SECTION 15990 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. SECTION INCLUDES

1. This Section specifies the requirements for test and balance of HVAC and related systems.

B. RELATED REQUIREMENTS

1. Section 15050: Basic HVAC Materials and Methods.
2. Section 15900: Automated Temperature Controls.
3. Section 15840: Low Pressure Ductwork.
4. Section 15780: Heating and Cooling Systems.

PART 2 - PRODUCTS (Not used)

PART 3 - EXECUTION

3.01 DEFINITIONS AND APPLICABLE PUBLICATIONS

A. For the purposes of this Section definitions are as indicated in applicable publications of AABC, NEBB, TABB, ASHRAE, ANSI and SMACNA.

1. TAB: Testing, Adjusting and Balancing.
2. TABB: Testing, Adjusting and Balancing Bureau.
3. AABC: Associated Air Balance Council.
4. NEBB: National Environmental Balancing Bureau.
5. ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers.
6. ANSI: American National Standards Institute.
7. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.
8. OAR: OWNER (OAR)'S Authorized Representative
9. AHJ: Authority Having Jurisdiction

3.02 QUALITY ASSURANCE

A. The General Contractor shall contract directly with the test and balance agency. Tests performed by testing agencies contracted with the system's subcontractor will not be accepted. The qualifications of the agency shall comply with Article 3.02, Quality Assurance. The agency shall be responsible for furnishing labor, instruments, and tools required to test, adjust, and balance the heating, ventilating, and air conditioning (HVAC) systems and related plumbing systems, as described and/or as indicated in the Contract Documents.

B. CONTRACTOR shall obtain services of an independent, qualified testing agency acceptable to Architect to perform testing and balancing Work as specified and as follows:

1. Agency shall be currently certified by either the Associated Air Balance Council (AABC), the National Environmental Balancing Bureau (NEBB), or the Testing, Adjusting and Balancing Bureau (TABB). NEBB or TABB certification shall be for Air and Hydronic Testing, Adjusting and Balancing and Sound and Vibration Measurement.
2. Work shall be in accordance with the latest edition of the AABC, NEBB, or TABB National Standards. Where the requirements of the two standards are different, the more stringent requirements shall prevail. Also, if the Contract Documents impose a more stringent standard, then the Contract Documents shall prevail.

C. Performance Criteria: Work of this Section shall be performed in accordance with approved Testing, Adjusting, and Balancing agenda.

D. Test Equipment Criteria: Basic instrumentation requirements and accuracy/calibration required by Section Two of the AABC, Section II of the NEBB, or TABB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.

E. Verification: The Test and Balance Agency shall recheck 10 percent (minimum 10) of the measurements listed in the report. The locations shall be selected by AHJ or OAR. The recheck will be witnessed by AHJ or OAR. If 20 percent of the measurements that are retested differ from the report and are also out of the specified range, an additional 10 percent will be tested. If 20 percent fall outside the specified range, the report will be considered invalid and all test and balance work shall be repeated.

3.03 SUBMITTALS

A. Submit name of agency to perform the Work. Include in the submittal the certified qualifications of all persons responsible for supervising and performing actual Work of this Section. Agency shall submit a minimum of five commercial or industrial HVAC system TAB projects of similar type, size, and degree of difficulty completed within the last two years. Agency shall provide name and telephone number of contact person for each listed project.

B. Submit, for approval, 6 copies of the Agenda as indicated in Article 3.06 to test and balance all mechanical and relevant plumbing systems.

C. Preliminary Report: Review the Contract Documents, examine Work installations and submit a written report to ARCHITECT, AHJ and OAR indicating deficiencies in Work precluding proper testing and balancing of the Work.

D. Final TAB Report: Submit the final TAB report for review by ARCHITECT, AHJ, and OAR outlining the conditions and Work completed on each HVAC system. All outlets, devices, HVAC equipment, etc. shall be identified, along with a numbering system corresponding to report unit identification.

E. Submit an AABC "National Project Performance Guaranty" or "NEBB Quality Assurance Certification", assuring the Project systems were tested, adjusted, and balanced in accordance with the Specifications and AABC, NEBB, or TABB National Standards.

F. CAD drawings: Submit single line, multi-color CAD drawings indicating outside return and supply air, volume control boxes, each outlet and inlet, room numbers, duct sizes at traverse locations, temperatures and pressures, systems balanced, components changed, and CONTRACTOR installed access points. In addition, drawings shall identify controls, equipment settings, including manual damper quadrant positions, manual valve indicators, fan speed control levers, and similar controls, and devices shall be marked on the drawings to show final settings. CAD files shall be submitted on CD-ROM upon final submittal of TAB report. Reports shall identify discrepancies between completed Work and the Contract Documents affecting the performance and longevity of the system.

3.04 GENERAL SCOPE OF WORK

A. The general scope of Work shall include but not be limited to the following:

1. Measure airflow rates of HVAC systems and make adjustments to achieve design airflow rates, tabulate results, and submit reports.
2. Measure water-flow rates of HVAC systems and make adjustments to achieve design water flow rates, tabulate results, and submit reports.
3. Measure flow velocities, temperatures, static pressures or head, rotational speed, and electrical power demand of fans, pumps, and other related HVAC system components, tabulate results, and submit reports.
4. Reports shall contain sufficient data for the system designer to evaluate system performance and solve installation problems such as system pressure profiles and pressure drops across system components

3.05 SPECIFIC SCOPE OF WORK

A. The specific scope of Work shall include the following HVAC system components as indicated on the Drawings:

1. Air Conditioning Units.
2. Heating and Ventilating Units.
3. Heating and Cooling Coils.
4. Supply, Return, Relief and Exhaust Fans.
5. Outside Air and Return Air Plenums.
6. Outside Air Intakes.
7. All Supply and Return Ductwork.
8. All associated Air Terminal Devices, i.e. Supply Diffusers, Return Registers, etc.
9. Reheat Coils (Electric or Hot Water).
10. Exhaust Duct Systems.
11. Fire and Fire/Smoke Dampers.
12. Kitchen Hoods.

3.06 TESTING, ADJUSTING, AND BALANCING AGENDA

A. Provide proposed materials, methods, procedures, forms, diagrams, and reports for test and balance Work.

B. Agenda to be completed by the test and balance agency and submitted to ARCHITECT, AHJ, and OAR for review and approval.

C. Agenda shall include one complete set of AABC, NEBB, or TABB publications listed in Sub-paragraph 3.02.B.2, applicable publications, or, in case of other test and balance agencies and or organizations, comparable publications to establish an approved, systematic, and uniform set of procedures.

D. Agenda shall also include the following detailed narrative procedures, system diagrams, and forms for test results:

1. Specific standard procedures required and proposed for each system of the Work.
2. Specified test forms for recording each procedure and for recording sound and vibration measurements.
3. Systems diagrams for each air and water system. Diagrams may be single line.

E. In addition to information recorded for standard AABC, NEBB, or TABB procedures, the following information is required:

1. Fan data.
2. System number, location, manufacturer, model, and serial number.
3. Fan wheel type and size.
4. Motor horse power, type, and rpm.
5. Sheave size, type, number of grooves, and open turns on Variable Pitch Sheave.
6. Number and size of belts, motor and fan shaft sizes, center-to-center of shafts in inches, and adjustment available motor data, including nameplate data, actual amps, rated, and actual motor rpm, volts, phase, hp, kW, starter heater size, and capacity.
7. Fan design airflow and service (supply, return, outdoor air or exhaust).
8. Fan static pressure, suction/discharge and static control point.
9. Nameplate picture.

F. The following traverse data is required:

1. Traverse location, size of duct (inside dimensions), and area of duct in square feet.
2. Column for each hole traversed/lines for each reading.
3. Barometric pressure.
4. Temperature/Static pressure in the duct.
5. Actual CFM corrected to SCFM.
6. Notes.

G. The following air distribution data is required:

1. Room identification.
2. Outlet or intake balance sequence number.
3. Size of outlet or inlet.
4. K Factor.
5. Design and Actual FPM and CFM.
6. Notes.

H. The following DX coil data is required:

1. Air flow through the coil in CFM.
2. Dry and wet bulb temperatures entering/leaving coil.
3. Enthalpy or total heat difference across coil in BTU/ pound.
4. Capacity in BTU/hour at time of test.
5. Air pressure drop across coil.
6. Notes.

I. The following electric heating coil data is required:

1. Heating coil identification number.
2. Nameplate data; manufacturer, model and serial number.
3. Amperage/Voltage on each phase.
4. Phase, kW, and Stages.
5. Safety device installed.
6. Air pressure drop across coil.
7. Notes.

J. The following domestic water heater data is required:

1. Performance test results for rated capacity.
2. Water Heater identification number.
3. Nameplate data; manufacturer, model, and serial number.
4. Water temperature entering/leaving the water heater.
5. Outside conditions: temperature, humidity, general cloud cover.
6. Barometric pressure.

K. The following air-cooled split system condensing unit data is required:

1. Performance test results for rated capacity.
2. Unit identification number.
3. Nameplate data, manufacturer, model, and serial number.
4. Compressor nameplate and actual amps, volts, phase, and hertz.
5. RPM of motors, where applicable.
6. Refrigerant type.
7. Suction/Discharge pressure when gage installed.
8. Number of stages.
9. Low-pressure/High-pressure control setting.
10. Condenser fan sequence stages.
11. Crankcase heater watts (nameplate).
12. Hot gas bypass installed - yes/no.
13. SCFM Air Flow Measurement vs. Design CFM.

L. The following air-cooled split system heat pump data is required:

1. Performance test results for rated heating and cooling capacities.
2. Unit identification number.
3. Nameplate data, manufacturer, model, serial number and picture.
4. Compressor nameplate and actual amps, volts, phase, and hertz.
5. RPM of motors, where applicable.
6. Refrigerant type.
7. Suction/Discharge pressure for both heating and cooling modes when gage installed.
8. Number of stages.
9. Low-pressure/High-pressure control setting.
10. Condenser fan sequence stages.
11. Crankcase heater watts (nameplate).
12. Hot gas bypass installed - yes/no.
13. SCFM Air Flow Measurement vs. Design CFM.

M. The following mixing damper leakage test data is required:

1. Equipment identification number (unit, box, zone, etc.).
2. Dry bulb temperature in the cold/hot (or bypass) deck.
3. Dry bulb temperature in the mixed air stream.
4. Calculated percent leakage.
5. Data above taken in the full cool and full heat (or bypass) mode.
6. Notes.

N. The following unit heater data is required:

1. Equipment identification number.
2. Nameplate data; manufacturer, model, and serial number.
3. Test CFM (use manufacturer rated CFM if not ducted).
4. Heat test data per applicable procedure (hot water, electric, etc.).
5. Notes.

O. The following fan coil and unit ventilator data is required:

1. Equipment identification number.
2. Nameplate data; manufacturer, model, and serial number.
3. Tested supply CFM or manufacturer rated CFM if not ducted.
4. Tested outside air in CFM.
5. Motor data and actual amps and volts.
6. Cooling/Heating test data.
7. Static pressure.
8. Notes.

P. The following kitchen hood data is required:

1. Hood identification number.
2. Nameplate data; manufacturer, model, and serial number.
3. Pitot-tube traverse total air flow.
4. Exhaust and supply (when part of hood) CFM.
5. Exhaust and supply (when part of hood) test velocities shown on hood face diagram.
6. Face velocities.
7. Hood opening dimensions.
8. Notes (turbulence and flow patterns at the face and inside the hood).

Q. The following pump data for heating hot water is required:

1. Pump number.
2. Nameplate data; manufacturer, model, and serial number.
3. Motor data including nameplate data, actual amps, volts, RPM, horsepower, starter heater size, and capacity.
4. Pump discharge and suction pressure along with total dynamic head in the following modes.
5. Shut-off head FT, Wide open Head FT, and Final operating Head FT.
6. Final GPM Test plotted on a pump curve.
7. Notes.

R. The following terminal box data is required:

1. Box identification number.
2. Node, address, or designation on system.
3. Box size.
4. Cooling CFM.
5. Minimum CFM (if applicable).
6. Heating CFM (if applicable).
7. Box fan amps and volts (if applicable).
8. Notes.

3.07 PROCEDURES

A. Schedule the Work of this Section in order for test and balance activities to be completed prior to the date of Substantial Completion. CONTRACTOR shall place all heating, ventilating, and air conditioning equipment into operation during each day and until all HVAC adjusting, balancing, testing, demonstrations, and instructions on systems are completed. Agency shall prepare and submit reports within ten (10) days from completion of the Work of this Section to allow sufficient time for corrective measures to be completed before Substantial Completion of the Work. When an individual building or portion thereof is ready for occupancy, all equipment relative to such portion of Work shall be put into service, tested, and balanced.

B. Prior to the date of Substantial Completion, and upon completion of test and balance Work, place all exhaust fans in operation, force all air handling units, and air conditioning units into a 100 percent outdoor air economizer mode with heating and cooling locked out and flush the building continuously for a period of fourteen (14) days.

C. Coordinate test and balance procedures with any phased Project requirements so test and balance procedures on each phased portion of the Work will be completed prior to completion of said designated phase.

3.08 FIELD EXAMINATION

A. Before the commencement of test and balance Work, CONTRACTOR shall ascertain that following conditions are fulfilled:

1. Ensure that all water heating and water cooling systems have been flushed, cleaned, and filled and high points vented.
3. Refrigerant systems are fully charged with specified refrigerant.
4. Over-voltage and current protection have been provided for motors.
5. Equipment has been labeled as required.
6. Curves and descriptive data on each piece of equipment to be tested and adjusted are available as required.
7. Operations and maintenance manuals have been supplied.
8. Controls manufacturer and boiler-burner representatives shall be available for consultation and supervision of adjustments during tests.
9. Verify that heating and cooling coil fins are cleaned, combed and air filters clean, and installed.
10. Verify that duct systems are clean of debris and leakage is minimized, access doors are closed and duct end caps are in place, and fire and volume dampers are in place and open.
11. Automatic control systems are completed and operating.
12. Start up and initial commissioning of all HVAC equipment except fans shall be by the manufacturer.

B. In addition to the above, CONTRACTOR shall establish a specific, coordinated plan which details how each area of existing building will be balanced during the various phases of the Work. The evaluation shall address, at a minimum, the following concerns:

1. OWNER (OAR) operations.
2. Building safety and security policies. Prior to any fire safety or security systems shutdown at any time during the Work, CONTRACTOR shall first advise and coordinate with OWNER (OAR) to ensure all concerned parties are notified.
3. Protecting furniture, computers, photocopiers, and other office equipment.
4. Protecting fixtures and equipment.
5. Concerns specific and unique to building related issues.
6. Downtime required for each Air Handling Unit including projected time to return each portion of the building back to its normal occupancy temperature and humidity.
7. Shutdown and reactivation of the fire alarm system to avoid accidental alarms during test and balance and related Work.

3.09 TEST AND BALANCE

A. For each heating, ventilating, or air conditioning system the following shall be performed, recorded, and submitted in an approved format for review. Make, type, and model of unit, and location of each piece of equipment shall be included in the report. Readings shall include but not be limited to following:

1. Air Systems:

a. General

1) Verify all ductwork, dampers, grilles, registers, and diffusers have been installed per design and set in the full open position. Agency shall perform the following TAB procedures in accordance with AABC or NEBB National Standards. Where the requirements of the two standards are different, the more stringent requirements shall prevail. Also, if the Contract Documents impose a more stringent standard then the Contract Documents shall prevail.

b. Zone, Branch, and Main Ducts:

1) Adjust ducts to within design CFM requirements by means of Pitot-tube duct traverse.

c. Supply Fans:

1) Fan Speeds: Test and adjust fan RPM to achieve maximum or design CFM. CONTRACTOR shall provide new belt pulleys when required.
2) Current and Voltage: Test and record motor voltage and amperage, and compare data with the nameplate limits. Ensure fan motor is not in or above the service factor as published by the motor manufacturer.
3) Pitot-Tube Traverse: Perform a Pitot-tube traverse of main supply and return ducts, record total CFM.
4) Outside Air: Test and adjust the outside air using Pitot-tube traverse.
5) Static Pressure: Test and record system static profile of each supply fan.
6) Current and Voltage: Test and record motor voltage and amperage, and compare data with the nameplate limits. Ensure fan motor is not in or above the service factor as published by the motor manufacturer.

d. Return, Relief, and Exhaust Fans:

1) Fan Speeds: Test and adjust fan RPM to achieve maximum or design CFM. CONTRACTOR shall provide new belt pulleys where required.
2) Pitot-Tube Traverse: Perform a Pitot-tube traverse of the main return ducts to obtain total CFM.

2. Static Pressure: Test and record system static profile of each fan.

f. Diffusers, Registers and Grilles:

1) Tolerances: Test and balance each diffuser, grille, and register to within 10 percent of design requirements.
2) Identification: Identify the type, location, and size of each grille, diffuser, and register. This information shall be recorded on air outlet data sheets.

g. Coils: Air Temperature: Once airflow is set to acceptable limits, agency shall take wet bulb and dry bulb air temperatures on the entering and leaving side of each cooling coil. Dry-bulb temperature shall be taken on the entering and leaving side of each heating coil.

h. Duct Leakage Testing:

1) On existing ductwork, agency shall calculate duct leakage by traversing the unit and reading associated diffusers.
2) On new installations each and every section of the entire air distribution system (all supply, return, exhaust, and relief ductwork) shall be tested at 1.5 times design static pressure. All ducts shall demonstrate 5 percent leakage maximum (per CBC).

i. Air Handling Units:

1) Prepare pressure profile and show design and actual CFM (outside air, return air, and supply air).
2) Measure and record each mode (minimum OA and 100 percent OA) where economizer cycle is specified.
3) Record pressure drops of all components (coils, filters, sound attenuators, louvers, dampers, and fans) and compare with design values.
4) Pressure profile and component pressure drops are performance indicators and are not to be used for flow measurements.

j. System Pressure Profiles:

1) Prepare pressure profiles from fan (supply, return, and exhaust) or air handling unit to extremities of system.
2) As a minimum, show pressure at each floor, main branch, and airflow measuring device.
3) Make pitot-tube traverses of all trunk lines and major branch lines where required for analysis of distribution system. Airflow measuring devices installed in ductwork, if available, may be utilized.
4) Record residual pressures at inlets of volume controlled terminals at ends of system.
5) Show actual pressures at all static pressure control points utilized for constant or variable flow systems.

k. Fan speed adjustments and balancing for optimum acoustical performance:

1) As the very first step, the speed of all fans (supply, return, and exhaust inside packaged equipment or air handling units) shall be adjusted to deliver the required fan total air quantity with all volume dampers and other flow rate control devices fully open. Adjustments shall be made with the outdoor air intake dampers, return air dampers, and relief air dampers in the minimum outdoor air position. The adjustments shall be made again in the 100 percent outdoor air position in systems with 100 percent outdoor air economizers.
2) The above adjustment shall be done with wet cooling coils, where cooling coils are provided.
3) The airflow rates at each branch duct shall be adjusted as the second step with air with all volume dampers and other flow rate control devices fully open.
4) The airflow rates at each air inlet and outlet shall be adjusted as the final step. The volume damper in the branch duct shall be used for balancing. Opposed blade dampers at air inlets and outlets where provided shall only be used for fine adjustments and shall not be closed beyond 60 percent open or when the dampers start to generate audible noise.
5) CONTRACTOR shall provide the labor and materials for all dampers, pulleys, and belt changes required for balancing. The design documents indicate the worst-case scenario with safety factors in fan static pressures for contingency. Properly coordinated and installed air systems may require a lower static pressure and a reduction in fan speed.

B. Pumps:

1. Test and adjust hot water pumps to achieve maximum or design GPM.
2. Measure and record suction and discharge pressures.
3. Check pumps for proper operation. Pumps shall be free of vibration and cavitation.
4. Current and Voltage: Agency shall test and record motor voltage and amperage and compare data with the nameplate limits. Ensure pump motor is not in or above the service factor as published by the motor manufacturer.
5. Adjust pump flow by adjusting and setting balancing valves to obtain amperage reading on a clamp-on ammeter that corresponds to amperage indicated on pump's curves for required flow.
6. Verify that the motor is not drawing more current than indicated on motor plate rating. When actual flows of primary pumps are found by test to vary more than 5 percent from specified amount, system shall be re-balanced to regulate flow within this tolerance. When a flow indicating device(s) is in circuit, it shall be used to verify pump flows.
7. When testing is completed, a pump capacity chart with pump number and location indicated shall be marked indicating operating point of pump on the curve. Chart shall then be included in the report.

C. Heating Hot Water Boilers and Domestic Hot Water Boilers:

1. Current and Voltage: Test and record motor voltage and amperage, and compare data with the nameplate limits. Ensure motor is not in or above the service factor.
2. Test and balance water flow through water boilers.
3. Test and record temperature and pressure profiles of water and/or steam boilers.
4. Upon completion of tests, controls and devices shall be returned to their normal operating condition and boiler shall remain in service.

D. System Mains and Branches including chilled water, heating hot water, cooling tower water, domestic hot water and domestic cold water:

1. Balance water flow in pipes to achieve maximum or design GPM.
2. Air Conditioning Units: (Start-up and initial commissioning by manufacturer only.)

a. Suction pressure and temperature.

b. Discharge pressure and temperature.

c. Amps and volts.

d. Make, type, and model of unit, capacity rating.

e. Ambient temperature: WB, DB.

f. Supply, return, relief, and exhaust fans shall be balanced as indicated in Section 3.09, A, 1, Air Systems.

g. Proper operation of controls: Temperature controllers and safety devices shall be tested during operating tests, with all other controls and devices, except one under test, being by-passed.

h. Upon completion of tests, controls and devices shall be returned to their normal operating condition and boiler shall remain in service.

3. Split System Heat Pump Units: (Start-up and initial commissioning by manufacturer only.)

a. Suction pressure and temperature.

b. Discharge pressure and temperature.

c. Amps and volts.

d. Make, type, and model of unit, capacity rating.

e. Ambient temperature: WB, DB.

f. Supply, return, relief and exhaust fans shall be balanced as indicated in Sub-paragraph 3.09.A.1, Air Systems.

g. Proper operation of controls: Temperature controllers and safety devices shall be tested during operating tests, with all other controls and devices, (except one under test) being by-passed.

h. Upon completion of tests, controls and devices shall be returned to their normal operating condition and boiler shall remain in service.

4. MISCELLANEOUS:

a. Electric Heaters:

a.1. Amperage.
a.2. Voltage.
a.3. Make, type, model, and name plate capacity rating.

3.10 Verification of HVAC Controls

A. Agency shall verify in conjunction with CONTRACTOR all control components are installed in accordance with the intent of the Contract Documents and are functioning according to the design intent, including all electrical interlocks, damper sequences, air and water resets, fire stats, and other safety devices.

B. CONTRACTOR shall verify all control components are calibrated and set for design operating conditions and intent.

3.11 Temperature Testing

A. To verify system control and operation, agency shall perform a series of three temperature tests taken at approximately two hour intervals in each separately controlled zone. The resulting temperatures shall not vary more than two degrees Fahrenheit from the thermostat or control set point during the tests. Outside temperature and humidity shall also be recorded during the testing periods.

3.12 KITCHEN Hood Testing

A. Agency shall test and adjust hood total airflow by duct Pitot-tube traverse. If a Pitot-tube traverse is not practical, an explanation of why a traverse was not made must be made in writing to Architect and subsequently appear on the appropriate data sheet. Face velocities shall be tested under design operating conditions using a maximum of a one square foot grid pattern across the entire open face. CONTRACTOR shall set sash height on hoods to obtain face velocities within 20 percent of 100 feet per minute unless specified otherwise. Agency shall test and adjust exhaust airflows and make-up air flows to maintain design hood pressures and face velocities and design room pressurization. Agency shall test for turbulence and proper air flow patterns at the face and inside the hoods using a hand-held smoke puffer or other approved smoke-emitting device.

3.14 Building/Zone Pressurization

A. Agency shall test and adjust building/zone pressurization by setting the design flows to meet the required flow direction and pressure differentials. Positive/Negative area(s) supply air shall be set to design flow and exhaust air rates adjusted to obtain the required pressure differential(s).

3.15 Fire and Smoke DAMPER Testing

A. This work is to be performed by OWNER (OAR) and State Fire Marshall. Do not include in agency scope of work.

3.16 Life Safety Controls TESTING

A. This work is to be performed by OWNER (OAR) and State Fire Marshall. Do not include in agency scope of Work.

3.17 FINAL TABULATION

A. After heating, ventilating, and air conditioning components are satisfactorily tested and balanced, entire system shall be put into operation and all pressures, temperatures, gpm, cfm, velocities, etc., shall be recorded and checked against design schedules. Design requirements shall be listed on reports and final tabulation shall be within a tolerance of plus or minus five percent of design requirements.

B. Readings at various locations as described herein will be made every hour for four (4) hours, during normal working hours for three (3) days. Forced air furnaces shall be started up far enough in advance to meet design conditions during period of testing.

END OF SECTION

STATE OF MAINE · JOHNNY DOWDY · 13949 · LICENSED · PROFESSIONAL ENGINEER

lenity architecture
3150 Kettle Court SE, Salem, Oregon 97301
P 503 399 1090 F 503 399 0565 W lenityarchitecture.com

COLSON AND COLSON
GENERAL CONTRACTOR, INC.
2260 McGILCHRIST STREET SE, SUITE 200
SALEM, OREGON, 97302
PHONE (503) 586-7401

PORTLAND
RETIREMENT RESIDENCE
802 OCEAN AVE. PORTLAND, MAINE 04103

MECHANICAL SPECIFICATIONS

DATE
8/28/2015

REVISED DATE
1 9/22/2015

SHEET
M4.5