SECTION 15991
TESTING, ADJUSTING AND BALANCING (TAB) OF
HEATING, VENTILATING & AIR CONDITIONING (HVAC) SYSTEMS

PART 1 GENERAL

1.1 SCOPE OF SERVICES:

A. The HVAC/Mechanical Contractor shall provide an independent TAB Contractor to perform TAB work for HVAC systems. The TAB Contractor shall report to the Florida Tech Representative on all TAB activities.
B. The TAB Contractor shall be a firm registered by the State of Florida to perform Mechanical Engineering, or a firm certified by either the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB).
C. The TAB Contractor shall provide all technically qualified personnel, equipment, instrumentation, and materials on a continuous basis in order to complete TAB services in a timely manner.
D. The scope of services shall include, but not be limited to, the following:
    1. Review project documents to verify that the HVAC systems are designed in such a manner that TAB may be accomplished.
    2. Provide pre-TAB inspections of the HVAC systems during construction to assure that the systems are installed in conformance with project documents and approved shop drawings.
    3. Perform TAB of the HVAC systems in accordance with industry standard (Paragraph 1.2 References) to assure correct air/water flow rates and energy efficient operation.
    4. Provide certified TAB report of the HVAC systems in accordance with industry standards (Paragraph 1.2 References) and Florida Tech's special requirements (Section 15991).
    5. Provide coordination of TAB activities between the Design Mechanical Engineer, Mechanical Contractor, and Energy Management and Control System (EMCS) Contractor. Initiate conference calls and/or schedule meetings to resolve TAB issues and document solutions to TAB issues rather than engage in an endless paper war of finger pointing. If resolution is not possible or is not timely, schedule a meeting with the appropriate parties and the Florida Tech staff (Project Manager and/or the Director of Facilities Management).
    6. Unacceptable performance by the TAB Contractor may result in Florida Tech hiring an independent TBA Contractor and deducting the cost of such from the HVAC Contractor's contract and accessing delays to the HVAC Contractor.

1.2 REFERENCES

A. Associated Air Balance Council (AABC) - National Standard for Field Measurement and Instrumentation, Total System Balance, latest edition.
B. National Environmental Balancing Bureau (NEBB) - Procedural Standard for Testing, Balancing, and Adjusting of Environmental Systems, latest edition.
C. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE) - HVAC Systems and Applications Handbook, Testing, Adjusting and Balancing, latest edition.
D. Sheet Metal and Air Conditioning Contractors National Association (SMACNA) - HVAC Systems Testing, Adjusting and Balancing, latest edition.

PART 2 PROJECT DOCUMENT REVIEW

2.1 The HVAC Contractor will provide the TAB Contractor with design documents for review and analysis.

A. Mechanical drawings
B. Division 15 specifications
C. Room-by-room air balance analysis from the HVAC System Design Notebook

2.2 Within 15 calendar days, provide written design review report of deficiencies (errors, omissions, conflicts, etc.) that would preclude TAB in accordance with industry standards and Section 15991, and schedule a meeting with the Mechanical Engineer, Florida Tech Project Manager, and the Design Mechanical Engineer to resolve these deficiencies. The report shall address each item in Paragraphs 2.3 through 2.7 by itemizing each area reviewed and the results. The format for the design review report shall in accordance with Article 1.3.

2.3 Verify that the air distribution systems are completely defined.

A. Turning vanes are located in all mitered elbows greater than 45°
B. Splitter vanes are located in all smooth radius elbows greater than 45° with r/D ratios less than 1.5.
C. Volume dampers are properly located for correct air distribution and for low system noise. Volume dampers shall be located a minimum of five duct diameters from grilles and diffusers. Opposed blade dampers in grilles and diffusers shall not be utilized for balancing.
D. Volume dampers are factory manufactured rather than shop fabricated. For externally insulated ducts, 2" high standoffs for the locking quadrants are provided.
E. Air outlets are properly defined.

	PATTERN	CFM	SIZE
Supply Air Grilles	X	X	X
Ceiling Diffusers	X	X	X
Return Air Grilles (plenum)	NAP	X*	X
Return Air Grilles (ducted)	NAP	X**	X
Exhaust Air Grilles	NAP	X	X
Transfer Air Grilles	NAP	X*	X
Door Undercuts	NAP	X*	3/4"
Door Grilles	NAP	X*	X
Outdoor Air Intakes	NAP	X	X

* CFMs are shown to indicate proper air balance but are not balanced.
** CFMs are not balanced for VAV systems.
NAP Not Applicable

F. For relief air systems and outdoor air systems, the traverse locations have adequate lengths of straight duct for accurate traverses. Less accurate methods to determine CFMs are not acceptable.
G. The room-by-room air balance analysis results in a properly balanced and positively pressurized building. During student occupancy, exfiltration air shall equal either 0.10 CFM/SF with a relief air system or up to 0.15 CFM/SF without a relief air system.
H. For VAV systems, the scheduled maximum CFM for each VAV box is equal to the sum of the supply air CFMs for the VAV box.

2.4 Verify that the hydronic systems are completely designed.

A. For each cooling coil, the Venturis are properly located. Circuit setter valves, pitot tube flow meters and automatic flow control valves are not acceptable, and condenser water pumps, the gage cocks and pressure gages are properly located using the pump flange taps.
B. For each chiller evaporator and condenser, the Venturis are properly located. Circuit setter valves, pitot tube flow meters and automatic flow control valves are not acceptable.
C. For chilled water

D. For each chiller, the chilled water and condenser water gage cocks are properly located using the chiller manifold taps.
E. For each cooling coil, the thermometers are properly located.
F. For each chiller evaporator and condenser, the thermometers are properly located.
G. The scheduled GPMs for the cooling coils are consistent with the equipment schedules for the chilled water pumps and chiller evaporators.
H. The scheduled GPMs for the cooling towers are consistent with the equipment schedules for the condenser water pumps and chiller condensers.
I. The scheduled GPMs for the heating coils are consistent with the equipment schedules for the hot water pumps and boilers.

2.5 Verify that the isolation components for sound and vibration attenuation are properly located.

2.6 Verify that the EMCS and the sequence of operations are compatible with the HVAC system and TAB requirements.

2.7 Verify that other components - not specifically listed above, but necessary for TAB - are properly located.

2.8 Distribute the design review report per the Distribution List in Article 7.1.

2.9 The TAB Contractor is responsible for scheduling the meeting in Article 2.2.

PART 3 PRE-TAB INSPECTIONS

3.1 Coordinate inspection schedule with the Mechanical Contractor and provide written inspection schedule. Note Substantial Completion and Final Completion milestones on the TAB schedule.

3.2 Provide periodic inspections during construction and written pre-TAB punch lists within seven calendar days after each inspection. The frequency of inspections shall be determined by the TAB Contractor to provide adequate inspection coverage but shall not be less than monthly during HVAC system installation. Inspection reports shall define area inspected and shall itemize TAB punch items.

3.3 Inspections shall include, but not be limited to, the following areas:

A. Ductwork Systems (Outdoor, Supply, Return, Exhaust, Relief, etc.): Verify the proper installation of duct fittings, balancing devices, access doors, turning vanes, transitions, flexible connections, etc.
B. Piping Systems (Chilled Water, Condenser Water, Make-up Water, etc.): Verify the proper installation of pipefittings, balancing valves, Venturis, flexible connections, gage cocks, pressure gages, thermometers, etc.
C. HVAC Equipment: Verify that the manufacturer, model number, power supply, motor horsepower, accessories, etc. are per approved shop drawings. When shop drawings of a different manufacturer than scheduled in the project documents are approved, the data per the shop drawings shall be listed in the TAB report as design data. Verify that the motor starter's overload protectors are correct for the motor's rated load amperes.
D. Installation of HVAC Equipment: Verify that the installation is per the project documents and/or approved shop drawings.
E. Hydronic System Commissioning: Monitor the cleaning, flushing, filling and chemical treatment. Observe water samples being drawn and labeled. Advise the Project Manager, Department of

Facilities Management if the system commissioning is acceptable. Obtain copy of the chemical treatment test report and provide same in the TAB report.

3.4 Distribute the inspection schedule per the Distribution List in Article 7.2.

3.5 Distribute the pre-TAB punch lists per the Distribution List in Article 7.3.

3.6 Obtain a complete set of approved HVAC shop drawings, addenda, architect supplement instructions, change orders, etc. from the Mechanical Contractor (Section 15990).

3.7 The TAB Contractor is responsible for scheduling meetings with the Mechanical Contractor to obtain construction schedules for pre-TAB inspections and to resolve TAB punch items.

PART 4 TAB WORK

4.1 Coordinate TAB work schedule with the Mechanical Contractor and provide written TAB work schedule. Note Substantial Completion and Final Completion milestones on the TAB schedule.

4.2 Provide written punch lists summarizing non-complying items as soon as they are discovered but at least weekly. Punch lists shall clearly delineate the responsible party (Mechanical Contractor or Design Mechanical Engineer) for each punch item.

4.3 Punch items, relative to system performance, shall be documented by providing TAB test reports and plotting measured data on equipment performance curves. See Articles 8.2 thru 8.4. These punch items are the responsibility of the Design Mechanical Engineer if the HVAC systems have been installed per the project documents and approved shop drawings.

4.4 The TAB Contractor shall coordinate with the responsible party (Mechanical Contractor or Design Mechanical Engineer) to resolve punch items. However, any resolution that modifies the HVAC system design, operational modes or performance levels shall be approved, in writing, by the Design Engineer of Record.

4.5 After written notification of punch list repairs by the Mechanical Contractor, the TAB Contractor shall provide one re-TAB per item within this contract. Additional TAB fees due to repeat TAB punch items and retesting are the responsibility of the Mechanical Contractor. Documentation that is unclear, inaccurate or untimely will not be accepted.

4.6 Provide personnel on a continuous basis in order to complete the TAB work in a timely manner. Every effort shall be made to complete the TAB work before Florida Tech occupancy and/or Substantial Completion. After Florida Tech occupancy, access to occupied areas may be restricted

4.7 And work schedules shall be modified accordingly. Work after normal business hours shall be coordinated. With the Project Manager, Department of Facilities Management.

4.8 On a regular basis, inform the Project Manager, Department of Facilities Management of the work in progress, work schedules and potential problem areas, which may delay the timely completion of TAB work.

4.9 Distribute the TAB work schedule per the Distribution List in Article 7.2.

4.10 Distribute the TAB punch lists per the Distribution List in Article 7.3.

4.11 The TAB Contractor is responsible for scheduling meetings with appropriate parties to obtain construction schedules for TAB work and to resolve TAB punch items.

PART 5 TAB REPORT

5.1 Publish the TAB report within 15 calendar days after Substantial Completion. The publishing of the TAB report shall not be delayed for unresolved punch items.

5.2 Data for non-complying systems shall be provided so that all parties are working with the same information to solve these outstanding punch items.

5.3 Coordinate with the Mechanical Contractor and Design Mechanical Engineer in order to resolve TAB punch items and provide written monthly status report. Provide revised TAB test reports for incorporation into the TAB report within 15 calendar days after outstanding punch items have been resolved. All punch items shall be resolved and TAB report shall be completed prior to Final Completion.

5.4 Distribute the TAB report, monthly status reports and revised TAB test reports per the Distribution List in Article 7.4.

PART 6 VERIFICATION OF MEASUREMENTS

6.1 Florida Tech shall have the option of requesting verification of measurements in the TAB report. Measurement verification shall involve 10% or less of the measurements in the TAB report. Florida Tech shall select the measurements to be verified and the TAB Contractor shall retest, in the presence of the Florida Tech Representative, those measurements.

6.2 To pass the measurement verification, at least 90% of those measurements shall be within the acceptable tolerance of the DESIGN value. The measurements that are out-of-tolerance shall be re-balanced to within acceptable tolerances.

6.3 If the measurement verification fails, the TAB Contractor shall rebalance all systems at no cost to Florida Tech. The measurement verification shall be repeated with another set of measurements that shall be selected by the Florida Tech.

6.4 The TAB Contractor shall provide revised TAB test reports for the re-balanced systems within 15 calendar days of measurement verification. Distribute revised TAB test reports according to the Distribution List in Article 7.4.

PART 7 DISTRIBUTION LIST

7.1 Design Review Report:

A. Direct report to the Mechanical Engineer of Record.
B. Provide copy of report to the Architect.
C. Provide 2 copies of report to Florida Tech Facilities Department.

7.2 Pre-TAB Inspection Schedule and TAB Work Schedule:

A. Direct schedules to the Project Manager, Department of Facilities Management.
B. Provide copy of schedules to the Design Mechanical Engineer. This information shall be used to verify the compliance by the TAB Contractor with the TAB Specification.
C. Provide copy of schedules to the Architect.
D. Provide copy of schedules to the General Contractor.
E. Provide copy of schedules to the Mechanical Contractor.

7.3 Pre-TAB Inspection Punch Lists and TAB Work Punch Lists:

A. Direct punch lists to the Mechanical Contractor.
B. Provide copy of punch lists to Design Mechanical Engineer. This information shall be used to verify the compliance by the TAB Contractor with the TAB Specifications.
C. Provide copy of punch lists to the Architect.
D. Provide copy of punch lists to the the Project Manager, Department of Facilities Management .
E. Provide copy of punch lists to the General Contractor.

7.4 TAB Report, Monthly Status Reports and Revised TAB Test Reports:

A. Direct punch lists to the Mechanical Contractor.
B. Provide copy of punch lists to Design Mechanical Engineer. This information shall be used to verify the compliance by the TAB Contractor with the TAB Specifications.
C. Provide copy of punch lists to the Architect.
D. Provide copy of punch lists to the Project Manager, Department of Facilities Management .
E. Provide copy of punch lists to the General Contractor.
F. Provide copy of reports to the Mechanical Contractor.

PART 8 TAB REPORT REQUIREMENTS

8.1 Provide reports in hard cover, letter size, 3-ring binders with identification on front and binder. Include set of reduced HVAC floor plans with air outlets and equipment identified to correspond with test reports. Number all pages, i.e., Page X of XX. Provide report per the following format:

A. Title Page (8.10.B)
B. Certification Page (8.10.C)
C. Table of Contents
D. Summary of Non-complying Systems (ALL ITEMS)
    1. Itemize all outstanding TAB punch items.
    2. Itemize all out-of-tolerance parameters from each test report. (NO EXCEPTIONS)
E. Instrument Calibration Report (8.10.D)
F. Test reports for each building
G. Test reports for the central cooling/heating plant
H. Test reports for the chemical treatment of the hydronic systems
I. Reduced set of HVAC floor plans (NO EXCEPTIONS)

8.2 Central Station Air Handler Units (AHU)

A. General
    1. Air handler unit CFM may be determined either by totaling individual CFMs from supply air grilles or by supply air duct traverse. However, if design CFM (within -5%) cannot be

achieved, air handler unit CFM shall be verified by supply air duct traverse; return air duct traverse is not acceptable. When a duct traverse is utilized, provide a Duct Traverse Report (8.10.L) in TAB report and note traverse locations on reduced set of HVAC floor plans.

2. Adjust fan RPM until either design CFM (-5%/+10%) is obtained or motor is at rated FLA. Do not use motor service factor.
3. Plot TAB data on manufacturer's fan performance curve. Include fan performance curve in TAB report. The following information shall be provided:
   a. Plot design point. Label data point DESIGN POINT.
   b. Plot measured CFM and RPM. Label data point OPERATING POINT.
   c. Plot system resistance curve.
4. If design CFM (-5%/+10%) cannot be obtained, provide specific recommendations in order to obtain design CFM.
5. Provide measured static pressure data at the following locations:
   a. Filter inlet pressure
   b. Filter delta pressure
   c. Coil (cooling/heating/reheat) delta pressure
   d. Fan suction pressure
   e. Fan discharge pressure. Determine value from fan performance curve based on CFM and RPM; measured values are not reliable.
6. Provide Air Handler Unit Test Report (8.10.E).
7. Provide Coil Test Report (8.10.F). Plot actual data on psychrometric chart and include psychrometric chart in TAB report. The following data shall be provided:
   a. Plot outdoor air DB/WB temperature. Label data point (OA).
   b. Plot return air DB/WB temperature. Label data point (RA).
   c. Plot coil-entering air DB/WB temperature. Label data point (CEA).
   d. Plot coil-leaving air DB/WB temperature. Label data point (CLA). For draw-thru AHUs, the location of coil leaving air temperatures is after the coil but before the fan.
   e. Measured data, when plotted on a psychrometric chart, shall represent consistent HVAC system processes. Inconsistent measured data shall be redone.
8. Provide Air Outlet Test Report (8.10.H). Note any outlet not within ± 10% of design CFM and any outlet with an objectionable noise level. See Article 8.6. Define area served using both drawing room number and actual room number.
9. For variable air volume systems, provide Variable Air Volume Box Test Report (8.10.P).

B. Provide test reports and data in the following order:
   1. Air Handler Unit Test Report (8.10.E)
   2. Fan Performance Curve
   3. Coil Test Report (8.10.F)
   4. Psychrometric Chart
   5. Air Outlet Test Report (8.10.H)
   6. Variable Air Volume Box Test Report (8.10.P)
   7. Duct Traverse Reports (8.10.L): Provide per Article 8.2, A.1.

8.3 Fans (Outdoor, Supply, Exhaust, Relief, Etc.)

A. Provide test reports in the following order:
   1. Fan Test Report (8.10.G)
   2. Air Outlet Test Report (8.10.H): Provide for fans with multiple supply and/or exhaust grilles. Note any outlet with an objectionable noise level. See Article 8.6.

B. Adjust fan RPM until either design CFM (-5%/+10%) is obtained or motor is at rated FLA. Do not use motor service factor.

C. If design CFM (-5%/+10%) cannot be obtained, provide fan suction and discharge static ressures to determine external static pressure.
D. If design CFM (-5%/+10%) cannot be obtained, provide specific recommendations in order to obtain design CFM.

8.4 Pumps (Primary Chilled Water, Secondary Chilled Water, Condenser Water, Hot Water, etc.)

A. General
1. Determine pump head using pump flange gage taps in order for TAB data to correlate with the pump performance curve.
2. Determine GPM using venturi. Provide venturi diameter and differential head.
3. Adjust system-balancing valves (coils and pump discharge) until either design GPM (-5%/+10%) is obtained or motor is at rated FLA. Do not use motor service factor.
4. Plot TAB data on manufacturer's pump performance curve. Include performance curve in TAB report. The following information shall be provided:
a. Plot valve shut head.
b. Plot valve open head and GPM. Verify motor will not overload.
c. Plot impeller curve.
d. Plot final operating head and GPM. Label data point OPERATING POINT.
e. Plot design head and GPM. Label data point DESIGN POINT.
f. Plot system-operating curve.
5. If design GPM (-5%/+10%) cannot be obtained, provide specific recommendations in order to obtain design GPM.
B. Provide test reports and data in the following order:
1. Pump Test Report (8.10.K)
2. Pump Performance Curve

8.5 Water Coils: Adjust individual coils to within ± 10% of design GPM, as long as total system water flow is within -5%/+10% of design GPM. Refer to Article 3.3, C.

8.6 Noise: Provide Acoustical Test Report (8.10.X) for those areas that, during TAB work, appear to have an objectionable noise level. Plot octave band acoustical data on NC curves in order to identify problem frequencies and to quantify the level of attenuation required. For student occupied areas, NC levels shall be NC35 or less.

8.7 Venturis: Provide calibration charts (GPM versus differential head loss) in TAB report.

8.8 Balancing Valves and Combination Balancing/Shutoff Valves: All valves used to set GPM shall have adjustable memory stops. Permanently mark the final position of each memory stop.

8.9 Volume Dampers: All dampers used to set CFM shall have locking quadrants. Permanently mark the final position of each locking quadrant. For externally insulated ducts, all volume dampers shall have 2" high standoffs for the locking quadrants.

8.10 Report Forms

A. Each test report shall bear the name of the person who recorded the data, the date when the data was recorded, and the seal of the supervisor. Test reports shall be computer generated and shall provide all data listed, as well as any required data not listed.
B. Title Page

1. Date
2. Project's name and address
3. Project Manager, Facilities Management name.
4. Architect's name and address
5. Design Mechanical Engineer's name and address
6. General Contractor's name and address
7. Mechanical Contractor's name and address
8. TAB Contractor's name, address and phone number

C. Certification Page
1. Project's name and address
2. Certification statement
3. TAB Contractor's name
4. TAB Supervisor's name
5. Certification number
6. Date
7. Seal and signature of TAB Supervisor

D. Instrument Calibration Report
1. Instrument
2. Manufacturer
3. Model number
4. Serial number
5. Range
6. Calibration date

E. Central Station Air Handler Unit Test Report
1. Air Handler Unit Data
   a. Mark
   b. Manufacturer, model number and serial Number
   c. Wheel type: Forward curve (FC), airfoil (AF), backward incline (BI).
   d. Wheel diameter (IN)
   e. Fan arrangement: Draw thru (DT), blow thru (BT)
   f. Fan discharge: Upblast front (UBF), upblast rear (UBR), top horizontal (TH), bottom horizontal (BH)
   g. Number of fan belts, manufacturer and size
   h. Number of filters, type and size
   i. Note if the filter pull strip and spacers are installed. If there are obvious leak paths around the filters, the AHU is not acceptable until the leaks are repaired.
2. Motor Data
   a. Manufacturer
   b. Frame size
   c. Nameplate HP, volts, amps, phase, RPM and service factor
   d. Starter size and overload element capacity, amps
3. Performance Data (Design and Actual)
   a. Supply air CFM
   b. Outside air CFM
   c. Fan RPM
   d. Motor volts T1-T2, T2-T3, T3-T1
   e. Motor FLA T1, T1, T3
   f. Fan total static pressure, IN WC
   g. Fan suction static pressure, IN WC (Actual)
   h. Fan discharge static pressure, IN WC (Actual). Refer to Article 8.2, A.5.e.

i. Filter static pressure loss, IN WC
j. Cooling coil static pressure loss, IN WC
k. Heating coil static pressure loss, IN WC
l. Reheat coil static pressure loss, IN WC
m. AHU casing static pressure loss, IN WC
n. External static pressure loss, IN WC
o. Inlet guide vane position at design CFM (Actual)
p. Variable speed drive output at design CFM (Actual)
q. Note any abnormal vibration.

F. Coil Test Report
1. Coil Data
a. AHU Mark
b. Number of rows and fins per foot
c. Coil CFM
d. Face area, SF
e. Face velocity, FPM
2. Air-side Performance Data (Design and Actual)
a. Outside air CFM
b. Outside air DB and WB temperatures, °F
c. Return air CFM
d. Return air DB and WB temperatures, °F
e. Coil CFM
f. Coil entering air DB and WB temperatures, °F
g. Coil leaving air DB and WB temperatures, °F
h. Calculate coil capacity, BTUH (=4.5*CFM*DH)
3. Water-side Performance Data (Design and Actual)
a. Coil GPM
b. Coil entering water temperature, °F
c. Coil leaving water temperature, °F
d. Coil head loss, FT (=2.31*PSID)
e. Venturi diameter, IN (Actual)
f. Venturi differential head, IN WC (Actual)
g. Calculate coil capacity, BTUH (=500*GPM*DT)

G. Fan (Outdoor, Supply, Exhaust, Relief, etc.) Test Report
1. Fan Data
a. Mark
b. Manufacturer, model number and serial number
c. Type: Ceiling, inline, roof, wall
d. Wheel type: Forward curve (FC), airfoil (AF), backward incline (BI)
e. Wheel diameter, IN
f. Number of belts, manufacturer and size
2. Motor Data
a. Manufacturer
b. Frame size
c. Nameplate HP, volts, amps, phase, RPM and service factor
d. Starter size and overload element capacity, amps
3. Performance Data (Design and Actual)
a. CFM
b. Fan RPM
c. Fan suction static pressure, IN WC (Actual)

d. Fan discharge static pressure, IN WC (Actual)
e. Fan total static pressure, IN WC
f. Motor volts T1-T2, T2-T3, T3-T1
g. Motor FLA T1, T2, T3
h. Note any abnormal vibration.

H. Air Outlet Test Report
1. Outlet Data
a. Mark
b. Manufacturer
c. Drawing and actual room numbers (both room numbers)
d. Type: Ceiling diffuser (CD), sidewall grille (SWG), exhaust grille (EG), return grille (RG), transfer grille (TG), etc.
e. Size, IN
2. Performance Data
a. Design CFM
b. Actual CFM
c. Note all outlets that are not balanced within ±10% of design. (Actual CFM-Design CFM)/ Design CFM)*100
d. Note all outlets with an objectionable noise level. See Article 8.6.

I. Duct Heater Test Report
1. Unit Data
a. Mark
b. Manufacturer, model number and serial number
c. Design KW, volts, amps, phase and number of steps
2. Performance Data (Actual)
a. Volts T1-T2, T2-T3, T3-T1
b. Amps T1, T2, T3

J. Unit Ventilator/Fan Coil Unit Test Report
1. Unit Data
a. Mark
b. Manufacturer, model number and serial number
c. Control valve: 2-way or 3-way, 2-position or modulating
d. Fan motor nameplate HP, volts, amps, phase, RPM and service factor
e. Electric heater KW, volts, amps, phase and number of steps
2. Performance Data (Design and Actual)
a. Outside air CFM
b. Fan motor volts T1-T2, T2-T3, T3-T1
c. Fan motor FLA T1, T2, T3
d. Coil GPM
e. Coil entering water temperature, °F
f. Coil leaving water temperature, °F
g. Venturi size, IN (Actual)
h. Venturi differential head, IN WC (Actual)
i. Heater volts T1-T2, T2-T3, T3-T1
j. Heater amps T1, T2, T3

K. Pump Test Report
1. Pump Data
a. Mark
b. Manufacturer, model number and serial number
c. Design GPM, head, RPM and impeller diameter

d. Required NPSH
e. Seal type

2. Motor Data
   a. Manufacturer
   b. Frame size
   c. Nameplate HP, volts, amps, phase, RPM and service factor
   d. Starter size and overload element capacity, amps
3. Performance Data
   a. Valve shut differential head, FT
   b. Actual impeller diameter, IN
   c. Valve open differential head, FT. Verify motor will not overload.
   d. Valve open GPM
   e. Final suction pressure, PSIG
   f. Final discharge pressure, PSIG
   g. Final pump head, FT (=2.31*PSIG)
   h. Final pump GPM
   i. Motor volts T1-T2, T2-T3, T3-T1
   j. Motor amps T1, T2, T3
   k. Note any abnormal vibration.

L. Duct Traverse Test Report
1. Duct Data
   a. System/Branch
   b. Size, IN
   c. Area, SF
   d. Design airflow, CFM
   e. Design velocity, FPM
2. Traverse Data
   a. Duct static pressure, IN WC
   b. Air temperature, °F
   c. Traverse position, IN
   d. Traverse velocity pressure, IN WC
   e. Traverse velocity, FPM
   f. Average duct velocity, FPM
   g. Measured airflow, CFM

M. Chiller Test Report
1. Chiller Data
   a. Mark
   b. Manufacturer, model number and serial number
   c. Chiller volts, amps and phase
   d. Starter size and overload element capacity, amps
2. Evaporator Data (Design and Actual)
   a. CHW temperature set point, °F
   b. Entering/leaving CHW temperature, °F
   c. Entering/leaving CHW pressure, PSIG
   d. Differential CHW head, FT (=2.31*PSID)
   e. GPM
   f. Capacity, TONS (=GPM*DT/24)
   g. Note: Test each chiller at full load.
3. Compressor Data (Design and Actual)
   a. Manufacturer, model number and serial number

b. Volts T1-T2, T2-T3, T3-T1
c. Amps T1-T2, T2-T3, T3-T1

4. Air Cooled Condenser Data (Design and Actual)
   a. Number of fans
   b. Fan motor HP, volts, amps and phase
   c. Ambient temperature, °F
5. Water Cooled Condenser Data (Design and Actual)
   a. Entering/leaving CW temperature, °F
   b. Entering/leaving CW pressure, PSIG
   c. Differential CW head, FT (=2.31*PSID)
   d. GPM

N. Cooling Tower Test Report
1. Cooling Tower Data
   a. Mark
   b. Manufacturer, model number and serial number
   c. Fan motor HP, volts, amps, RPM, phase and service factor
   d. Starter size and overload element capacity, amps
   e. Number of fan belts, manufacturer and size
2. Performance Data (Design and Actual)
   a. Entering/leaving CW temperature, °F
   b. Design WB temperature, °F
   c. Ambient DB/WB temperatures, °F
   d. GPM
   e. Fan motor volts T1-T2, T2-T3, T3-T1
   f. Fan motor amps T1-T2, T2-T3, T3-T1
   g. Note any abnormal vibration.
3. Temperature Control System Data (Actual)
   a. Single speed fan: Aquastat set point (°F) for fan on/off
   b. Two speed fan: Aquastat set points (°F) for fan high/low/off

O. Heat Exchanger Test Report
1. Heat Exchanger Data
   a. Mark
   b. Manufacturer, model number and serial number
   c. Design capacity, BTUH
   d. Primary/secondary fluids
2. Performance Data (Design and Actual)
   a. Primary entering/leaving temperatures, °F
   b. Primary entering/leaving pressures, PSIG
   c. Primary differential head, FT (=2.31*PSID)
   d. Primary GPM
   e. Calculate primary capacity, BTUH (=500*GPM*DT)
   f. Secondary entering/leaving temperatures, °F
   g. Secondary entering/leaving pressures, PSIG
   h. Secondary differential head, FT (=2.31*PSID)
   i. Secondary GPM
   j. Calculate secondary capacity, BTUH (=500*GPM *DT)

P. Variable Air Volume Box Test Report
1. Box Data
   a. Mark
   b. Manufacturer, model number and serial number

c. Fan HP, volts, amps and phase
d. Heater KW, volts, amps, phase and number of steps

2. Performance Data (Design and Actual)
a. Cooling CFM: Primary maximum/minimum
b. Heating CFM: Primary minimum/secondary/total
c. Heater volts T1-T2, T2-T3, T3-T1
d. Heater amps T1, T2, T3
e. Fan volts T1-T2
f. Fan amps T1

Q. Boiler (Space Heating) Test Report
1. Unit Data
a. Mark
b. Manufacturer, model number and serial number
c. Type
d. Fuel
e. Number of passes
f. Ignition type
g. Burner control
h. Power supply volts, amps and phase
i. Input/output, MBH

2. Performance Data (Design and Actual)
a. Entering/leaving HW temperatures, °F
b. Entering/leaving HW pressures, PSIG
c. Differential water head, FT (=2.31*PSID)
d. GPM
e. Volts T1-T2, T2-T3, T3-T1
f. Amps T1, T2, T3

R. Make-up Water System Test Report
1. Backflow Preventer
a. Manufacturer and model number
b. Type: Backflow preventer shall be reduced pressure type.
c. Size, IN
d. Discharge funnel/air gap shall be installed.
e. Discharge shall be piped to a floor drain (interior location) or to 12" AFG (exterior location).

2. Pressure Regulating Valve
a. Manufacturer and model number
b. Set point, PSI. Refer to Article 8.10, S.1.c.
c. Size, IN

3. Pressure Relief Valve
a. Manufacturer and model number
b. Set point, PSI
c. Size, IN
d. Discharge shall be piped to a floor drain (interior location) or to 12" AFG (exterior location).

S. Expansion Tank Test Report
1. Full Acceptance Bladder Expansion Tank:
a. Manufacturer and model number
b. Acceptance tank volume, GAL

c. Precharged pressure, PSIG. Set point of the pressure-regulating valve shall be equal to the tank precharge pressure.

2. Diaphragm expansion tanks are not acceptable.
3. Closed compression tanks are not acceptable.

T. Surface Heater Test Report
1. Unit Data
   a. Mark
   b. Manufacturer, model number and serial number
   c. Design KW, volts, amps and phase
2. Performance Data (Actual)
   a. Volts T1-T2, T2-T3, T3-T1
   b. Amps T1, T2, T3

U. Rooftop Unit Test Report
1. Unit Data
   a. Mark
   b. Manufacturer, model number and serial number
   c. Number of filters, type and size
2. Evaporator Fan and Motor Data
   a. Motor nameplate HP, volts, amps, phase, RPM and service factor
   b. Number of fan belts, manufacturer and size
3. Evaporator Fan Data (Design and Actual)
   a. Supply air CFM
   b. Outside air CFM
   c. Fan RPM
   d. Motor volts T1-T2, T2-T3, T3-T1
   e. Motor amps T1, T2, T3
   f. Fan total static pressure, IN WC
   g. Fan suction static pressure, IN WC (actual)
   h. Fan discharge static pressure, IN WC (actual). Determine value from fan curve based on CFM and RPM. Refer to Article 8.2, A.5.e.
   i. External static pressure, IN WC
   j. Note any abnormal vibration.
4. Evaporator Coil Data (Design and Actual)
   a. Coil CFM
   b. Coil entering air DB/WB temperatures, °F
   c. Coil leaving air DB/WB temperatures, °F
   d. Coil capacity, BTUH (=4.5*CFM*DH)
   e. Coil circuiting: row split (intertwined) or face split
5. Condensing Unit Data (Design and Actual)
   a. Number of compressors/circuits
   b. Ambient temperature, °F
   c. Compressor volts T1-T2, T2-T3, T3-T1
   d. Compressor amps T1, T2, T3
   e. Number of condenser fans (Actual)
   f. Condenser fan HP, volts, amps, phase, RPM (Actual)
6. Heater Data (Design and Actual)
   a. KW (Design)
   b. Volts T1-T2, T2-T3, T3-T1
   c. Amps T1, T2, T3
   d. Number of steps

V. Condensing Unit Test Report
   1. Unit Data
      a. Mark
      b. Manufacturer, model number and serial number
      c. Number of compressors/circuits
   2. Compressor Data
      a. Ambient temperature, °F
      b. Compressor volts T1-T2, T2-T3, T3-T1
      c. Compressor amps T1, T2, T3
   3. Condenser Fan Data
      a. Number of fans
      b. Fan HP, volts, amps, phase and RPM

W. Packaged Terminal Air Conditioner Test Report
   1. Mark
   2. Manufacturer, model number and serial number
   3. Nameplate volts, amps and phase
   4. Outside air CFM
   5. Nameplate cooling capacity, BTUH
   6. Cooling mode volts and amps
   7. Nameplate heating capacity, KW
   8. Heating mode volts and amps

X. Acoustical Test Report
   1. Drawing and actual room numbers (both room numbers)
   2. Noise level (dB re 10-12W) by octave band (63 Hz, 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, 8000 Hz)
   3. dBA
   4. NC. Plot noise levels on NC curve.
   5. Note, which systems are not within acceptable tolerance (NC35 or less in student occupied areas).

END OF SECTION