Packaged Outdoor HVAC Equipment

Guide Specifications

Energence® Rooftop Units

September 1, 2017

Note: This specification specifies **Lennox Industries Energence® Rooftop Units**. Revise specification section number and title below to suit project requirements, specification practices and section content. Refer to CSI MasterFormat for other section numbers and titles.

This specification utilizes the Construction Specifications Institute (CSI) Manual of Practice, including MasterFormat®, SectionFormat® and PageFormat®. Optional text and text requiring a decision is indicated by bolded brackets **[ ]**; delete text not required in final copy of specification. Specifier Notes typically precede specification text; delete notes in final copy of specification. Trade/brand names with appropriate symbols typically are used in Specifier Notes; symbols are not used in specification text. Metric conversion, where used, is soft metric conversion.

Packaged Outdoor HVAC Equipment

SECTION 15730 UNITARY AIR CONDITIONING EQUIPMENT

PART 1 GENERAL

PART 1.01 SUMMARY

A. Section Includes: 35, 40, 45 and 50 ton packaged gas/electric and electric/electric rooftop units with variable air volume.

Specifier Note: Revise paragraph below to suit project requirements. Add section numbers and titles per CSI MasterFormat and specifier's practice.

B. Related Sections:

Specifier Note: Article below may be omitted when specifying manufacturer's proprietary products and recommended installation. Retain Reference Article when specifying products and installation by an industry reference standard. If retained, list standard(s) referenced in this section. Indicate issuing authority name, acronym, standard designation and title. Establish policy for indicating edition date of standard referenced. Conditions of the Contract or Division 1 References Section may establish the edition date of standards. This article does not require compliance with standard, but is merely a listing of references used. Article below should list only those industry standards referenced in this section. Retain only those reference standards to be used within the text of this Section. Add and delete as required for specific project.

PART 1.02 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI/ASHRAE 15 Safety Standard for Refrigeration Systems.
2. ANSI/ASHRAE/IESNA 90.1 Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings.
3. ANSI Z21.47 Gas-Fired Central Furnaces.

B. Air Conditioning, Heating and Refrigeration Institute (AHRI):

C. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE):

1. ASHRAE 52.2 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size (ANSI approved).
2. ASHRAE 62.1 Ventilation Standard for Acceptable Indoor Air Quality.

D. Canadian Standards Association (CSA):

1. CAN/CSA B149.1 Natural Gas and Propane Installation Code.
2. CAN/CSA B149.2 Propane Storage and Handling Code.
3. CSA C22.1 Canadian Electrical Code.
4. CSA 2.3 Gas-Fired Central Furnaces.

E. U.S. Energy Policy Act of 1992 (EPACT).

F. U.S. National Appliance Energy Conservation Act (NAECA):

1. NAECA 1988.

G. National Fire Protection Association (NFPA):

1. NFPA 90A Installation of Air Conditioning and Ventilation Systems.

H. Underwriters Laboratories, Inc. (UL):

1. UL 1995 Standard for Safety for Heating and Cooling Equipment.

Specifier Note: Article below should be restricted to statements describing design or performance requirements and functional (not dimensional) tolerances of a complete system. Limit descriptions to composite and operational properties required to link components of a system together and to interface with other systems.

PART 1.03 SYSTEM DESCRIPTION

A. Design Requirements: Provide products and systems that have been manufactured, fabricated and installed to the following criteria:

1. ANSI/ASHRAE/IESNA 90.1.

2. ANSI Z21.47-2000/CSA 2.3.

3. CAN/CSA B149.1.

4. CAN/CSA B149.2.

5. CSA C22.1.

6. UL 1995.

Specifier Note: Article below includes submittal of relevant data to be furnished by Contractor before, during or after construction. Coordinate this article with Architect's and Contractor's duties and responsibilities in Conditions of the Contract and Division 1 Submittal Procedures Section.

PART 1.04 SUBMITTALS

A. General: Submit listed submittals in accordance with Conditions of Contract and Division1 Submittal Procedures.

B. Product Data: Submit product data, including manufacturer's product data sheets, for specified products.

C. Shop Drawings:

1. Submit shop drawings in accordance with Section [01330 - Submittal Procedures].

2. Indicate:

a. Equipment, piping and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.

b. Piping, valves and fittings shipped loose showing final location in assembly.

c. Control equipment shipped loose, showing final location in assembly.

d. [Complete internal panel pneumatic tube piping and wiring and external panel pneumatic tube piping and wiring, both as schematics and as actually assembled].

e. Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.

f. Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.

g. Pump and fan performance curves.

h. Details of vibration isolation.

i. Type of refrigerant used.

j. Plan view, front view, end view, back view and curb detail with dimensions.

D. Quality Assurance:

1. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.

2. Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

3. Manufacturer's Instructions: Manufacturer's installation instructions.

Specifier Note: Coordinate paragraph below with Part 3 Field Quality Requirements Article herein. Retain or delete as applicable.

E. Manufacturer's Field Reports: Manufacturer's field reports specified.

F. Closeout Submittals: Submit following:

1. Warranty: Warranty documents specified.

2. Operation and Maintenance Data: Operation and maintenance data for installed products in accordance with Division 1 Closeout Submittals (Maintenance Data and Operation Data) Section. Include methods for maintaining installed products, and precautions against cleaning materials and methods detrimental to finishes and performance. Include names and addresses of spare part suppliers.

3. Provide brief description of unit, with details of function, operation, control and component service.

4. Provide equipment inspection report and equipment operation test report.

5. Commissioning Report: Submit commissioning reports, report forms and schematics in accordance with Section 01810 - Commissioning.

PART 1.05 QUALITY ASSURANCE

A. Qualifications:

1. Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project.

2. Manufacturer Qualifications: Manufacturer capable of providing field service representation during construction and approving application method.

Specifier Note: Paragraph below should list obligations for compliance with specific code requirements particular to this section. General statements to comply with a particular code are typically addressed in Conditions of the Contract and Division 1 Regulatory Requirements Section. Repetitive statements should be avoided. Current data on building code requirements and product compliance may be obtained from filter manufacturer technical support specialists

B. Regulatory Requirements: Provide Packaged Gas Electric, Rooftop Unit that complies with following requirements:

1. AHRI 340/360.

2. ASHRAE 52.2.

3. CAN/CSA B149.1.

4. CAN/CSA B149.2.

5. CSA C22.1.

6. NFPA 90A.

C. Preinstallation Meetings: Conduct preinstallation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements. Comply with Division 1 Project Management and Coordination (Project Meetings).

PART 1.06 DELIVERY, STORAGE & HANDLING

A. General: Comply with Division 1 Product Requirements.

B. Ordering: Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

C. Packing, Shipping, Handling and Delivery:

1. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

2. Ship, handle and unload units according to manufacturer's instructions.

D. Storage and Protection:

1. Store materials protected from exposure to harmful weather conditions.

2. Factory shipping covers to remain in place until installation.

PART 1.07 PROJECT CONDITIONS

A. Installation location: [Confirm design conditions and temperature.].

Specifier Note: Coordinate article below with Conditions of the Contract and with Division 1 Closeout Submittals (Warranty).

PART 1.08 WARRANTY

A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.

Specifier Note: Coordinate paragraph below with manufacturer's warranty requirements.

C. Warranty: Commencing on Date of Installation.

1. Aluminized Heat Exchangers: 10 years (limited).

2. Stainless Steel Heat Exchangers: 15 years (limited).

3. Compressors: 5 years (limited).

4. Unit Controller: 3 years (limited).

5. Other System Components: 1 year (limited).

PART 2 PRODUCTS

Specifier Note: Retain article below for proprietary method specification. Add product attributes, performance characteristics, material standards and descriptions as applicable. Use of such phrases as "or equal" or "or approved equal" or similar phrases may cause ambiguity in specifications. Such phrases require verification (procedural, legal and regulatory) and assignment of responsibility for determining "or equal" products.

PART 2.01 ROOFTOP UNITS

A. Manufacturer: Lennox Industries Inc.

1. Contact: 2100 Lake Park Blvd., Richardson, TX 75080; Telephone: (800) 453-6669; website: www.lennox.com.

B. Proprietary Products/Systems: Lennox' Energence® Packaged Rooftop Units, including the following equipment:

1. Cabinet: [Vertical] [Horizontal] supply and return airflow configuration with:

a. Interior Panels: Constructed of heavy gauge, galvanized steel [With factory installed, enhanced corrosion protection].

b. Exterior Panels: Constructed of heavy gauge, galvanized steel with 2-layer enamel paint finish.

c. Access Panel: Hinged for service access with seals and quarter-turn latching handles providing tight air and water seal.

d. Openings:

1) Unit base and horizontal access knockouts for electrical line entry.

2) Raised edges around duct and power entry openings.

e. Insulation:

1) Panels adjacent to conditioned air insulated with non-hygroscopic fiberglass insulation [And with factory installed metal liner].

2) Unit base fully insulated.

f. Base Rail: Full perimeter steel base rail with rigging holes.

2. Wiring:

a. Color-coded and continuously marked to identify point-to-point component connections.

3. Cooling System:

a. Capable of operating from 0 degrees F - 125 degrees F (-18 - 52 degrees C) without installation of additional controls.

b. [High efficiency, factory charged with R-410A (35-40 ton units only)] [Standard efficiency, factory charged with R-410A].

c. Four independent compressor circuits.

d. Compressors: Resiliently mounted, Copeland scroll type.

e. Compressor crankcase heaters.

f. Thermal expansion valves with removable element head.

g. Filter/driers.

h. High pressure switches for overload protection; manual reset.

i. Low pressure switches with manual reset.

j. Freezestats for ice damage protection.

k. Coil Construction: Factory leak tested, copper tube construction with enhanced rippled-edge aluminum fins, flared shoulder tubing connections and silver solder.

l. Evaporator Coil: [Row-split (MSAV® multi-stage air volume models) (variable air volume models] coils of cross flow circuiting with rifled copper tubing [With corrosion protection coating, painted base pan and painted door panels].

m. Condenser Coils: Slab design protected from weather or contact damage [With corrosion protection coating and painted base pan].

n. Outdoor Coil Fan Motors: Thermal overload protected, enclosed, permanently lubricated ball bearings, shaft up, wire basket mount.

o. Outdoor Coil Fan with PVC coated fan guard.

p. Condensate Drain Pan: [Polypropylene] [Stainless steel] with reversible positive slope and drain connection extending outside unit.

Specifier Note: The following features are optional. Include as necessary.

q. Optional factory installed equipment:

1) Compressor Vibration Isolation: Factory installed 2 inch springs, compressor deck completely isolated.

2) Service Valves: Factory installed, fully serviceable.

3) Blower Vibration Isolation: Factory installed, supply air, 2 inch (51 mm) springs, supply air mounting frame completely isolated.

4) Hot Gas Bypass. Factory installed, bypasses hot gas refrigerant from first stage compressor to suction line, de-superheater valve bypasses refrigerant from liquid line to maintain constant suction superheat [not available with Humiditrol® Dehumidification option]

Specifier Note: The following optional equipment is available only for MSAV (Multi-Stage Air Volume) models.

r. Humiditrol® Hot Gas Reheat: Factory installed humidity control with 3 modes of operation - No Dehumidification Demand, Dehumidification and Cooling Demand, Dehumidification Demand only.

4. Heating System:

a. Gas:

1) Aluminized steel inshot burners, direct-spark ignition, electronic flame sensor, 2-speed combustion air inducer, redundant automatic 2-stage gas valves with manual shutoff.

2) Heat Exchanger: Life cycle tested, [Aluminized steel, tubular design (for applications with entering mixed air temperatures of 45 degrees F (7 degrees C) or above)] [Stainless steel, tubular design (for applications with entering mixed air temperatures below 45 degrees F (7 degrees C))].

3) Fan and Limit Controls: Factory installed with fixed temperature setting.

4) Safety Switches: Flame rollout switches, flame sensors and combustion air inducer proving switches monitored by unit controller unit controller.

5) [Standard heat with 330,000 Btuh low fire/500,000 Btuh high fire input] [High heat with 528,000 Btuh low fire/800,000 Btuh high fire input] [Natural gas] [LPG/Propane].

Specifier Note: The following features are optional. Include as necessary.

6) Optional Factory Installed Equipment:

a) Low Temperature Vestibule Heater: Factory installed, allows operation down to minus 60 degrees F (minus 51 degrees C).

b) Modulating Gas: Stainless steel heat exchanger, full modulation from 25-100%, discharge air temperature control [Standard heat with 500,000 Btuh high fire input] [High heat with 800 Btuh high fire input] [Natural gas] [LPG/Propane]

b. Electric:

1) Elements shall be heavy duty nickel chromium internally wired with a maximum density of 47 watts per square inch.

2) Available on vertical downflow discharge units.

3) Power supply [Dual point power] [Single point power].

4) Rated airflow shall be a minimum of 280 CFM per nominal ton.

5) 35 ton unit, 208-230/3/60 with [30 kW] [45 kW] [60 kW] [75 kW] [90 kW] electric heater.

6) 35 ton unit, [460/3/60] [575/3/60] with [30 kW] [45 kW] [60 kW] [75 kW] [90 kW] [105 kW] [120 kW] electric heater.

7) 40 ton, 208-230/3/60 with [30 kW] [45 kW] [60 kW] [75 kW] [90 kW] electric heater.

8) 40 ton, [460/3/60] [575/3/60] with [30 kW] [45 kW] [60 kW] [75 kW] [90 kW] [105 kW] [120 kW] [135 kW] [150 kW] electric heater.

9) 45 ton, 208-230/3/60 with [45 kW] [60 kW] [75 kW] [90 kW] electric heater.

10) 45 ton, [460/3/60] [575/3/60] with [45 kW] [60 kW] [75 kW] [90 kW] [105 kW] [120 kW] [135 kW] [150 kW] [165 kW] electric heater.

11) 50 ton, 208-230/3/60 with [45 kW] [60 kW] [75 kW] [90 kW] electric heater.

12) 50 ton, [460/3/60] [575/3/60] with [45 kW] [60 kW] [75 kW] [90 kW] [105 kW] [120 kW] [135 kW] [150 kW] [165 kW] [180 kW] electric heater.

5. Air Filters:

a. [Disposable 2 inch (51 mm) pleated MERV 4] [Disposable 2 inch (51 mm) pleated MERV 8] [Disposable 4 inch (102 mm) pleated MERV 8] [Disposable 2 inch (51 mm) pleated MERV 13] [Disposable 4 inch (102 mm) pleated MERV 13] [Cleanable 2 inch (51 mm) metal mesh].

6. Blower:

a. [MSAV multi-stage air volume with adjustable pulleys and variable frequency drive]
[MSAV multi-stage air volume with adjustable pulleys and variable frequency drive with bypass]
[Variable air volume with adjustable pulleys and variable frequency drive]
[Variable air volume with adjustable pulleys and variable frequency drive with bypass].

b. Supply air blower: Forward curved blades, statically and dynamically balanced wheel, furnished grease fittings.

c. Overload protected motor with ball bearings.

7. Controls:

a. Intelligent Unit Controller: Microprocessor based control board with control voltage provided via 24 V transformer with built-in circuit protection. Built in functions include:

1) Blower on/off delay.

2) Built-in control parameter defaults.

3) Compressor time-off delay.

4) DDC compatible.

5) Dirty filter switch input.

6) Display/sensor readout.

7) Economizer control choice, including: sensible control, differential sensible control, global enthalpy control, outdoor enthalpy control and differential enthalpy control.

8) Fresh air tempering.

9) Greater than 85 extensive unit diagnostics.

10) Permanent diagnostic code storage.

11) Field changeable control parameters.

12) Indoor air quality input with setpoint and proportional modes of operation.

13) Low ambient controls.

14) Gas valve time delay between first and second stages.

15) Minimum compressor run time.

16) Network capability.

17) Night setback mode.

18) Return air temperature limit control.

19) Safety switch input.

20) Service relay output.

21) Smoke alarm mode with choices of unit off, positive pressure, negative pressure or purge.

22) Staging.

23) ”Strike Three” protection.

24) Hot gas reheat.

25) Thermostat bounce delay.

26) Warm-up mode delay.

27) On-board user interface.

28) PC interface.

29) Discharge air temperature staging control.

Specifier Note: The following features are optional. Include as necessary.

b. Optional Factory Installed Controls:

1) Blower proving switch.

2) Commercial DDC controls.

3) Dirty filter switch.

4) Smoke detector.

5) Indoor air quality (CO2) sensor.

6) Remote discharge air temperature sensor.

7) Thermostat control systems.

8. Electrical: [208/230 V] [460 V] [575 V], 3-phase, 60 Hz.

Specifier Note: The following features are optional. Include as necessary.

a. Optional Factory Installed Controls:

1) Circuit Breakers: Factory installed, externally accessible, up to 250 amps.

2) Disconnect Switch: Factory installed, externally accessible, up to 250 amps.

3) GFI Service Outlets: Factory installed, [Field wired] [Factory wired] 115 V ground fault circuit interrupter.

9. Economizer/Outdoor Air/Exhaust Options:

Specifier Note: The following features are optional. Include as necessary.

a. Optional Factory Installed Controls:

1) Economizer: Factory installed, parallel gear driven, 24 V fully modulating spring return motor for economizer control.

2) Differential Enthalpy Economizer Control: Two, factory installed, solid-state enthalpy sensors.

3) Outdoor Enthalpy Economizer Control: Factory installed outdoor air enthalpy sensor.

4) Global Enthalpy Economizer Control: Factory installed.

5) Differential Sensible Economizer Control: Two, factory installed, solid-state temperature sensors.

6) Outdoor Sensible Economizer Control: Factory installed outdoor air temperature sensor.

7) Barometric Relief Dampers: Aluminum blade, factory installed with bird screen.

8) Motorized Outdoor Air Damper Section: Linked mechanical dampers factory installed within unit.

9) Manual Outdoor Air Damper Section: Linked mechanical dampers factory installed within unit.

10) High Static Power Exhaust Blower[s]: [50%] [100%] factory installed [3] [5] [7.5] hp motor[s] controlled by [Damper position] [Solid state] [Solid state with VFD, no bypass] [Solid state with VFD, with bypass] [Pressure differential].

11) High Static Power Exhaust Blower Vibration Isolation: Factory installed, 2” (51 mm) springs, high static power exhaust fan deck completely isolated.

12) Standard Static Power Exhaust Fan[s]: [One] [Two] factory installed [Controlled by damper position] [Solid state] [Pressure differential].

13) Energy Recovery Wheel: Factory installed with defrost controls and bypass dampers for economizer operation (not available on units with horizontal supply and return airflow distribution).

14) Outdoor Air CFM Control:

a) Shall control outdoor airflow from 0 - 40% of total nominal unit airflow (400 CFM per ton).

b) Shall maintain +/- 5% of the set amount of outdoor air CFM airflow into the unit as specified by the design engineer.

c) Shall be located in the return air stream of the packaged rooftop unit.

Specifier Note: Edit Article below to suit project requirements. If substitutions are permitted, edit text below. Add text to refer to Division 1 Project Requirements (Product Substitutions Procedures) Section.

PART 2.02 PRODUCT SUBSTITUTIONS

A. Substitutions: No substitutions permitted.

PART 3 EXECUTION

PART 3.01 MANUFACTURER'S INSTRUCTIONS

Specifier Note: Article below is an addition to the CSI SectionFormat™ and a supplement to MANU-SPEC. Revise article below to suit project requirements and specifier's practice.

A. Compliance: Comply with manufacturer's written data, including product technical bulletins, product catalog installation instructions, product carton installation instructions and [Lennox Industries Inc.] SPEC-DATA sheets.

PART 3.02 EXAMINATION

A. Site Verification of Conditions: Verify substrate conditions, which have been previously installed under other sections, are acceptable for product installation in accordance with manufacturer's instructions.

PART 3.03 INSTALLATION

A. Install packaged rooftop units in accordance with manufacturer's instructions [On roof curbs provided by manufacturer] [As indicated].

B. Run drain line from cooling coil condensate drain pan to discharge [Over roof drain].

C. Duct Connections:

1. Insulate and weatherproof exterior ducts, joints and openings in roof or building walls with flashing and sealing compounds.

2. Insulate ducts passing through unconditioned spaces.

D. Condensate Drains:

1. Install trap between drain connection and open vent for proper condensate removal.

2. Fit tee to trap to direct condensate downward.

3. Vent condensate line.

4. Dispose of condensate in accordance with local codes.

5. Refer to manufacturer's instructions for condensate drain location.

Specifier Note: Include the following section for Gas Units.

E. Gas Piping:

1. Install drip leg on vertical pipe runs.

2. Install ground joint union between gas control manifold and main manual shutoff valve.

3. Ensure threaded joint compounds are resistant to action of liquefied petroleum gases.

4. Disconnect and isolate gas valve prior to pressure testing gas lines.

5. Check piping connections for gas leaks.

Specifier Note: Use following sentence when units are installed above 2000 feet (610 m).

F. High Altitude Derate: Derate units 4% for every 2000 feet (610m) above sea level.

G. Electrical Connections:

1. Power Supply:

a. Complete installation prior to applying power or closing disconnect switch.

b. Refer to unit startup directions and wiring diagram.

c. Refer to unit nameplate for minimum circuit ampacity and maximum fuse size.

2. Control Wiring:

Specifier Note: For all applications using remotely installed electromechanical and electronic thermostats, 18 AWG wire is required.

a. Use [18 AWG] [____] wire. If remote temperature controller uses triacs, ensure load on triacs is a minimum of 40ma by using relay interface to input terminals on unit or provide 1000 ohm, 5 watt resistors wired in parallel to unit input terminals.

PART 3.04 FIELD QUALITY CONTROL

Specifier Note: Use the following Articles only when manufacturer's field services are desired to verify the quality of the installed components. Establish the number and duration of periodic site visits required by Manufacturer and specify below. Consult Manufacturer for services required. Delete if field services are not required.

A. Have manufacturer of products supplied under this Section review Work involved in handling, installation/application, protection and cleaning of its product[s], and submit written reports in acceptable format to verify compliance of Work with Contract.

B. Manufacturer's Field Services: Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

C. Schedule site visits to review Work at stages listed:

1. After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.

2. [Twice] during progress of Work at [25%] and [60%] complete.

3. Upon completion of Work, after cleaning is carried out.

D. Obtain reports within [3] days of review and submit.

PART 3.05 UNIT POWERUP

A. Install unit in accordance with installation instructions and applicable codes.

B. Inspect field- and factory-installed electrical wiring for loose connections, and tighten as required.

PART 3.06 PERFORMANCE VERIFICATION

Specifier Note: Commissioning must ensure performance verification of every part of the unit including, but not necessarily limited to, the following components, as a factory-built and packaged unit: mixing chamber or plenum with outside air and return air dampers; filters; gas-fired heating unit; DX refrigeration system (with air-cooled condenser and DX cooling coil with drain pan); supply fan with motor and drive; exhaust fan with motor and drive; exhaust air dampers; weatherproof curbs.

A. General:

1. Perform rooftop air handling unit verification in accordance with Section 01750 - Starting and Adjusting, supplemented as follows:

2. Settings:

    a. Set outside air and return air dampers for minimum outside air.

3. Measurements:

    a. Measure supply fan capacity.

    b. Measure pressure drop at each component of air handling unit.

    c. Measure DBT, WBT of SA, RA, EA.

    d. Measure air-cooled condenser discharge DBT.

    e. Measure flow rates (minimum and maximum) of SA, RA, EA, relief air.

    f. Measure radiated and discharge sound power levels under maximum heating demand and under maximum cooling demand with compressors running.

    g. Measure exhaust fan capacity.

    h. Measure DX refrigeration system performance as specified.

4. Simulations:

    a. Simulate maximum cooling load and measure refrigerant hot gas and suction temperatures and pressures.

    b. Simulate maximum heating load and:

        1) Verify temperature rise across heat exchanger.

        2) Perform flue gas analysis. Adjust for peak efficiency.

        3) Verify combustion airflow to heat exchanger.

        4) Simulate minimum heating load and repeat measurements.

5. Control Strategies:

    a. Verify operating control strategies, including:

        1) Heat exchanger operating and high limit.

        2) Early morning warm-up cycle.

        3) Freeze protection.

        4) Economizer cycle operation, temperature of change-over.

        5) Alarms.

6) Voltage drop across thermostat wiring.

7) Operation of remote panel including pilot lights, failure modes.

6. Operation and Adjustment:

a. Check for smooth, vibration-less correct rotation of supply fan impeller and scroll compressors.

b. Adjust impeller speed as necessary and repeat measurement of fan capacity.

c. Reduce differences between fan capacity at minimum and maximum outside air to less than [5]%.

d. Reduce difference between fan capacity at full cooling and fan capacity at full heating to less than [5]%.

e. OAD: Verify for proper stroking, interlock with RAD.

f. Use smoke test to verify no short-circuiting of EA, relief air to outside air intake.

g. Check for smooth, vibration-less, correct rotation of exhaust fan impeller.

h. Adjust impeller speed as necessary and repeat measurement of exhaust fan capacity.

i. Check capacity of heating unit.

j. Refer to other sections of these specifications for PV procedures for other components.

PART 3.07 COMPLETION AND CLEANUP

A. On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

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