F to a dewpoint of 35°F at 100 psig, corresponding to a dewpoint of minus 10°F at atmospheric pressure. Pressure drop across unit shall not exceed 4 psig at 100 scfm flow. For convenience in identifying the quality of unit required refer to Hankison Cooperation Refrigerator.

MS 22. HUMIDIFIER: A humidifier shall be installed as shown on the drawings. Unit shall be the centrifugal atomizing type, arranged for mounting in the supply duct. Unit shall be complete with reservoir, and float valve, a capacitor type motor. All materials exposed to water vapor shall be non-ferrous. All materials exposed to water shall be suitable for use with demineralized water. Unit shall be connected to demineralized water supply as shown on the drawings.

MS 23. THERMOMETERS: Thermometers of the separable-socket type, with not less than 5-inch scales and stems of appropriate length for indicating representative temperature, shall be installed in the ducts and piping where indicated on the drawings or where specified. The thermometers shall have suitable operating ranges and shall be installed so as to be conveniently read.

MS 24. AUTOMATIC CONTROLS: Automatic controls shall be as indicated on the drawings or as specified, and may be either of the electric, electronic, or pneumatic type. Dry oil-free air at approximately 100 psig will be available for control use downstream from the instrument air dryer in the mechanical equipment room, as shown on the drawings. Air accumulators, reducing valves, relief valves, block valves, gages, filters, and other
appurtenances shall be provided as required. Air lines for pneumatic controls shall consist of suitable tubing, with airtight fittings. Unless otherwise approved by the Contracting Officer, the entire automatic control equipment shall be standard catalog products of a single reputable manufacturer. The automatic control equipment shall be installed under the direct supervision of the manufacturer's representative, in strict accordance with the control diagram recommended by the manufacturer and approved by the Contracting Officer. Before the air-conditioning installation is accepted, the Contractor shall deliver to the Contracting Officer, a statement from the manufacturer or his authorized agent, certifying that the automatic control equipment has been inspected and found to be properly installed and functioning satisfactorily. The supervision and inspection shall be at the Contractor's expense with no additional cost to the Government.

(a) Space-Temperature Control; Room-Thermostat Method and Hot Water Valves:

The controls shall be essentially a series of electric or electronic motor-operated or pneumatic operated 3 way modulating hot water valves at the coils of the air handling system, damper operators, window operators, room thermostats, and other components, as indicated on the drawings.

(b) Safety Controls. The Contractor shall submit proof that the safety controls conform to the standards of the Underwriters' Laboratories, Inc., or the Factory Mutual Laboratories.

(c) Motor Operated Hot Water Valves. Motor-operated hot water valves or pneumatic operated hot water valves shall be installed in the supply lines where indicated or specified. The valves shall be of the modulating type. The valve body shall be designed for a static pressure of 125 psig, and the motor shall have ample power to operate the valve at the specified operating pressure. Valves larger than 2 inches shall be equipped with renewable seats of rust-resistant material.
(d) **Thermostats.** (1) **Room Thermostats.** Room thermostats shall be tamperproof, and of the lock-shield type designed to operate on a 2-degree F. differential over a temperature range of approximately 55 to 85 degrees F. Room thermostats shall be set to maintain a room temperature as indicated for each room or space. Thermostats shall be finished as required for the approval of the Contracting Officer, and shall be equipped with red reading thermometer and lock type adjustments.

(2) **Insertion Thermostats.** Insertion thermostats shall be similar in design to room type instruments except that they shall be equipped with remote bulb sensing elements connected to the instrument by not less than 5 feet of capillary tubing. They shall have either external or lock type adjustments and visible scales. Remote bulb dial type thermometers shall be furnished for each insertion thermostat location, and the bulbs shall be mounted adjacent to the bulb of the insertion thermostat. Thermometers shall have suitable ranges in degrees Fahrenheit. Thermometers and thermostat indicator cases shall be located within 5 feet of the floor in the room or space nearest the bulb location. Thermometer cases shall be not less than 3 inches in diameter, and shall be properly identified as to system and service. Thermostats located out of doors shall be provided with suitable weatherproof housings.

(e) **Dampers and Water Valve Motors.** Dampers and water valve motors shall be normally open or closed as noted on the drawings and shall have ample capacity to operate dampers and valves under all load conditions. Pneumatic damper operators, if used, shall incorporate a positive position positioning device on dampers 15 square feet or greater so dampers will adjust to required position regardless of pressures on damper. Water control valves shall have progressive throttling characteristics. Pneumatic valves, if used, shall be equipped with positioning device on split range control and all valves 2 inches and larger, or where indicated on the drawings.
(f) **Manual Switches.** Manual switches shall be of the lever indicating type with indicating plates designating the function of each switch.

(g) **Solenoid Air Valves.** Solenoid valves shall be 3 way type with bleed, suitable for connection to copper tubing. Solenoids shall be suitable for operation on 120 volt, single phase, 60 cycle current.

(h) **Pneumatic Electric and Pressure Switches.** Pneumatic electric and pressure switches shall be positive action units suitable for energizing electrical circuits upon a change in the sensed pressure. Pneumatic switches shall be suitable for pressures up to 15 psig with a maximum of one psig differential. Pressure switches shall be sensitive to a change in pressure of as little as 0.1 inch WG.

(i) **Selective Relay.** Selective relay shall be suitable for selecting the higher or lower of 2 control pressures and transmitting the signal to the controlled items.

(j) **Reversing Relay.** Reversing relays shall be suitable for reversing branch line pressures inversely proportional to the input air signal transmitted to it.

(k) **Positive Relay.** Positive relay shall be 2 position, acting to transmit a full 15 psig or bleed the branch air pressure from the branch line at an adjustable set pressure from a modulating controller.

(l) **Relays, Pressure Switches, Valves.** Relays, pressure switches, valves and other accessories shown on drawings specified herein, or required for the successful operation of the air conditioning systems shall be furnished and installed by the Contractor.
Sequence of Operation

Equipment for each zone consists essentially of a heating and ventilating unit, a ventilating unit, and two gravity roof ventilators. The ventilating unit and one gravity ventilator each for Zones 1 and 3 are for future installation.

Ventilation

On a rise in room temperature a modulating pneumatic thermostat gradually increases its output pressure. The return air dampers on the heating and ventilating units gradually close, and outside air dampers gradually open from the minimum (50%) setting. When dampers have moved approximately half of their travel, full air pressure is admitted to the roof vent pneumatic operator to open the roof vent. On a further rise in room temperature the ventilating unit is energized and the second gravity vent is opened simultaneously.

Heating

On a drop in room temperature the outside air damper at the heating and ventilating unit gradually closes and the return air damper gradually opens to reduce the percent of outside air to 50%.

On a further drop in room temperature the modulating three way valve port, permitting hot water circulation through the heating coil, gradually opens.

Zone 5 Entrance & Toilets, First Floor, Two Story Wing

Equipment for this zone consists essentially of a heating and ventilating unit containing filters, heating coil and fan, and an exhaust fan.

Heating

On a drop in space temperature the zone thermostat output pressure gradually drops. The modulating three way valve permits hot water circulation through the heating coil. An auxiliary thermostat prevents the supply air temperature from dropping below 55°F.
Ventilating
The heating and ventilating unit fan runs continuously and provides 100% outside air to the space. The toilet exhaust fan is interlocked so as to run whenever the heating and ventilating unit operates. A slight positive pressure is maintained in the space.

Zone 6 First Floor Offices
The equipment for this zone consists essentially of a reheat coil. Ventilating air is supplied from the ventilating unit serving Zone 9.

Heating
On a drop in room temperature the zone thermostat output pressure gradually decreases. The three way valve modulates to permit hot water circulation through the heating coil.

Ventilation
The ventilation rate is increased by automatically shifting the fan to high speed. The change in fan speed for summer-winter operation is accomplished by the thermostat in the Fabrication area, Zone 9. Air is relieved from the offices to the Fabrication area through door louvers.

Zones: 6, 8, 9 Fabrication, Aluminum Spray and Cold Test, Final Assembly
Equipment for these zones consists essentially of a ventilating unit, zone heating coils, motor operated dampers, and a hood exhaust fan.

Heating
On a drop in room temperature in a zone the zone thermostat output pressure gradually drops. The three way valve modulates to permit hot water circulation through the heating coil.

Ventilation
On a rise in temperature in the Fabrication room a modulating pneumatic thermostat gradually increases its output pressure. A pressure electric switch operates to shift the fan motor to high speed and to partially close the pneumatic damper in the duct to the Aluminum Spray Room which keeps the air supply to the Aluminum Spray Room at approximately 500 cfm.
The hood exhaust fans runs continuously when the ventilating unit operates.

Zone 10 - Furnace Area

Equipment for this zone consists essentially of a roof mounted exhaust fan with a two speed explosion-proof motor, and four pneumatic type window operators with adjustable orifices.

Ventilation

On a rise in room temperature to 78°F the exhaust fan switches to high speed and the pneumatic window operators open the windows to admit outside air to the space. An interlock with the hydrogen detection system, and a manual switch are also provided to switch the fan to high speed and open the windows for emergency venting.

Zone 11 - Process Area

Equipment for this zone consists essentially of a roof mounted exhaust fan, three pneumatic type window operators with adjustable orifices and two unit heaters.

Heating

On a drop in room temperature the zone thermostat output pressure gradually decreases. At a room temperature of 70°F the two unit heater fans are energized.

Ventilation

On a rise in room temperature to 80°F the exhaust fan is energized and the pneumatic window operators open the three windows. An interlock with the hydrogen detection system prevents the operation of either the unit heaters or the exhaust fans when hydrogen is detected.

Zone 12 - Storage

Equipment for this zone consists essentially of a roof mounted exhaust fan, three pneumatic type window operators with adjustable orifices and a unit heater.
Heating

On a drop in room temperature the zone thermostat output pressure gradually decreases. At a room temperature of 70°F the unit heater fan is energized.

Ventilation

On a rise in room temperature to 80°F the exhaust fan is energized and the pneumatic window operators open the three windows. An interlock with the hydrogen detection system prevents the operation of either the unit heaters or the exhaust fans when hydrogen is detected.

Zones 13 through 21 - Light Laboratories

Equipment for these zones consists essentially of one two-speed ventilating unit containing filters and a supply fan, and nine individual zone heating coils and two speed exhaust fans.

Heating

On a drop in supply air temperature below 64°F the supply fan and the nine exhaust fans switch to low speed. On a drop in room temperature the zone thermostat output pressure gradually drops. The modulating three-way valve permits hot water circulation through the heating coil.

Ventilating

On a rise in supply air temperature above 66°F the supply fan and nine exhaust fans switch to high speed. Thermostats and hot water valves are to be compatible for future control of a system including three-way chilled water valves for air conditioning.

Zone 22 - Chemical Laboratory and Wet Blast Room

Equipment for this zone consists essentially of a heating and ventilating unit containing filters, hot water heating coil and fan, and an exhaust fan.
Heating

On a drop in room temperature in the Chemistry Laboratory the zone thermostat output pressure gradually drops. The three-way valve modulates to permit hot water circulation through the heating coil.

Ventilation

Supply and exhaust fans are interlocked with manually control and with manual override on the exhaust fan.

Zone 23 - Mechanical Equipment Room

Equipment for this zone consists essentially of an exhaust fan.

Ventilation

The exhaust fan and windows are manually controlled.

Zone 24 - General Assembly

Zone 25 - Ceramic Room, Metal Spray, Cathode Spray, Cathode Assembly Room, Air Lock

Equipment for these zones consists essentially of an air conditioning unit containing filters, cooling coil and fan, a refrigeration condensing unit, humidifier unit, hot water heating coils for each zone, exhaust fans for the Metal Spray Room and the Cathode Spray Room, and an absolute filter for the Cathode Assembly Room and the Air Lock.

Cooling

On a rise in temperature in the Cathode Assembly Room the output pressure from the thermostat gradually rises, is transmitted through a diverting relay, and operated a pressure electric switch which energizes the refrigerant liquid solenoid valve and admits refrigerant to the cooling coil. The refrigeration compressor maintains evaporator temperature by unloading its cylinders in steps of one-third capacity. When cooling is no longer required the refrigerant solenoid valve is closed and the compressor pumps down and shuts off.
Heating

On a drop in zone temperature the zone thermostat output pressure gradually drops. The modulating three-way valve permits hot water circulation through the zone heating coil.

Dehumidification

On a rise in humidity above 50% in the Cathode Assembly Room the output pressure from the humidistat rises. The pressure is transmitted to the pressure electric switch, through a pneumatic diverting relay, energizing the liquid refrigerant solenoid valve and admitting refrigerant to the cooling coil. Refrigeration is controlled as in the cooling sequence.

Humidification

On a drop in humidity below 40% in the Cathode Assembly Room the output pressure from the humidistat drops. The pressure electric switch energizes the humidifier which adds atomized water to the supply air stream.

MS5 - 26. REFRIGERANT: Refrigerant employed in the air conditioning system shall be the type indicated hereinbefore. The system shall be completely charged with refrigerant, after which it shall be tested and proved tight at all joints. The air conditioning system shall be subjected to the operating test hereinafter specified. Upon satisfactory completion of the tests, any refrigerant which has been lost from the system shall be replaced.

MS5 - 27. LUBRICATING OIL: The Contractor shall furnish 2 complete charges of lubricating oil for the compressor crankcase. The oil shall be of a type recommended by the manufacturer of the equipment. One charge shall be used during the testing period and at the end of 2 weeks and upon the satisfactory completion of the tests, the oil shall be drained and replaced with the second charge.
**MS5 - 28. DRAFT GAGES:** Draft gages for measuring the resistance to air flow through the filters shall be installed where shown on the drawings. Each draft gage shall be an inclined-tube differential type, equipped with a shut-off cock opening to atmosphere for checking the zero setting, and with shut-off cocks in the lines to points where the draft is measured. The scale shall have white background with heavy black divisions and unless otherwise indicated figures, shall not be less than 8 inches in length, and shall be graduated to read drafts up to one inch of water by hundredths of an inch. Each gage shall be provided with a bubble level gage and with screw adjustments for zero setting.

**MS5 - 29. DUCTWORK:** Ductwork shown on the drawings, specified, or required for the heating, ventilating and air conditioning systems shall be constructed and erected in a first-class, workmanlike manner. Ducts, unless otherwise approved by the Contracting Officer, shall conform accurately to the dimension indicated on the drawings, and shall be straight and smooth on the inside, with joints neatly finished. Ducts shall be securely anchored to the building in an approved manner, and shall be installed so as to be completely free from vibration under all conditions of operation. Curved elbows shall have a centerline radius not less than 1½ times the width of the duct. Air turns shall be installed in all abrupt elbows. The air turns shall consist of curved metal blades or vanes, arranged so as to permit the air to make the abrupt turns without appreciable turbulence, shall be the manufacturer's standard products, and shall be quiet and free from vibration when the system is in operation. Sheet metal ducts shall be properly braced and reinforced with galvanized steel angles or other structural members approved by the Contracting Officer. The internal ends of all slip joints shall be installed in the direction of flow. The sheet metal ducts and stiffeners shall conform to Tables I and II.
### TABLE I

**Sheet Metal Gages for Rectangular Duct Construction**

<table>
<thead>
<tr>
<th>Aluminum B &amp; S Gage</th>
<th>Steel U.S. Gage</th>
<th>Maximum Side Inches</th>
<th>Type of Transverse Joint Connections</th>
<th>Bracing</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>26</td>
<td>Up to 12</td>
<td>S, drive, pocket, or bar slips on 7', 10&quot; centers</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13 to 24</td>
<td>S, drive, pocket, or bar slips on 7', 10&quot; centers</td>
<td>None</td>
</tr>
<tr>
<td>22</td>
<td>24</td>
<td>25 to 30</td>
<td>S, drive, 1&quot; pocket or 1&quot; bar slips on 7', 10&quot; centers</td>
<td>1xlxl/8&quot; angles 1/4' from joint</td>
</tr>
<tr>
<td></td>
<td></td>
<td>31 to 40</td>
<td>Drive, 1&quot; pocket or 1&quot; bar slips on 7', 10&quot; centers</td>
<td>1xlxl/8&quot; angles 1/4' from joint</td>
</tr>
<tr>
<td>20</td>
<td>22</td>
<td>41 to 60</td>
<td>1 1/2&quot; angle connections, or 1 1/2&quot; pocket or 1 1/2&quot; bar slips with 1-3/8&quot;xl/8&quot; bar reinforcing on 7', 10&quot; centers</td>
<td>1 1/2xl1/8&quot; angles 1/4' from joint</td>
</tr>
<tr>
<td>18</td>
<td>20</td>
<td>61 to 90</td>
<td>1 1/2&quot; angle connections, or 1 1/2&quot; pocket or 1 1/2&quot; bar slips 3' 9&quot; maximum centers with 1-3/8&quot;xl/8&quot; bar reinforcing</td>
<td>1 1/2xl1/8&quot; diagonal angles, or 1 1/2xl1/8&quot; angles 2' from joint</td>
</tr>
<tr>
<td>16</td>
<td>18</td>
<td>91 up</td>
<td>2&quot; angle connections or 1 1/2&quot;xl1/2&quot; bar slips 3</td>
<td>1 1/2xl1/8&quot; diagonal angles, or 1 1/2xl1/8&quot; angles 2' from joint</td>
</tr>
</tbody>
</table>
a. Table I is for normal pressures and velocities utilized in typical ventilating and air conditioning system. Where special rigidity or stiffness is required, ducts should be constructed of metal 2 gages heavier. All insulated ducts 18 inches and larger should be cross-broken. Cross-breaking may be omitted on uninsulated ducts if metal 2 gages heavier is used.

b. Other approved joint connections of equivalent mechanical strength and air tightness may be used.

c. Duct sections of 3 feet 9 inches may be used with bracing angles omitted, instead of 7 feet 10 inches lengths with 0 joints indicated.

d. Ducts 91 inches and larger require special field study for hanging and supporting methods.

**TABLE II**

**SHEET METAL GAGES FOR CIRCULAR DUCTS.**

<table>
<thead>
<tr>
<th>Aluminum B &amp; S Gage</th>
<th>Steel U.S. Std. Gage</th>
<th>Diameter of Duct - Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>26</td>
<td>Up to 13</td>
</tr>
<tr>
<td>22</td>
<td>24</td>
<td>Over 13 to 33(\frac{1}{2})</td>
</tr>
<tr>
<td>20</td>
<td>22</td>
<td>Over 33(\frac{1}{2}) to 67(\frac{1}{2})</td>
</tr>
</tbody>
</table>

**MS-30. DAMPERS:** (a) Multilouvered, Butterfly, and Splitter or Air Intake Dampers. Multilouvered, butterfly, and splitter or air intake dampers shall be installed where indicated on the drawings, and shall be constructed of zinc-coated iron or steel sheets weighing not less than 1.6562 pounds per square foot (20 gage), or other suitable materials approved by the Contracting Officer. Dampers shall be reinforced to prevent vibration, and shall be equipped at both ends with bearings of a type approved by the Contracting Officer.
shall be close fitting, and unless automatic in operation, shall be provided with adjustment quadrants and locking devices mounted in an accessible location. Access doors shall be provided to adjustment quadrants and locking devices for dampers in ductwork concealed in furred spaces. In lieu of access doors, flush cup damper regulators with bearings of a type approved by the Contracting Officer may be installed. Dampers shall be designed to offer a minimum of resistance to the flow or air. Motor-operated dampers shall be provided where indicated in the drawings.

(b) Supply-Volume Dampers. Supply-volume dampers shall be standard catalog products, and shall be installed behind supply grilles where indicated on the drawings. Each volume damper shall consist of a metal frame containing a number of vanes, individually adjustable so as to control both the distribution of air over the face of the outlet, and the volume of air delivered to the space. The design of the Dampers shall be such that there will be no rattling or vibration when the system is in operation. Extractor type dampers with interconnected air directing blades shall be installed where indicated on the drawings. They shall be easily adjustable and shall provide uniform distribution of air in the branch.

MS5 - 31. FLEXIBLE CONNECTIONS: Unless otherwise indicated on the drawings or specified, flexible connections shall be provided between the air conditioning units or fan housings and the ducts with which they are connected. The material used shall be wire-reinforced glass or asbestos fabric of suitable weave and weight, and shall be rendered practically airtight in an approved manner. The necessary angles, bolts, clips, or other fastenings for securing the flexible material to the equipment and ducts shall be furnished. The use of canvas weighing not less than 15 ounces per square yard will be permitted in locations where the occurrence of fire in the duct or adjacent space is highly improbable.
MS5 - 32. REGISTERS AND GRILLES: Registers and grilles shall be installed where indicated on the drawings. Unless otherwise specified, air-supply grilles shall be of the air conditioning type, with adjustable directional vanes for obtaining the desired air distribution. Each supply grille shall have a net free area as indicated in the schedule, and in no case less than 70 percent. Exhaust registers and grilles shall be either of the air conditioning type or of the plain-lattice stamped-metal type, unless specifically described on the drawings, and shall have dimensions and net free area not less than 60 percent of the duct opening. Adjustable volume dampers installed back of the grille or register face shall be as hereinbefore specified. Key-operated dampers shall be provided where indicated on the drawings. Registers and grilles shall be standard catalog products, and shall be given a rust-inhibiting primer at the factory.

MS5 - 33. CEILING-TYPE AIR-DIFFUSING SUPPLY OUTLETS: Ceiling-type air-diffusing supply outlets designed to operate without noticeable drafts or noise shall be installed where indicated on the drawings. Each outlet shall uniformly distribute the specified volume of air over the horizontal cross-sectional area served, and at the same time shall induce the circulation of a volume of air from the room, and thoroughly mix it with the conditioned supply air. The outlets shall operate to maintain uniform temperatures throughout the space served, by keeping the air in slow motion without pockets, and shall not introduce undue resistance to the flow of air from the duct system. Volume dampers shall be provided in the necks of all outlets.

MS5 - 34. INSULATION: (a) DUCTS. Unless otherwise indicated on the drawings, supply and return ducts that are not exposed within occupied spaces after taping tight shall be insulated with not less than one inch thickness of impregnated mineral wool, thermally equivalent thickness of glass insulation, or other equally suitable material approved.
of glass insulation, or other equally equivalent thickness of glass insulation, or other equally suitable material insulation, or other equally suitable material approved by the Contracting Officer. The insulating material shall be set in a waterproof adhesive. Insulation on air conditioning supply and return ducts and supply ducts for the light laboratories Zones 13 through 21 shall be coating with suitable water-repellent cementing substance that will provide an effective vapor barrier. An approved vapor barrier envelope may be furnished if standard with the manufacturer of the insulation and suitable for the finish coating. Insulation exposed within equipment rooms or other spaces where it may be subject to damage shall be protected by means of a finish coating of suitable plaster not less than $\frac{\frac{1}{4}}{\frac{1}{4}}$ inch in thickness, applied in a manner recommended by the manufacturer of the insulation and approved by the Contracting Officer. Insulation on ducts on the roof or exposed to the weather shall be two inch thickness, shall have an approved vapor barrier as described above and shall be water-proofed with an application of 45 pound roofing felt, lapped three inches, and wired in place with No. 16 galvanized wire on 6-inch centers. The insulation shall be mechanically secured to the ducts by means of galvanized steel wire and corner angles, cemented surface anchors, or other approved devices or methods. If the wiring method is used, corners of the insulation shall be adequately protected.

MS5 - 35. **FIRE DAMPERS:** Fire dampers of suitable automatic type shall be installed where indicated on the drawings and wherever required by the applicable National Board of Fire Underwriters Codes. Construction and installation shall be as illustrated in applicable codes, and fusible links shall be designed to melt at a temperature of approximately 50 degrees F. in excess of the maximum temperature normally encountered.
MS5 - 36. PAINTING AND FINISHING: Duct hangers, and other ferrous metal work installed outside finished rooms, and not requiring finish painting, shall be thoroughly cleaned and given one coat of asphalt varnish. Air conditioning machinery, including compressors, motors, condensers, and pumps, shall be thoroughly cleaned and given 2 coats of machinery enamel in a color selected by the Contracting Officer. Unless otherwise specified, or otherwise provided for at the factory, ferrous metal specified to receive finish painting shall be primed as specified in Section, "Painting, Protective, On Metal". Finish painting of registers, grilles, diffusing supply outlets, equipment, and ductwork exposed within finished rooms is specified under Section, "Painting".

MS5 - 37. SAFETY CODES: The American Society of Refrigerating Engineers' Standard No. 15 and the State of California Industrial Safety Orders shall be followed in the installation of each system. Safety and protective devices called for in the Codes shall be furnished and installed by the Contractor.

MS5 - 38. CONTROL EQUIPMENT AND CONNECTIONS: All motors and control, starting, signaling, switching, interlocking, and protective equipment, and all control wiring and connections and/or all pneumatic control piping and connections required to properly operate all mechanical systems in the manner required and intended by the specifications shall be installed as specified in this Section. All wiring, other than control wiring for the temperature control system (such as pneumatic-electric and electric-pneumatic relays), and all connections required to furnish electric power to such control devices and mechanical equipment shall be installed in accordance with the electrical section. The automatic control equipment shall be installed under the direct supervision of the manufacturer's representative in strict accordance with
the wiring and/or pneumatic line diagrams as recommended by the manufacturer and approved by the Contracting Officer. Before the installation is accepted, the Contractor shall deliver to the Contracting Officer a statement from the manufacturer or his authorized agent, certifying that the automatic control equipment has been inspected and found to be properly installed and functioning satisfactorily. The supervision and inspection shall be at the Contractor's expense which no additional cost to the Government.

MS5 - 39. ELECTRICAL WORK: All manual or automatic control and protective or signal devices required for the operation of the air conditioning equipment herein specified and any wiring required but not indicated on the electrical plans shall be furnished and installed under this section of the specification. Wiring shall conform to the electrical section. A complete electrical-connection diagram for each piece of mechanical equipment having more than one automatic or manual electrical-control device shall be submitted to the Contracting Officer for approval.

MS5 - 40. INSTALLATION OF EQUIPMENT: Air conditioning equipment shall be installed in accordance with the recommendations of the manufacturer and to the satisfaction of the Contracting Officer.

MS5 - 41. OPERATION AND MAINTENANCE INSTRUCTIONS: Operation and maintenance instructions in printed form, for each major item of equipment shall be posted at locations designated by the Contracting Officer. Upon completion of the work, and at a time designated by the Contracting Officer, a competent engineer shall be provided by the Contractor for a period of not less than 3 days to instruct representatives of the Government in the operation and maintenance of the air conditioning system and other equipment.
TESTS. After the tests required for the piping system have been completed, and before each system is accepted, capacity and heating and ventilating general operating tests of the air conditioning system shall be conducted by a competent and experienced engineer in the presence of the Contracting Officer or his authorized representative. The tests shall demonstrate the specified capacities of the various pieces of equipment. A direct-reading velocity instrument that has been recently tested and calibrated shall be used to show that the air flow in the various ducts has been so regulated as to deliver or move the required number of cubic feet of air per minute at the respective supply or exhaust opening. The tests shall be recorded in quintuplicate on a form approved by the Contracting Office and with 2 copies to the Using Agency. The general operating tests shall cover a period of not less than 12 hours for each system, and shall demonstrate that the entire equipment is functioning in accordance with the specifications and to the entire satisfaction of the Contracting Officer. The Contractor shall furnish all instruments, test equipment, and personnel that are required for the tests, and the Contractor shall furnish the necessary fuel, water, and electricity.

GUARANTEE: The following equipment to be furnished under this section of the specifications shall be guaranteed for a period of one year from the date of acceptance thereof, either for beneficial use or final acceptance, whichever is earlier, against defective materials, design, and workmanship:

Air handling units
Compressors and motors
Condensers, water-cooled
Humidifier
Cooling coils
Heating coils
Circulating fans
Unit heaters
Air handling units
Pressure gages
Upon receipt of notice from the Government of failure of any part of the guaranteed equipment during the guarantee period, the affected part or parts including any damage to the building shall be replaced promptly with new parts by and at the expense of the Contractor.

MS5 - 44. EQUIPMENT OPERATING AND MAINTENANCE DATA: For each item of equipment and component thereto, the Contractor shall furnish the Contracting Officer 6 copies each of the Vendor's and/or manufacturer's catalogs, manuals, cuts, diagrams, parts lists, including list of spare parts recommended for one year's operation and related technical data. These data shall include, but not be limited to, such detailed information as operation, maintenance, trouble shooting, repair, service, installation, removal and inspection, as appropriate to the equipment. Specific operation and maintenance information for components of the major items of equipment shall be furnished by the Contractor as required to assure integration into the operating maintenance technical data for the major items of equipment affected. Each document submitted shall be annotated with Contract Number, Building Name, Major System, etc.