

SECTION 15950

TESTING, ADJUSTING, AND BALANCING

PART 1 –GENERAL

1.1 SUMMARY

- A. Section includes testing, adjusting, and balancing of air systems, testing, adjusting, and balancing of hydronic, steam and refrigerating systems, measurement of final operating condition of HVAC systems, sound measurement of equipment operating conditions, vibration measurement of equipment operating conditions.

1.2 REFERENCES

- A. AABC (Associated Air Balance Council) - National Standards for Total System Balance.
- B. ASHRAE 111 (American Society of Heating, Refrigerating and Air-Conditioning Engineers) - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.
- C. NEBB (National Environmental Balancing Bureau) - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.3 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Submittal procedures.
- B. Submittals: Three (3) copies each of the following information shall be submitted to the University's Project Manager:
 - 1. Balancing Data: All readings, measurements, and observations shall be recorded and submitted to the University's Project Manager. The content and format of submissions shall be in accordance with the Associated Air Balance Council (AABC) or National Environmental Balance Bureau (NEBB).
 - 2. A fume hood inspection report shall be included for each hood that is inspected. The report shall include a copy of the anemometer printout, and the calculated results, as well as the smoke test report.
 - 3. Fan and Pump Curves: Fan and pump curves with design and actual operation points plotted shall be submitted.
 - 4. Field Markings: Field markings shall be applied as follows
 - a. Final balancing position of manual air duct dampers shall be plainly marked.

- b. Final position of hydronic balancing valves shall be plainly marked in a manner that will allow the set position to be reestablished.
 - c. Field Quality Control: After the Balancing Contractor has submitted records of final readings and measurements for all systems, the University's Project Manager's Representative will make spot checks of each system. If spot check measurements differ from those submitted, the University's Project Manager will direct that the systems concerned be completely re balanced in the presence of the University's Project Manager's Representative and that new data be submitted. After submission of new data, the University's Project Manager's Representative will conduct a new series of spot checks of each system.
- C. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- D. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.
- E. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.
- F. Provide reports in 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
- G. Include detailed procedures, agenda, sample report forms, copy of AABC National Project Performance Guaranty, and Copy of NEBB Certificate of Conformance Certification 2 week prior to commencing system balance.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01770 - Execution Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.
- C. Systems Cleaning:
 - 1. General: The Project Specifications shall include a Cleaning Section for equipment, piping, ductwork, etc. The University will enforce the provisions of the Cleaning Section to the fullest extent.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance, ASHRAE 111, and NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
- B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

- A. Agency: Company specializing in the testing, adjusting, and balancing of systems specified in this section with minimum 3 years documented experience and certified by AABC or NEBB.
- B. Perform Work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, or a registered professional engineer experienced in performance of this work and licensed in the State of California.
- C. Field Quality Control
 - 1. Duct Air Leakage Tests: All tests shall be witnessed by the Project Manager's representative.
 - 2. High Pressure (S.P. greater than six (6) inches WG): High pressure ducts shall be tested for air leakage with a portable device that provides high pressure air and indicates amount of air leakage. Leakage shall not exceed 0.5% of total airflow. Also, noise generated from duct leakage shall not be acceptable. This test shall be witnessed and certified by the HVAC Design Consultant as well as the Project Manager's Representative.
 - 3. Medium Pressure (S.P. of 2-1/2 through six (6) inches, WG): Medium pressure ducts shall be tested using methods described in Paragraph 3.03.A.1 (above), except the leakage shall not exceed 1.0% of total airflow.
 - 4. Low Pressure (S.P. less than 2-1/2 inches WG): Low pressure ducts generally need not be tested for leakage as above; however, if visual inspection indicates leakage may exceed 5 % of total airflow, a leakage test may be required as directed by the Project Manager.

1.7 PRE-INSTALLATION MEETING

- A. Section 01330 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 SEQUENCING

- A. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.9 SCHEDULING

- A. Section 01330 - Administrative Requirements: Coordination and project conditions.
- B. Schedule and provide assistance in final adjustment and test of life safety, smoke evacuation, smoke control, toxic gas handling systems with Fire Authority.

PART 2 –PRODUCTS

2.1 NOT USED

PART 3 –EXECUTION

3.1 EXAMINATION

- A. Section 01330 - Administrative Requirements: Coordination and project conditions.
- B. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.
 - 13. Pumps are rotating correctly.
 - 14. Proper strainer baskets are clean and in place or in normal position.
 - 15. Service and balance valves are open.

C. Submit field reports. Report defects and deficiencies noted during performance of services, which prevent system balance.

D. SYSTEMS BALANCING

1. General:

- a. The decision regarding who shall retain the Balancing Contractor will be made on a project-by-project basis by the University. The Balancing Contractor shall comply with the Provisions of this article whether the Balancing Contractor is retained by the University under an independent contract, or is retained as a subcontractor, by the University, by the General, or by the Mechanical Contractor.
- b. The Balancing Contract Documents shall stipulate that within two (2) weeks of award of the Contract, the Balancing Contractor shall submit to the General Contractor a written statement detailing all special requirements and additional installation of dampers, valves, access panels, etc. necessary to accomplish the balancing work. The Balancing Contractor shall be responsible for providing all labor, materials, and equipment necessary to complete the balancing work after this two (2) week period.

2. Pre-Balancing:

- a. All systems shall be completed and tested early enough to enable completion of balancing prior to Owner moving in. The Architect and Project Manager shall be advised in writing when all systems have been completed and tested and are ready for balancing.
- b. Complete testing of all systems.
- c. The Mechanical Subcontractor shall complete or perform the following work prior to commencement of the balancing procedure:
 - 1) Prior to the start of balancing, complete all "Punch List" items that will affect balancing of the systems.
 - 2) Install all dampers and other balancing devices indicated in the Construction Documents and check to be sure they are properly installed, indexed, and in good working order.
 - 3) Place all systems in automatic operation.
 - 4) Schedule the work of all other trades to eliminate system shutdown for any reason once balancing is started.
 - 5) Schedule the work of other trades to assure uninterrupted access to mechanical equipment rooms and conditioned spaces.
 - 6) Check all motor starters and be sure the heater size is correct, taking length of electrical feeder into consideration.
 - 7) Provide labor and material necessary to perform any system revisions required to allow completion of balancing.

- 8) Align all drives.
 - 9) Set sheaves to provide indicated capacities at specified static pressures.
 - 10) Set all manual dampers to 100% open position.
 - 11) Set all balancing cocks to 100% open position.
 - 12) All adjustable pitch pulleys shall be removed from the motor shaft; the shaft and pulley threads shall be cleaned, lightly oiled, and the pulley remounted, aligned and properly adjusted.
 - 13) Clean interior of all plenums, casings, and ducts, and install temporary and final filters before starting any systems.
 - 14) Operate all systems simultaneously in normal operating mode for 72 consecutive hours without shutdown and with all equipment in perfect working order.
 - 15) Notify Contractor prior to start of tests to enable balancing to be scheduled.
 - 16) Drill 1/2 inch diameter test holes in ductwork in the following locations: immediately up-and-downstream of each filter, fan, coil, and motorized damper; 12 inch on center. for traverse readings in all main ducts or as directed by the Balancing Contractor. Install a replaceable rubber or plastic plug in each test hole. Plugs in fume exhaust ducts shall be corrosion proof.
- d. Performance and Capacity Measurements:
- 1) Reading shall be taken of pressures, flow rates, RPM, amps, and volts (as applicable) for the following equipment:
 - a) Pumps
 - b) Air handling equipment
 - c) Coils
 - d) VAV fans (take readings of amp draw over full, half, and minimum capacity operating ranges).
 - e) Verify set points for controls.
 3. Data indicating how the above readings compare with the manufacturer's published data shall be provided. Readings that do not conform to the manufacturer's published ratings shall be turned over to the Mechanical Contractor, whereupon corrections necessary to enable the equipment perform in accordance with the manufacturer's published data shall be made at no additional cost to the University.
 4. The above readings shall be taken by the Balancing Contractor, who will submit to the Architect and the University's Project Manager a certification stating that the equipment has been checked and is performing in accordance with the manufacturer's performance and design criteria.

5. Balancing of Air and Hydronic Systems:
 - a. General:
 - 1) System balancing shall be performed by a firm regularly engaged and specializing in the field of air and water balancing.
 - 2) The balancing firm must have experience in projects of similar type and scope, and shall submit to the Project Manager, prior to bidding, a list of names and qualifications of all personnel proposed to do this work, including the qualifications of the supervisor and engineering technician. Personnel shall have past experience of such a nature that qualifies them for balancing of these systems.
 - 3) The final balance report shall be checked by the Consulting Engineer.
 - 4) A detailed description of procedures shall be submitted. These are to reflect the specific system and components of the particular building to be balanced. A description of which instruments will be used for each type of measurement shall be included. Only procedures consistent with the provisions and standard format described in this Article will be accepted. Generalizations in lieu of specifics will be considered as non-compliant bids and as such will not be considered.
6. Scope of Work:
 - a. The test and balance service shall be performed upon completion of the air-handling and water systems and after completion of general operating tests.
 - b. Immediately following approval of mechanical shop drawings, the Balancing Contractor shall:
 - 1) Study the Contract specifications, and drawings, and prepare a schedule to inspect equipment for air and water systems.
 - 2) Recommend adjustments, corrections, and additions to equipment and air and water systems necessary for proper balancing, and submit these recommendations to the Architect and the University's Project Manager in a written report.
 - c. During installation of mechanical systems, the Balancing Contractor shall:
 - 1) Make field inspections prior to closing in portions of systems to be balanced; verify that all work, fittings, dampers, balancing devices, etc. are properly fabricated and installed as specified or shown on drawings, and that proper balancing can be done.

- 2) Prepare test and balancing procedures schedule, test record forms and technical information about the air and water systems necessary for balance work, and submit these materials to the Architect and the University's Project Manager for approval.
- d. Prior to the start of balancing work, the Balancing Contractor shall produce a single-line flow diagram of each system showing a representation of all components of the systems in their actual operational sequence. The diagram shall have a point-by-point tabulation of the flow, pressure and applicable temperature to be found at each point location on the diagram with design and actual final readings shown in the following format:
(design reading) (actual reading)
- e. Upon completion of installation of air and water systems, and after completion of general operating tests by the Mechanical Contractor, the following work shall be done:
 - f. Balancing shall include as a minimum, but not be limited to the following design and test-balance information:
7. Adjust and measure fume hood performance as follows:
 - a. Each hood shall be visually inspected for deficiencies. Each hood shall have an airfoil at the front edge of the counter top.
 - b. Set all fume hood sashes (on one fan system) at fifteen inch (15") height.
 - c. Measure the face velocity at the center of evenly spaced areas (approx. one square foot) in the face opening of the hood with a hot wire anemometer. Report the average of these readings as the fume hood face velocity.
 - d. After measuring the face velocity, each hood shall be tested by a smoke test following the ASHRAE 110 Standard, Sections 6.2.1 and 6.2.2.
 - e. Make allowance for air filter resistance at the time of the tests. The main air supplies shall be at design air quantities and at an air resistance across the filter bank midway between the design specifications for clean and dirty filters.
 - f. Verify control sequence, setting and operation of automatically controlled dampers. Final position of manual dampers shall be plainly marked after balancing is complete
 - g. Assure that all modulating control valves provided full-throttling wide-open (design) flows to 100% shutoff. Verify control sequences, settings and operation of all automatic control valves.
 - h. Final position of balance valves shall be plainly marked after balancing is complete. Read and record shut-off head and wide open head of each pump.
 - i. Air terminal reading shall be performed in accordance with the recommendations of the air device manufacturer. Submit a report

- for all tests made and for all readings taken.
- j. Sound readings shall be made as directed by the University's Project Manager for each specific project.
8. Balancing Performance Criteria:
- a. Total supply, return, or exhaust air quantities for any floor or major zone: -0% to +10%
 - b. Air flow through grills, diffusers and registers
 - 1) Air flow greater than 200 CFM: + 5%
 - 2) Air flow 200 CFM or less: + 10%
 - 3) Air flow at fume hoods: +/- 10 LFM (Avg.). Average fume hood face velocity tolerance with sash height at fifteen inches (15") and no single measured velocity less than seventy feet (70') per minute. LFM is linear feet per minute.
 - c. Waterflow through individual system components: +/- 5%
 - d. Pressure Reading
 - 1) Air systems: +/- 0.02 inch WG
 - 2) Water systems: +/- 0.5 psig
 - e. Temperature drop across coils: + 0.5°F
9. Notify the University's Project Manager and General Contractor immediately and discontinue all balancing work if it is found that any part of the system cannot be balanced to design specifications. Submit a written report to the University's Project Manager and General Contractor as necessary, describing the component, i.e., fan drive, damper, pump, valve, etc., that does not function properly to permit proper balancing to be performed.
10. Instruments shall have been calibrated within the last six months and checked for accuracy prior to starting the balancing procedure. Make velocity reading with an instrument that does not require a separate timer. Submit to the University's Project Manager for approval a list of all instruments, their proposed applications, and the date of latest calibration.
11. Test Conditions: Capacity checks of the heating systems shall be performed during the balancing period and again during a design day the following winter. Capacity checks for the cooling systems shall be performed during the balancing period and again during a design day the following summer. Building lights shall be off for the heating check and on for the cooling check at time of initial balancing. Two weeks notice shall be given to the General Contractor and the University's Project Manager prior to each of the design day capacity checks.
12. Field Markings: Field markings shall be applied as follows:
- a. Final balancing position of manual air duct dampers shall be plainly marked.
 - b. Final position of hydronic balancing valves shall be plainly marked in a manner that will allow the set position to be reestablished.

13. Field Quality Control: After the Balancing Contractor has submitted records of final Readings and measurements for all systems, the University's Project Manager's Representative will make spot checks of each system. If spot check measurements differ from those submitted, the University's Project Manager will direct that the systems concerned be completely re balanced in the presence of the University's Project Manager's Representative and that new data be submitted. After submission of new data, the University's Project Manager's Representative will conduct a new series of spot checks of each system.

3.2 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.3 ADJUSTING

- A. Section 01770 - Execution Requirements: Testing, adjusting, and balancing.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- F. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- G. Check and adjust systems approximately six months after final acceptance and submit report.

3.4 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.

- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes as required to vary fan speed. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries and in clean rooms.
- M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.
- N. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.
- O. On fan powered VAV boxes, adjust airflow switches for proper operation

3.5 WATER SYSTEM PROCEDURE

- A. Adjust water systems, after air balancing, to provide design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.6 EQUIPMENT REQUIRING TESTING, ADJUSTING, AND BALANCING

- 1. Fire Pumps
- 2. Sprinkler Air Compressor
- 3. Electric Water Coolers
- 4. Plumbing Pumps
- 5. Steam Condensate Pumps
- 6. Boiler Feedwater Pumps
- 7. HVAC Pumps
- 8. Water Tube Boilers
- 9. Packaged Steel Water Tube Boilers
- 10. Packaged Steel Fire Tube Boilers
- 11. Forced Air Furnaces
- 12. Direct Fired Furnaces
- 13. Reciprocating Water Chillers
- 14. Air Cooled Water Chillers
- 15. Centrifugal Water Chillers
- 16. Absorption Water Chillers
- 17. Induced Draft Cooling Tower
- 18. Blow Through Cooling Tower
- 19. Air Cooled Refrigerant Condensers
- 20. Packaged Roof Top Heating/Cooling Units

21. Packaged Terminal Air Conditioning Units
22. Unit Air Conditioners
23. Computer Room Air Conditioning Units
24. Air Coils
25. Evaporative Humidifier
26. Sprayed Coil Dehumidifier
27. Terminal Heat Transfer Units
28. Induction Units
29. Air Handling Units
30. Fans
31. Air Filters
32. Air Terminal Units
33. Air Inlets and Outlets
34. Controls Compressor
35. Heat Exchangers

B. Report Forms

1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude
 - j. Report date
2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate amount of building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions
3. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date

4. Electric Motors:
 - a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP and kW
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Service factor
 - g. Starter size, rating, heater elements
 - h. Sheave Make/Size/Bore
5. V-Belt Drive:
 - a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM
 - d. Belt, size and quantity
 - e. Motor sheave diameter and RPM
 - f. Center to center distance, maximum, minimum, and actual
6. Pump Data:
 - a. Identification/number
 - b. Manufacturer
 - c. Size/model
 - d. Impeller
 - e. Service
 - f. Design flow rate, pressure drop, BHP and kW
 - g. Actual flow rate, pressure drop, BHP and kW
 - h. Discharge pressure
 - i. Suction pressure
 - j. Total operating head pressure
 - k. Shut off, discharge and suction pressures
 - l. Shut off, total head pressure
7. Combustion Test:
 - a. Manufacturer
 - b. Model number
 - c. Serial number
 - d. Firing rate
 - e. Overfire draft
 - f. Gas meter timing dial size
 - g. Gas meter time per revolution
 - h. Gas pressure at meter outlet
 - i. Gas flow rate
 - j. Heat input
 - k. Burner manifold gas pressure
 - l. Percent carbon monoxide (CO)
 - m. Percent carbon dioxide (CO₂)
 - n. Percent oxygen (O₂)
 - o. Percent excess air

- p. Flue gas temperature at outlet
 - q. Ambient temperature
 - r. Net stack temperature
 - s. Percent stack loss
 - t. Percent combustion efficiency
 - u. Heat output
8. Air Cooled Condenser:
- a. Identification/number
 - b. Location
 - c. Manufacturer
 - d. Model number
 - e. Serial number
 - f. Entering DB air temperature, design and actual
 - g. Leaving DB air temperature, design and actual
 - h. Number of compressors
9. Chillers:
- a. Identification/number
 - b. Manufacturer
 - c. Capacity
 - d. Model number
 - e. Serial number
 - f. Evaporator entering water temperature, design and actual
 - g. Evaporator leaving water temperature, design and actual
 - h. Evaporator pressure drop, design and actual
 - i. Evaporator water flow rate, design and actual
 - j. Condenser entering water temperature, design and actual
 - k. Condenser pressure drop, design and actual
 - l. Condenser water flow rate, design and actual
10. Cooling Tower:
- a. Tower identification/number
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Rated capacity
 - f. Entering air WB temperature, specified and actual
 - g. Leaving air WB temperature, specified and actual
 - h. Ambient air DB temperature
 - i. Condenser water entering temperature
 - j. Condenser water leaving temperature
 - k. Condenser water flow rate
 - l. Fan RPM
11. Exchanger:
- a. Identification/number
 - b. Location
 - c. Service

- d. Manufacturer
 - e. Model Number
 - f. Serial Number
 - g. Steam pressure, design and actual
 - h. Primary water entering temperature, design and actual
 - i. Primary water leaving temperature, design and actual
 - j. Primary water flow, design and actual
 - k. Primary water pressure drop, design and actual
 - l. Secondary water leaving temperature, design and actual
 - m. Secondary water leaving temperature, design and actual
 - n. Secondary water flow, design and actual
 - o. Secondary water pressure drop, design and actual
12. Cooling Coil Data:
- a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Entering air DB temperature, design and actual
 - g. Entering air WB temperature, design and actual
 - h. Leaving air DB temperature, design and actual
 - i. Leaving air WB temperature, design and actual
 - j. Water flow, design and actual
 - k. Water pressure drop, design and actual
 - l. Entering water temperature, design and actual
 - m. Leaving water temperature, design and actual
 - n. Saturated suction temperature, design and actual
 - o. Air pressure drop, design and actual
13. Heating Coil Data:
- a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Water flow, design and actual
 - g. Water pressure drop, design and actual
 - h. Entering water temperature, design and actual
 - i. Leaving water temperature, design and actual
 - j. Entering air temperature, design and actual
 - k. Leaving air temperature, design and actual
 - l. Air pressure drop, design and actual
14. Electric Duct Heater:
- a. Manufacturer
 - b. Identification/number
 - c. Location

- d. Model number
 - e. Design kW
 - f. Number of stages
 - g. Phase, voltage, amperage
 - h. Test voltage (each phase)
 - i. Test amperage (each phase)
 - j. Air flow, specified and actual
 - k. Temperature rise, specified and actual
15. Induction Unit Data:
- a. Manufacturer
 - b. Identification/number
 - c. Location
 - d. Model number
 - e. Size
 - f. Design air flow
 - g. Design nozzle pressure drop
 - h. Final nozzle pressure drop
 - i. Final air flow
16. Air Moving Equipment:
- a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Arrangement/Class/Discharge
 - f. Air flow, specified and actual
 - g. Return air flow, specified and actual
 - h. Outside air flow, specified and actual
 - i. Total static pressure (total external), specified and actual
 - j. Inlet pressure
 - k. Discharge pressure
 - l. Sheave Make/Size/Bore
 - m. Number of Belts/Make/Size
 - n. Fan RPM
17. Return Air/Outside Air Data:
- a. Identification/location
 - b. Design air flow
 - c. Actual air flow
 - d. Design return air flow
 - e. Actual return air flow
 - f. Design outside air flow
 - g. Actual outside air flow
 - h. Return air temperature
 - i. Outside air temperature
 - j. Required mixed air temperature
 - k. Actual mixed air temperature

- l. Design outside/return air ratio
- m. Actual outside/return air ratio
- 18. Exhaust Fan Data:
 - a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Air flow, specified and actual
 - f. Total static pressure (total external), specified and actual
 - g. Inlet pressure
 - h. Discharge pressure
 - i. Sheave Make/Size/Bore
 - j. Number of Belts/Make/Size
 - k. Fan RPM
- 19. Duct Traverse:
 - a. System zone/branch
 - b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity
 - g. Test air flow
 - h. Duct static pressure
 - i. Air temperature
 - j. Air correction factor
- 20. Duct Leak Test:
 - a. Description of ductwork under test
 - b. Duct design operating pressure
 - c. Duct design test static pressure
 - d. Duct capacity, air flow
 - e. Maximum allowable leakage duct capacity times leak factor
 - f. Test apparatus
 - 1) Blower
 - 2) Orifice, tube size
 - 3) Orifice size
 - 4) Calibrated
 - g. Test static pressure
 - h. Test orifice differential pressure
 - i. Leakage
- 21. Air Monitoring Station Data:
 - a. Identification/location
 - b. System
 - c. Size
 - d. Area
 - e. Design velocity

- f. Design air flow
 - g. Test velocity
 - h. Test air flow
22. Flow Measuring Station:
- a. Identification/number
 - b. Location
 - c. Size
 - d. Manufacturer
 - e. Model number
 - f. Serial number
 - g. Design Flow rate
 - h. Design pressure drop
 - i. Actual/final pressure drop
 - j. Actual/final flow rate
 - k. Station calibrated setting
23. Terminal Unit Data:
- a. Manufacturer
 - b. Type, constant, variable, single, dual duct
 - c. Identification/number
 - d. Location
 - e. Model number
 - f. Size
 - g. Minimum static pressure
 - h. Minimum design air flow
 - i. Maximum design air flow
 - j. Maximum actual air flow
 - k. Inlet static pressure
24. Air Distribution Test Sheet:
- a. Air terminal number
 - b. Room number/location
 - c. Terminal type
 - d. Terminal size
 - e. Area factor
 - f. Design velocity
 - g. Design air flow
 - h. Test (final) velocity
 - i. Test (final) air flow
 - j. Percent of design air flow
25. Sound Level Report:
- a. Location
 - b. Octave bands - equipment off
 - c. Octave bands - equipment on
 - d. RC level – equipment on
26. Vibration Test:
- a. Location of points:

- 1) Fan bearing, drive end
 - 2) Fan bearing, opposite end
 - 3) Motor bearing, center (if applicable)
 - 4) Motor bearing, drive end
 - 5) Motor bearing, opposite end
 - 6) Casing (bottom or top)
 - 7) Casing (side)
 - 8) Duct after flexible connection (discharge)
 - 9) Duct after flexible connection (suction)
 - 10) Test readings:
 - 11) Horizontal, velocity and displacement
 - 12) Vertical, velocity and displacement
 - 13) Axial, velocity and displacement
- b. Normally acceptable readings, velocity and acceleration
 - c. Unusual conditions at time of test
 - d. Vibration source (if non-complying)

END OF SECTION