SECTION 15650 - AIR CONDITIONING AND VENTILATION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

The General Provisions of the contract, including the General Provisions for Construction Projects (2016), Special Provisions, and General Requirements of the Specifications, apply to the work specified in this Section.

1.02 SUMMARY

A. Provide complete and operating air conditioning and ventilation systems. "Provide" shall mean "Furnish and Install" when used herein. The air conditioning and ventilation systems shall include all equipment and all related items necessary to complete the work as shown on the drawings and herein specified. The work shall include the following:

1. Removal of existing materials and equipment.
2. Refrigerant piping and accessories.
3. Condensate drain piping.
4. Ductwork and accessories.
5. Insulation
6. Air cooled condensing unit.
7. Air handling units/Fan Coil Units.
8. Controls and control wiring.
9. Corrosion protection.
10. Adjusting, balancing and testing.
11. Painting and finishing.
12. Operating and maintenance instructions.
13. Manufacturer's literature, shop drawings, record drawings.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 15400 - PLUMBING.

B. Line voltage wiring and conduit is specified in Division 16 - ELECTRICAL.

1.04 GENERAL REQUIREMENTS

A. It is the intent of the plans and specifications to provide a complete installation. Should there be omissions or discrepancies in the plans and specifications, the Contractor shall call the attention to such omissions and discrepancies in advance of the date of bid opening so that the necessary corrections can be made. Otherwise the Contractor shall furnish and install the omissions or discrepancies as if the same were specified and provided for.

1. Standards:

a. All work shall be done in accordance with applicable ordinances and codes of the County of Hawaii and in accordance with State Department of Health regulations.

b. Work shall comply with applicable regulations of the State of Hawaii, National Fire Protection Association (NFPA) Pamphlet No. 90A, and American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Standard 15-1978.

c. Contractor shall obtain all permits, licenses and certificates and pay for all fees.

2. Drawings and Specifications: The drawings and specifications are intended to cover the complete installation of systems to function as described. The omission of reference to any necessary item of labor or material shall not relieve the Contractor from providing such labor or material. Drawings do not attempt to show exact details of piping and ductwork. Provide offsets as necessary to avoid local obstructions or interferences with other trades.

a. Contract Drawings: Mechanical plans are essentially diagrammatic, showing locations of ducts, and other mechanical equipment. Where locations are not dimensioned, they are approximate, and before installing, Contractor shall study existing conditions and make installation in most logical manner.

b. Shop Drawings: As soon as practical, and within 30 days after award of contract and before commencement of installation of any materials and equipment, six sets of shop drawings shall be submitted. Submittals shall consist of a complete list of equipment and materials, including

manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Incomplete and partial submittals will be returned unreviewed. Shop drawings shall also be submitted which contain layout drawings of ductwork and piping showing locations of hangers and supports, capacity curves or ratings to assure balanced refrigeration at the design conditions, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Where piping and equipment are to be supported other than as indicated, the details shall include loadings and types of frames, brackets, stanchions, or other supports. Control diagrams shall be submitted which identify each component and show all interconnected or interlocked components and the control sequence.

c. Record Drawings: Contractor shall keep a record set of drawings available at the jobsite on which all changes and additions in the Mechanical Work are shown. Contractor shall furnish the reproducible drawings of each installation showing the exact location of all items which are different from the original drawings.

1.05 WARRANTY

A. All work in this Section shall be under warranty for a period of 1 year from the date of acceptance of the work as a whole by DAGS, through the contracting officer. Should any equipment or material fall within this period, the Contractor shall replace or repair that item at no cost for material and/or services, if such is due to faulty workmanship or quality of material furnished.

B. The Contractor shall be responsible for all damage to any part of the premises caused by failure in the equipment furnished under this section for a period of 1 year after the final acceptance of the work as a whole.

PART 2 – PRODUCTS

2.01 MATERIALS

A. All materials delivered to the job site and installed shall be new, best of their respective grades and as specified on the drawings. Materials shall be of the same brand or manufacturer throughout for each class of material or equipment.

1. Refrigerant Piping and Accessories:

a. Copper tubing, ASTM B280, soft-annealed where bending is required and hard drawn where no bending is required. Soft annealed shall not be used larger than 1-3/8 inches. Joints shall be brazed.

b. Fittings: Wrought copper or forged brass sweat fittings, ANSI B16.22 and ASTM B75.

c. Solder: Silver solder conforming to AWS A5.8. Melting point not less than 1145 degrees F.

d. Refrigerant Shut-Off Valves: Valves shall be designed for use with the refrigerant used and shall have pressure ratings compatible with system working pressures encountered. Valves for copper tubing shall be all-brass, hand wheel operated, diaphragm packless type globe or angle valves in sizes up to and including 5/8 inch. In sizes over 5/8 inch the valves shall be brass or bronze globe or angle type, wrench operated with ground-finish stems, packed especially for refrigerant service, back-seated, and provided with seal caps.

e. Supports: MSS-SP-58 and SP-69, types 1, 5 ,6, 7, 9, 10, or 11 for suspended piping. Provide turnbuckles type 13 and 15 where required for vertical adjustment. Maximum spacing shall be specified in SP-69.

f. Strainers: Brass or cast-iron body, Y-pattern, cleanable, minimum 60-mesh non-corrodible screen with net free area not less than 10 times the pipe area, with pressure rating compatible with refrigerant service.

g. Solenoid Valves: The valves shall be of the 2 position, direct acting or pilot operated types, opened or closed, electrically as specified for use with liquid or gas refrigerant. The valves shall be designed for the required pressure drop and shall conform to ARI 760 and shall be listed by the Underwriters' Laboratories, Inc. for the service.

h. Thermostatic Expansion Valves: The expansion valves shall be of the diaphragm and spring-loaded type with external equalizers, bulb and tubing, and external superheat adjustment with seal cap. The valve size and superheat adjustment shall be as recommended by the valve manufacturer. Valves shall be tested and rated in accordance with ANSI B60.1 and 750 for capacities up to 135,000 Btu per hour. Valves shall have brass, bronze or semi-steel bodies with stainless steel or non-corrosive non-ferrous internal parts. Valves shall have brazing connections. Thermostatic expansion valve bulb shall be stable, and non-migrating and shall be suitable for the refrigerant valve capacity and evaporator temperature and shall be as recommended by the valve manufacturer.

i. Liquid Line Driers: The liquid line drier shall be the solid desiccant type. Flow rate capacity shall be within the maximum allowable pressure drop, and safety shall conform to the requirements of ARI Standard 710. Drier body shall be of brass or steel and shall be provided with means for holding the desiccant securely in place and distributing the liquid refrigerant evenly

throughout the desiccant. Driers shall be capable of withstanding a pressure of 350 psi. Driers may be of the combination drier-indicator type.

j. Moisture Indicators: The moisture indicators in the liquid line of refrigerant systems shall contain indicating material that will indicate moisture by varying degrees of color change, based on 100 degrees F and a moisture content in the range of 45 to 180 particles per million in R22 refrigerant. Indicators shall be a brass or bronze or heavily copper plated steel fitting with the indicator material located under a bulls-eye. Indicators shall be capable of withstanding a test pressure of 350 psig without damage.

k. Liquid Refrigerant Sight Glass: The sight glass shall be of the double-port see-through type with two bulls-eyes and part of the moisture indicator. Sight glass indicators shall be capable of withstanding a test pressure of 350 psig without damage. Sight glass body shall be forged brass or bronze with fittings as specified hereinbefore for refrigerant piping.

l. Liquid Receiver: Liquid receiver shall be the vertical or horizontal type, designed, fitted and rated in conformity with ARI 495, except as modified herein. The receiver shall be constructed and tested in conformity with Section VIII of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. Each receiver shall have a storage capacity not less than 20 percent in excess of that required for fully charged system. Each receiver shall be equipped with inlet, outlet drop pipes, drain plug, purging valve, relief valves of capacity and setting required by ANSI B9.1, and two bulls-eye liquid level sight glasses. Sight glasses shall be in same vertical plane, 90 degrees apart, perpendicular to axis of receiver.

2. Condensate Drain Piping:

a. Pipe and Fittings: Standard weight galvanized steel pipe, ASTM A120 or A53, with galvanized malleable iron threaded fittings.

OR

b. Pipe and Fittings: Schedule 40 PVC socket joint pipe and fittings, ASTM D1785, with solvent cement joints.

OR

c. Pipe and Fittings: Copper tubing, Type L, ASTM B88, with solder joint fittings, type 50/50 solder.

d. Supports: As specified for refrigerant piping.

3. Ductwork and Accessories:

    a. Sheet Metal Ductwork: Galvanized steel sheets, ASTM A527. Construction, gages, and reinforcement shall comply with SMACNA HVAC Duct Construction Standards, 1985 Edition.

    b. Exhaust Air and Unconditioned Outside Air Ductwork: Stainless Steel Type 316. Construction, gages, and reinforcement shall comply with SMACNA HVAC Duct Construction Standards, 1985 Edition.

    c. Fittings: Vaned elbows, take-offs, branch connections, transitions, volume dampers, and flexible connections shall comply with SMACNA standards. Dampers shall be opposed blade type with locking quadrant. Provide turning vanes in all elbows and where indicated.

    d. Supports: Galvanized steel straps or hanger rods in accordance with SMACNA Duct Construction Standards.

    e. Flexible Connections: Neoprene coated glass fabric weighing approximately 30 ounces per square yard.

    f. Fire Dampers: Provide where indicated and where required by NFPA 90A. Dampers shall comply with UL 555 and installation shall comply with SMACNA Fire Damper Guide for Air Handling Systems. Provide duct access panel at each fire damper for accessibility.

    g. Birdscreens: Two by two mesh, 0.063 inch diameter aluminum wire or .031 inch diameter stainless steel wire, with frame.

    h. Air Filters: Disposable type, 2 inches thick conforming to Underwriter's Laboratories (UL) Publication 900, Class 1 or Class 2, filter efficiency shall be 30% based atmospheric dust spot efficiency based on ASHRAE test method 52-92.

4. Air Devices:

    a. Security Supply Air Registers: Provide supply air registers that are steel with perforated faceplate, flat surface margin, extension sleeve, opposed blade damper and back mounting flanges. Provide 14 gage (minimum) faceplate with 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent. Provide a 14 gage (minimum) wall sleeve.

    b. Security Exhaust Air Registers: Provide steel exhaust air registers with perforated faceplate, flat surface margin, wall sleeve, opposed blade damper and back mounting flanges. Provide 14 gage (minimum) faceplate

with 1/2 by 1/2 inch holes on 3/16 inch spacing and a minimum free area of 45 percent. Provide a 14 gage (minimum) wall sleeve.

5. Insulation: Insulation, adhesives, coatings and accessories shall have surface burning characteristics as determined by ASTM E84, NFPA 255 and UL 723, not to exceed 25 for flame spread and 50 for smoke developed.

   a. Refrigerant Suction Piping:

      (1) Flexible Unicellular: ASTM C534, Type 2.

      (2) Polystyrene: Closed cell type, for outdoor use only.

   b. Pipe Insulation Finishes:

      (1) All Purpose Jacket: Provide factory applied all purpose jacket with integral vapor barrier. Jackets in exposed locations shall have smooth, white surface suitable for painting. Jacket may be omitted on flexible unicellular insulation only.

      (2) Vapor Barrier Material: Fed. Spec. HH-B-100, Type I.

      (3) Aluminum Jackets: ASTM C921, Type II, 0.016 inch thick, smooth.

      (4) Vinyl Lacquer: Provide two coats of vinyl lacquer finish or equal on flexible unicellular insulation located outdoors.

   c. Duct Insulation: Flexible fiberglass blanket, ASTM C 553, Type 1, class B-4, 1-1/2 pcf.

   d. Duct Insulation Finishes:

      (1) Multi-Purpose Jacket:: Provide factory applied jacket with integral vapor barrier.

      OR

      (1) Vinyl Vapor Retarder Jacket: Provide factory applied jacket with integral vapor barrier.

      (2) Vapor Barrier Material: Fed. Spec. HH-B-100B, Type I or II.

   e. Equipment Insulation:

      (1) Flexible Fiberglass, ASTM C 553, Type 1, Class B-3, with vapor barrier.

(2) Rigid Fiberglass, ASTM C 612, Class 2 with vapor barrier.

2.02 EQUIPMENT

A. Provide a complete air source, cooling only type Variable Refrigerant Flow (VRF) System consisting of one or more outdoor compressor units and multiple indoor fan coil units, or a Direct Expansion Split System unit (DX)consisting of one outdoor compressor unit and one indoor fan coil unit as specified in the mechanical schedule.

2.03 CONTROLS

A. General: Controls shall be electric, electronic, or solid-state electronic, or a combination that will provide the required sequence of operation control. Schematic control diagrams shall be submitted. All control work shall be performed by an experienced and licensed controls sub-contractor, and only the following manufacturers/installers shall do the work: Johnson Controls, Honeywell, Barber-Colman, Hawaii Instrumentation and Controls.

B. Thermostats: Full proportioning or two-positioning type, as indicated. Thermostats shall respond to a change of not over 1-1/2 degrees.

1. Space thermostats shall have concealed setpoint and exposed indicator.

2. Remote thermostats shall be duct, or immersion type, as required, with set point and throttling range adjustment in a remote metal case. Sensing elements, shall be secured in the duct or pipe to respond to the overall temperature.

C. Humidistats: Space type, with accuracy of plus or minus 5 percent, set point range of 20 to 80 percent relative humidity.

D. Control Relays: General purpose type, with plug in socket screw terminal connections, with 2 normally open and 2 normally closed sets of contacts unless otherwise indicated, and coil voltage as indicated.

E. Timeclocks: Seven-day type, with independently adjustable set points at increments not greater than 15 minutes, minimum of 4 on-off cycles per day, 10 hour reserve power. Intermatic, Paragon, or equal.

F. Wiring and Accessories: Provide all required interconnecting wiring to complete the system. Provide transformers as required. Electrical work shall comply with local codes and the electrical section of this specification.

G. Motor Starters: Horsepower rated manual or magnetic starters shall be provided, as indicated. Starters shall conform to NEMA ICS and shall have thermal overload protection and other appurtenances necessary and as indicated.

2.04 CORROSION PROTECTION

A. The finned coils shall be coated by an experienced and approved applicator who has developed the coating techniques necessary to apply uniform coating to all surfaces, avoiding excessive buildup on fin edges and other areas that would impair heat exchange. Coating shall be applied under shop conditions utilizing a clean, dry under-roof area with specialized equipment. Such an experienced and approved applicator with proper facilities is International A/C Coatings, Honolulu, Hawaii or approved applicator.

B. The entire apparatus being coated shall be dismantled to the maximum degree without disturbing piping or wiring. Upon completion of the coating, the apparatus shall be reassembled with care so that the coating surface is not damaged.

C. Surface preparation and application shall be in strict accordance with the coating manufacturer's instructions.

D. Coating System for Finned Coils: Heresite P-413, baked phenolic with plasticizer or approved equal shall be properly modified and applied by the approved applicator not to exceed 6 mils DFT in a 4 to 5 coat system. The coating shall withstand dry heat up to 205 degrees C (400 F), and show no signs of attack after 3000 hours of salt spray test to ASTM Specification B117.

E. Coating System for Other Surfaces: Ameron PSX 700 Engineered Siloxane shall be properly modified and applied by the approved applicator until a total of 6-8 mils DFT is achieved.

F. Primers: Apply a base primer of Heresite P-700.

G. Workmanship: Application of coating materials shall be done by skilled applicators. Criteria of good workmanship desired and neat appearance of the finished surfaces are: absence of sags, runs, and unnecessary brush marks. Other criteria are: thorough mixing of coatings, limited use of thinners, uniformity of film thickness, proper drying time between coats, and protection of surfaces not to be coated.

PART 3 – EXECUTION

3.01 INSTALLATION REQUIREMENTS

A. Necessary supports and vibration isolators shall be provided for equipment and appurtenances as required. Equipment shall be installed in accordance with manufacturer's instructions.

3.02 REFRIGERANT PIPING INSTALLATION

A. Unless otherwise specified, pipe and fitting installation shall conform to requirements of ASHRAE Standard 15 and ANSI B31.5. Pipe shall be cut accurately to measurement established at the jobsite and worked into place without springing or forcing. Pipes shall be cut square, shall have burrs removed by reaming, and shall be so installed as to permit free expansion and contraction. Filings, dust, or dirt shall be wiped from interior of pipe before connections are made. Changes in direction shall be made with fittings. Piping shall be installed with sufficient pitch to insure adequate oil drainage. Open ends of refrigerant lines or equipment shall be capped or plugged during installation to keep moisture, dirt or other foreign material out of the system.

B. Joints:

1. Joints in copper tubing shall be brazed with silver solder. Surplus brazing material shall be removed at all joints in lines not insulated. Tubing shall be protected against oxidation during brazing by using nitrogen in the tubes.

2. Threaded joints shall be made with tapered threads and made tight with a stiff mixture of graphite and oil or with polytetrafluoroethylene tape or other equivalent thread-joint compound applied to the male threads only.

C. Valves: Valves shall be installed with stems horizontal.

D. Hangers and Supports: Hangers, inserts, and supports shall conform to MSS SP-58 and SP-69. Hangers and other supports for insulated pipe shall be of sufficient size to accommodate the insulation and protection shield.

E. Returning Oil From Refrigerant System: Refrigerant lines shall be installed so that the gas velocity in the evaporator suction line is sufficient to move the oil along with the gas to the compressor. Except as indicated otherwise where equipment location requires vertical riser, the line size shall be such as to allow sufficient velocity to lift the oil at minimum system loading pressure and corresponding reduction of gas volume. A double riser shall be installed when excess velocity and pressure drop would result from full system loading. The larger riser shall have a trap, of minimum volume, obtained by use of 90 degree and 45 degree ells. The smaller riser shall be arranged with inlet close to end of lower horizontal line, and the larger riser shall connect from end of lower horizontal line to top of upper horizontal line. Valves shall not be installed in risers.

F. Charging Valves: Except as indicated otherwise provide charging valves for refrigerant system located on the receiver side or in the liquid line between the shut-off valve to the receiver or condenser-receiver and the liquid line sight glass. Valve shall be connected by full size liquid line tee.

G. Pipe Penetrations Thru Walls: Pack annular space between pipe and wall with a fire seal of asbestos rope, mineral wool or similar non-combustible material. Seal with silicone sealant or calking.

3.03 DUCTWORK INSTALLATION

A. Ductwork installation shall be in accordance with SMACNA Duct Construction Standards, 1985 Edition. Ducts shall be installed leaktight so that no leakage of air can be detected. Adjust dampers, diffusers, registers, and accessories to deliver air quantities indicated and so that draft and objectionable noise are eliminated. Provide turning vanes at all elbows and tees and extractors at all branch connections.

1. Sizes, runs, and connections of ducts shall be as indicated. Adhere to drawings as closely as possible. Install ductwork in adherence to heights permitted by the structure and consult with other trades, and in conjunction with them, establish necessary space requirements for each trade. Duct sizes shown on drawings are net size.

2. Openings through construction required for ductwork shall be provided; prepare shop drawings locating such duct openings, and obtain approval in ample time to meet building construction schedule. Ductwork specified herein shall have rectangular cross section unless otherwise indicated.

3. Details of construction, metal gauges, reinforcement and materials not specified herein shall be in accordance with SMACNA Low Velocity Duct Construction Standards, NFPA 90A or as approved. Fabricate ductwork in first class manner with airtight joints, presenting smooth surface on the inside, neatly finished on the outside.

4. Where square elbows are used, provide fixed double radius turning vanes. Construct, brace and support ducts in such a manner that they will not sag or vibrate when fans are operating.

5. Ductwork connections to air conditioning unit and exhaust fan shall be flexible duct connector material with 4" of free space between collars connected.

    a. Install a sheet metal band completely around collar at each end of connections and fasten to collars with screws through the band and glass fabric. Screws shall be placed no more than 3" on centers.

B. During construction, keep openings in ductwork closed with sheet metal to prevent injury and take all possible precautions to keep interior of ducts, air intake chambers and fan housings free from dirt or dust.

C. Support galvanized horizontal ducts and at changes of direction with hangers in accordance with SMACNA Duct Construction Standards.

D. All duct openings to exterior shall be weatherproofed with sheet metal blocking. Thoroughly seal all exterior duct openings and joints with silicone sealant.

3.04 INSULATION

A. Insulation shall be installed by an experienced licensed insulation contractor in accordance with best trade practices. Insulation shall be continuous through hangers and penetrations. Insulation shall be sealed to maintain integrity of vapor barrier. Insulate fittings, flanges, valves, etc., with premolded or precut insulation segments, same thickness as adjoining pipe.

1. Pipe Insulation: Insulate all refrigerant suction piping.

   a. Provide protective galvanized shields on pipes passing through hangers, MSS SP-69, Type 40.

   b. Thickness of pipe insulation shall be as follows:

      (1) Refrigerant Suction Piping:

         (a) Flexible Unicellular: 3/4 inch thick on pipes up to 2 inches and 1 inch thick on pipes over 2 inches.

         (b) Polystyrene: 1-1/2 inches thick on pipes up to 2 inches and 2 inches thick on pipes over 2 inches.

2. Vapor Barrier Jacket: Insulation shall be covered with vapor barrier jackets.

3. Pipe: Insulation shall be applied with joints tightly butted and ends sealed with vapor barrier coating. Jackets shall overlap and be sealed. Factory self-sealing lap systems may be used. All breaks and punctures in jackets shall be sealed.

4. Fittings, Flanges, Valves: Insulation of the same thickness and type shall be placed around the item, either premolded or segmented. Voids shall be filled with loose insulation or cement. Insulation shall be coated with glass tape embedded in two coats of vapor barrier coating or with premolded PVC fitting covers applied over a layer of vapor barrier coating.

5. Piping Exposed to Weather: Provide aluminum jacketing with overlapped joints over the above specified insulation and vapor barrier jacket.

B. Duct Insulation: Insulate all indoor ducts in strict accordance with the manufacturer's written instructions.

1. Thickness of duct insulation shall be 2" for all indoor ducts and 3" for exterior ducts.

3.05 ADJUSTING, BALANCING, AND TESTING

A. Cleaning and Adjusting: Pipes, strainers, valves and pumps shall be cleaned free of scale and thoroughly flushed of all foreign matter. Strainers and valves shall be thoroughly cleaned. Inside of air-cooled condensers shall be thoroughly cleaned of all debris and blown free of all small particles of rubbish and dust. Equipment shall be wiped clean with all traces of oil, dust, dirt, or paint spots removed. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

B. Tests:

1. Refrigerant Piping: The system shall be subjected to a pneumatic test. Pneumatic leak testing shall be done with dry nitrogen before any refrigerant pipe is covered. High and low side of the refrigerant system shall be tested for the minimum refrigerant leak field test pressure specified in ASHRAE 15, for the refrigerant employed in the system. System shall be proved tight under pneumatic test pressure by checking each joint with soap solution and after charging with refrigerant system shall be checked with a halide torch or by electronic leak detection. To repair leaks, the joint shall be taken apart, thoroughly cleaned, and remade as a new joint. System shall be proven tight and free of leaks by successfully completing the soap solution test and by allowing the pneumatic leak-test pressure to remain on the system for 24 hours with no drop in pressure. Correction of 0.3 psi will be allowed for each degree change in the initial and final temperature of the surrounding air, plus for an increase and minus for a decrease. After the foregoing tests have been satisfactorily completed and the pressure relieved, entire system shall be evacuated to an absolute pressure of 300 microns. Vacuum line shall be closed, and the system shall stand for 1 hour. After this period the absolute pressure shall not exceed 500 microns. Upon completion of the vacuum test, the system shall be completely charged with dry refrigerant. Provide a complete charge of lubricating oil, type as recommended by the manufacturer.

C. Performance Tests: Testing and balancing of the systems shall be performed by an independent testing agency, by personnel who are not employees of the installing contractor. After cleaning and testing are completed as specified, each system shall be tested as a whole to see that all items perform as integral parts of the system. Corrections and adjustments shall be made as necessary.

D. Balancing:

1. Duct systems shall be balanced as follows:

a. System (or air moving device) to not less than design cfm.

b. Diffusers, registers, and grilles.

E. Test Reports:

1. Typewritten schedules of readings taken during the balancing and testing operations indicating the required or specified reading, and the final balanced reading shall be provided for the following items:

a. Fans: Size, type, speed in rpm, outlet velocity in fpm, static pressure in inches water gage, air quantity in cfm, and motor load in amperes.

b. Air Handling Units: Size, type, fan speed in rpm, outlet velocity in fpm, external static pressure in inches water gage, total static pressure in inches water gage, air quantity in cfm, and motor load in amperes.

c. Air Balance:

(1) Air Outlets and Inlets: Size, velocity in fpm, and air quantity in cfm.

(2) Coils: Size, face velocity in fpm; air temperature entering coil and air temperature leaving coil, wet-bulb and dry-bulb in degrees F.

(3) Ducts: Size, velocity in fpm, and air quantity in cfm.

3.06 ELECTRICAL WORK

A. Electric motor driven equipment specified herein shall be provided complete with motors, motor starters, control wiring and controls. Electrical equipment and wiring shall be in accordance with ELECTRICAL Section. Motor starters shall be provided by Mechanical Contractor complete with properly sized thermal overload protection and other appurtenances necessary for the motor control specified. Manual or automatic control and protective devices required for the operation herein specified and any control wiring required for controls and devices but not shown on the electrical plan shall be provided. Electrical work shall conform to NFPA 70.

3.07 PAINTING AND FINISHING

A. Field painting of mechanical systems shall be as follows:

B. Provide touch-up painting on equipment whose factory finish has been damaged and on all walls, ceilings and other finished surfaces affected by this work. Touch up painting shall match adjacent surfaces.

C. Clean up all areas around the work installed under this section and remove all debris, dust, and dirt caused by the work.

3.08 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Bound Instructions: Six complete sets of instructions containing the manufacturer's operating and maintenance instructions for each piece of equipment shall be furnished. Flysheet shall be placed before instructions covering each subject. The instruction sheets shall be approximately 8-1/2 by 11 inches, with large sheets of drawings folded in. The instructions shall include, but shall not be limited to, the following:

1. Wiring and control diagrams, with data to explain the detailed operation and control of each component.

2. A control sequence describing startup, operation and shutdown.

3. Operating and maintenance instructions for each piece of equipment, including lubrication instructions.

4. Manufacturer's bulletins, cuts and descriptive data.

5. Parts lists and recommended spare parts.

B. Field Instructions: Upon completion of the work and at a time designated, the services of one or more project engineers shall be provided by the Contractor for a period of not less than one day to instruct the State in the operation and maintenance of the system. These field instructions shall cover all the items contained in the bound instructions.

PART 4 – MEASUREMENT AND PAYMENT

4.01 BASIS OF MEASUREMENT AND PAYMENT

A. Work under this section will not be measured nor paid for separately but shall be considered incidental to and included in the price bid for the various items of work in this project.

END OF SECTION