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ACCA Standard

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HVAC Quality Installation Specification

Residential and Commercial Heating, Ventilating, and Air Conditioning (HVAC) Applications

The Air Conditioning Contractors of America Educational Institute (ACCA-EI) Standards Task Team (STT) develops standards as an American National Standards Institute (ANSI) accredited standards developer (ASD). ACCA develops voluntary standards as outlined in the ACCA Essential Requirements and the ANSI Essential Requirements. ACCA standards are developed by diverse groups of industry volunteers in a climate of openness, consensus building, and lack of dominance (e.g., committee/group/team balance). Essential requirements, standard activities and documentation can be found in the standards portion of the ACCA website at www.acca.org. Questions, suggestions, and proposed revisions to this standard can be addressed to the attention of the Standards Task Team, ACCA, 2800 Shirlington Road, Suite 300, Arlington, VA 22206.

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1.0 PURPOSE

This specification establishes minimum criteria for use by stakeholders concerned with the proper installation, maintenance, and servicing of HVAC systems to meet occupant demands for energy efficiency, comfort, and IAQ in residential and commercial applications.

2.0 SCOPE

This specification applies to HVAC equipment/components being installed in residential and commercial buildings:

2.1 EQUIPMENT APPLICATION

2.1.1 Residential Equipment:

a) Unitary air conditioners and air-source/water-source heat pumps up to 65,000 BTU/H
b) Furnaces (gas-fired, oil-fired, electric, and other) up to 225,000 BTU/H
c) Boilers up to 300,000 BTU/H

2.1.2 Commercial Equipment:

a) Unitary equipment (packaged and split) greater than 65,000 BTU/H
b) Furnaces greater than 225,000 BTU/H
c) Boilers greater than 300,000 BTU/H
d) Residential equipment used in commercial three-phase applications.]

Note: Due to differing design aspects and control/operation situations, built-up systems (i.e., chillers, custom or specialty-built penthouse units, etc.) are not included in this specification. Buildings employing built-up systems are generally designed by architects or professional engineers. Additionally, commercial buildings using built-up equipment are more likely to benefit from increased owner scrutiny via building commissioners, owner agents, etc.

2.2 EQUIPMENT SYSTEMS / COMPONENTS

2.2.1 Heating Systems / Components – Single Zone and Multizone

a) Heating-only equipment and heat pumps
b) Hot-water coil and/or fin-tube radiation, and/or unit heaters, and/or unit ventilators
c) Electric resistance coil and/or fin-tube radiation, and/or gas unit heaters, and/or unit ventilators
d) Hot air heating (fossil fuel or electric furnace, direct-fired and indirect-fired makeup air equipment)
e) Radiant heat equipment

2.2.2 Cooling Systems / Components – Single Zone and Multizone

a) Cooling-only equipment and heat pumps
b) Rooftop single zone, rooftop multi-zone (hot-deck/cold-deck)
c) Single-zone unitary (packaged terminal air conditioners/heat pumps, split-coil-ductless)

3.0 EQUIPMENT ASPECTS

This section focuses on the upfront design procedures/tasks undertaken before the equipment is actually installed.

3.1 BUILDING HEAT GAIN / LOSS LOAD CALCULATIONS

The contractor shall ensure that heat loss and heat gain load calculations are performed for every HVAC system installation/replacement.

3.1.1 REQUIREMENTS

The contractor shall provide evidence that:

a) For NEW residential and commercial buildings, or when adding new ducts to an existing structure, room-by-room heat gain/loss load calculations are completed
b) For EXISTING residential and commercial buildings, without contractor modification of the existing duct system, block load heat gain/loss load calculations are completed

Notes: For EXISTING BUILDINGS:

- Load calculations are not required if the original use of the structure has remained unchanged from that noted in the original engineering design plans and/or original load calculations.
- Room-by-room load calculations may be undertaken if so chosen by the contractor.

3.1.2 ACCEPTABLE PROCEDURES

The contractor shall perform one or all of the following acceptable procedures for fulfilling the desired criteria:

a) Follow an appropriate methodology/procedure to perform building load calculations (e.g., ACCA Manual J®, ACCA Manual N®, ASHRAE Handbook Guidelines, DOE EnergyPlus™, or other approved equivalents per the authority having jurisdiction)

b) Confirm that the calculations were performed (whether by the contractor or a qualified third party)

3.1.3 ACCEPTABLE DOCUMENTATION

a) Load calculation worksheets included in the job file, OR
b) Appropriate documentation in job file

3.2 PROPER EQUIPMENT CAPACITY SELECTION

The contractor shall ensure that all equipment is properly sized and selected prior to being installed.

3.2.1 REQUIREMENTS

The contractor shall provide evidence of the following:

a) For CENTRAL AIR CONDITIONERS and HEAT PUMPS - the sensible and latent capacity of the selected equipment will satisfy the building sensible and latent load requirement at representative operating conditions

i. Manufacturer product data verify that application latent loads are addressed

ii. Total equipment capacity between:

- 95% and 115% of calculated system load (for air conditioners and heat pumps)
- 95% and 125% of calculated system load (for heat pumps with winter heating dominated requirements)
- OR the next largest nominal piece of equipment that is available for either

b) For gas-fired or oil-fired WARM AIR SYSTEMS and HEATING BOILERS - the heating capacity of the selected equipment will satisfy the heating requirement at design conditions

i. WARM AIR SYSTEMS - output capacity between 100% and 140% of calculated system load unless dictated by the cooling equipment selection OR customer needs

ii. HEATING BOILERS - equipment capacity between 100% and 115% of calculated system load, OR the next largest nominal piece of equipment that is available

3.2.2 ACCEPTABLE PROCEDURES

Using OEM performance information and industry-approved procedures (e.g., ACCA Manual S® for residential applications, ACCA Manual CS® for commercial applications, OEM guidelines, or other approved

equivalent per the authority having jurisdiction), the contractor is to confirm that the selected equipment satisfies/meets the load requirements at the system design conditions.

3.2.3 ACCEPTABLE DOCUMENTATION

a) Equipment performance information in the job file
b) Documentation indicating the application objectives were met
c) Written job documentation or checklist in job file

3.3 MATCHED SYSTEMS

The contractor shall ensure that all evaporators, condensing units, and furnaces are properly matched systems as identified by industry-recognized certification programs.

3.3.1 REQUIREMENTS

The contractor shall provide evidence of matched systems according to one or more of the following for the pertinent equipment being installed:

a) ARI Product Certification directory/database (www.aridirectory.org)
b) CEE directory of ARI-verified equipment (www.ceehvacdirectory.org)
c) Gas Appliance Manufacturers Association (GAMA) directory/database (www.gamapower.org)

3.3.2 ACCEPTABLE PROCEDURES

The contractor shall use one or both of the following acceptable procedures for fulfilling the desired criteria:

a) Confirmation of system matching compliance as compared to a recognized product certification database
b) Confirmation of the matched system operational performance data to OEM documentation for all equipment being installed (i.e., air handling unit, indoor coil, outdoor condensing unit)

3.3.3 ACCEPTABLE DOCUMENTATION

a) Copy of the ARI, CEE-ARI, and/or GAMA certification record/certificate with appropriate reference number indicated for the matched system
b) Copy of OEM-provided catalog data indicating acceptable combination selection and performance data

4.0 EQUIPMENT INSTALLATION ASPECTS

This section focuses on the HVAC system installation.

4.1 AIRFLOW ACROSS INDOOR HEAT EXCHANGERS

The contractor shall verify that the airflow across the indoor heat exchanger is within acceptable ranges.

4.1.1 REQUIREMENTS

The contractor shall provide evidence of the following for the measured airflow across the indoor heat exchanger for installed systems (with all accessories and system components in place)1:

a) For cooling coil (e.g., refrigerant, water) and heat pump applications

i. Airflow across the coil, at fan design speed and full operating load, is within 15% of the airflow required per the system design. and

ii. Airflow across the coil is within the range recommended by the OEM product data2

b) For gas- or oil-fired heat exchanger applications

i. Airflow, across the heat exchanger, at fan design speed and full operating load, is within 15% of the airflow required per the system design.

ii. Airflow across the indoor heat exchanger is within the range recommended by the OEM product data

iii. Heat exchanger airflow requirements shall be considered separately from any combined and attached cooling coils sharing the same distribution duct system.

4.1.2 ACCEPTABLE PROCEDURES

The contractor shall test using one or all of the following acceptable devices for fulfilling the desired criteria:

a) Pressure matching method3

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1 When verifying airflow at full design fan speed, there is little distinction between a split capacitor fan motor (PSC) or a variable speed fan motor (e.g., electronically commutated motor; ECM). See "Fan Airflow" in Appendix B. Note: ECM fan motors are designed to modify their RPMs in order to provide a prescribed (programmed) air volume in response to static pressure conditions (actually torque on the output shaft). Hence, an ECM may use more or less power than a comparable PSC motor in the same application.

2 Airflow across the coil is typically between 350 to 450 CFM per ton

b) An anemometer (e.g., hot wired, rotary style) or other methods (e.g., transverse pitot tubes) for measuring total static and velocity pressures to determine airflow velocity in several traversing locations per AABC, NEBB, or ASHRAE procedures
c) Flow grid measurement method
d) A manometer to determine the pressure drop across a clean cooling coil or fan coil unit and compare with values from the OEM CFM/pressure drop coil tables
e) The temperature rise method (for heating equipment only – gas or oil furnace, electric heat) to verify proper airflow across the heat exchanger or heater elements. [Note: It is not acceptable to use the temperature rise method for cooling (i.e., airflow over the indoor coil).]

4.1.3 ACCEPTABLE DOCUMENTATION

a) Documented field data and calculations recorded on start-up sheet
b) Documented field data and calculations recorded on service records
c) Written job documentation or checklist in job file

4.2 REFRIGERANT CHARGE

The contractor shall ensure that the HVAC system has the proper refrigerant charge.

4.2.1 REQUIREMENTS

The contractor shall provide evidence of the following for charging installed systems:4

a) For the SUPERHEAT method, system refrigerant charging per OEM charging data/instructions and within ± 5°F of the OEM-recommended optimal refrigerant charge
b) For SUBCOOLING method, system refrigerant charging per OEM charging data/instructions and within ± 3°F of the OEM-recommended optimal refrigerant charge
c) Any method approved and specifically stated by the OEM that will ensure proper refrigerant charging of the system

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3 Use of a calibrated fan to match the supply plenum pressure and measure the system airflow through an active fan.
4 Refrigerant charge tolerances noted (i.e., ± 5°F and/or ± 3°F of the OEM-recommended optimal refrigerant charge) are not additive to any OEM-specified tolerances.

4.2.2 ACCEPTABLE PROCEDURES

The system shall be charged according to an approved/acceptable charging method. The charging method used should be documented, including:
- system conditions
- calculations conducted
- results obtained

If ambient conditions require a follow-up visit to finalize the charging process, this should be recorded both at the initial visit and the follow-up visit.

The contractor shall use one or all of the following acceptable procedures for completing the desired measurements after confirmation of required airflow over the indoor coil per §4.1:

a) Superheat test done under outdoor ambient conditions, as specified by the OEM instructions (typically, 55°F drybulb temperature or higher)
b) Subcooling test done under outdoor ambient conditions, as specified by the OEM instructions (typically, 60°F or higher)

4.2.3 ACCEPTABLE DOCUMENTATION

a) Documented field data AND operating conditions recorded on start-up sheet
b) Documented field data AND operating conditions recorded on service records
c) Written job documentation or checklist in job file

4.3 ELECTRICAL REQUIREMENTS

The contractor shall ensure all electrical requirements are met as related to the installed equipment.

4.3.1 REQUIREMENTS

The contractor shall provide evidence of the following:

a) LINE and LOW VOLTAGES per equipment (single and three-phase) rating plate - the percentage (or amount) below or above nameplate values are within OEM specifications and/or code requirements
b) AMPERAGES per equipment (single and three-phase) rating plate - the percentage (or amount) below or above nameplate values are within OEM specifications and/or code requirements
c) LINE and LOW-VOLTAGE wiring sizes per NEC (National Electric Code) or equivalent
d) GROUNDING/BONDING per NEC or equivalent

4.3.2 ACCEPTABLE PROCEDURES

The contractor shall test using the following acceptable procedures for fulfilling the design criteria:

a) Volt meter to measure the voltage
b) Amp meter to measure the amperage
c) Verify measurements with nameplate and over current protection criteria

4.3.3 ACCEPTABLE DOCUMENTATION

a) Documents showing that selections are in compliance with OEM specifications
b) Written job documentation or checklist in job file

4.4 ON-RATE FOR FUEL-FIRED EQUIPMENT

The contractor shall ensure the equipment "on-rate" (BTU/H input during steady-state operation) for gas-fired or oil-fired equipment is at the equipment nameplate value.

4.4.1 REQUIREMENTS

a) Gas-Fired Equipment:

The contractor shall provide evidence of the following:

i. Firing rate within ± 5% of nameplate input for gas equipment (or per OEM specifications)
ii. Temperature rise per nameplate

b) Oil-Fired Equipment:

The contractor shall provide evidence of the following:

i. Correct nozzle flow rate and spray angle for correct firing rate per nameplate input,
ii. Correct oil pump pressure for nozzle installed and at OEM's specified values, and
iii. Temperature rise per nameplate

4.4.2 ACCEPTABLE PROCEDURES

a) Gas-Fired Equipment:

The contractor shall test using both of the following acceptable procedures for fulfilling the desired criteria:

i. Clocking the meter or other fuel input measurement per OEM instructions, and
ii. Measuring the temperature rise at steady state conditions (with airflow first verified by §4.1) – furnaces only.

NOTE: Combustion analysis may be necessary in some cases.

b) Oil-Fired Equipment:

The contractor shall fulfill the following criteria

i. Verify nozzle or alternate input nozzle per OEM installation or oil burner instructions.
ii. Adjust oil pump pressure with a dial or electronic gauge designed for oil pressure measurement
iii. Measure the temperature rise at steady-state conditions (with airflow first verified by §4.1) –furnaces only.
iv. Perform a combustion analysis per OEM installation or oil burner instructions.5

4.4.3 ACCEPTABLE DOCUMENTATION

a) Documented field measurements
b) Written job documentation or checklist in job file

4.5 COMBUSTION VENTING SYSTEM

The contractor shall ensure proper sizing, design, material selection and assembly of the combustion gas venting system.

4.5.1 REQUIREMENTS

The contractor shall provide evidence of compliance with one of the following:

a) CATEGORY I vent system sized per OEM instructions and the National Fuel Gas Code (NFGC, NFPA 54)
b) CATEGORY I vent system sized per OEM instructions and the International Fuel Gas Code (IFGC)
c) CATEGORY II, III and IV vent system sized per OEM instructions
d) CATEGORY II, III and IV vent system sized per required local code

5 Combustion analysis is necessary when setting up an oil burner. Additionally, new oil-fired equipment no longer standardizes the pump pressure at 100 psig. Hence, incorrect pump pressure may result in an incorrect input rate for the equipment.

4.5.2 ACCEPTABLE PROCEDURES

The contractor shall use one or both of the following acceptable procedures for fulfilling the design criteria:

a) Comparison of the actual installation to appropriate fuel gas venting tables for Category I vent systems
b) Comparison of the actual installation to appropriate OEM instructions, for Category II, III and IV vent systems

4.5.3 ACCEPTABLE DOCUMENTATION

a) Documented field data recorded on start-up sheet
b) Documented field data recorded on service records
c) Written job documentation or checklist in job file

4.6 SYSTEM CONTROLS

The contractor shall ensure proper selection and functioning of system operational and safety controls.

4.6.1 REQUIREMENTS

The contractor shall provide evidence of the following:

a) Operating controls and safety controls are compatible with the system type and application, and the selected controls are consistent with OEM recommendations and industry practices, and
b) Operating controls and safety controls lead to proper sequencing of equipment functions, with all controls and safeties functioning per OEM or customer design specifications

NOTE: Examples of operating controls include: thermostats, humidistats, economizer controls, etc. Examples of safety controls include: temperature limit switch, airflow switch, condensate overflow switch, furnace limit switch, boiler limit switch, etc.

4.6.2 ACCEPTABLE PROCEDURES

The contractor shall use the following acceptable procedures for fulfilling the desired design criteria:

a) Confirmation of the control/safety selections made
b) Supporting OEM literature related to the selections made
c) Verification of correct cycling/operational sequences of controls and safety devices/systems per OEM specifications

4.6.3 ACCEPTABLE DOCUMENTATION

a) Documents showing that controls/safeties selections are in compliance with OEM specifications
b) Written job documentation or checklist in job file indicating that controls/safeties function properly

5.0 DUCT DISTRIBUTION ASPECTS

This section focuses on duct-related elements of the installed HVAC system.

5.1 DUCT LEAKAGE

The contractor shall ensure the ducts are sealed and that air leakage (CFM) is minimized.

5.1.1 REQUIREMENTS

The contractor shall provide evidence of meeting the following:

a) For NEW CONSTRUCTION, test using any one of the four options:
i. Ducts located inside the thermal envelope have no more than 10% total duct leakage (airflow CFM), or iv.
ii. Ducts located outside the thermal envelope have no more than 6% total duct leakage (airflow CFM), or iv.
iii. EnergyStar™ Qualified Homes specification requiring that ducts must be sealed and tested to be less than 4 CFM leakage to outdoors per 100 square feet of conditioned floor area, or iv.
iv. Per local code or authority having jurisdiction if they meet or exceed the requirements of a)i., a)ii., or a)iii.

b) For EXISTING CONSTRUCTION, test using any one of the three options:
i. No more than 20% total duct leakage (airflow CFM) or iii.
ii. 50% improvement on existing leakage rate or until i. is achieved or iii.
iii. Per local code or authority having jurisdiction if they meet or exceed the requirements of b)i. or b)ii.

Notes: The total duct leakage requirement pertains to the percentage of CFM leakage as compared to the overall air handling fan flow (see §4.1) operating at design conditions. The airflow leakage shall be based on the higher design airflow requirement (i.e., the higher of the winter heating airflow or of the summer cooling airflow).

TOTAL duct leakage = SUPPLY duct leakage + RETURN duct leakage.

5.1.2 ACCEPTABLE PROCEDURES

The contractor shall test using one or more of the following acceptable procedures for fulfilling the desired criteria:

a) Duct pressurization tests6

b) For COMMERCIAL BUILDINGS: Total room supply CFMs and return CFMs compared with blower capability (e.g., flow hood method)

c) Blower door subtraction method7

d) A hybrid duct pressurization test / blower door subtraction8

5.1.3 ACCEPTABLE DOCUMENTATION

a) Documented field data recorded on start up sheet

b) Documented field data recorded on service records

c) Written job documentation or checklist in job file

d) Signed documentation from the customer that duct system repair/replacement was refused

5.2 AIRFLOW BALANCE

The contractor shall ensure room volumetric airflow CFMs meet the design/application requirements.

5.2.1. REQUIREMENTS

The contractor shall provide evidence that:

a) For NEW CONSTRUCTION or addition of new ducts to an existing structure (with bedroom doors closed) –

For Residential Buildings: The individual room airflows are within the greater of ± 20%, or 25 CFM of the design/application requirements for the supply and return ducts.

For Commercial Buildings: The individual room airflows are within the greater of ± 10%, or 25 CFM of the design/application requirements for the supply and return ducts.

b) For EXISTING CONSTRUCTION without contractor modification of existing ductwork –

No ACCA requirements apply.

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6 Duct leakage is measured using a duct pressurization test through a calibrated fan or orifice. Duct registers are sealed, a fan is attached to one opening, the ducts are pressurized to match the system operating pressures, and the amount of air flowing through the fan is quantified. A commonly known system is Duct Blaster®; there are several others as well.

7 A calibrated fan measures whole-building leakage, then the duct grilles are sealed and the house re-measured. The difference is the amount of leakage attributable to the duct system.

8 A hybrid of the duct pressurization test and the blower door subtraction methods in which: (1) a pressure match is performed in the house and the ducts and the values then compared against (2) separate measurements of the airflow into the ducts.

c) For NEW OR EXISTING CONSTRUCTION the airflow balance is per local code or authority having jurisdiction if such meet or exceed the requirements of 5.2.1.a or 5.2.1.b.

5.2.2 ACCEPTABLE PROCEDURES

The contractor shall test using one or all of the following acceptable devices for fulfilling the desired criteria:

a) Flow hoods used per specifications from the flow hood manufacturer
b) Traverse with anemometer (hotwire or rotary) used per specifications from the test equipment manufacturer
c) Pitot tube and slant manometer used per procedures specified by AABC, ASHRAE, NEBB, or TABB

Note: The use of certain measurement instruments/devices that determine airflow based on velocity measurements may be acceptable if (1) grille 'free areas' can be correctly determined and (2) the instrument/device measurement tolerances are tighter than the airflow balance tolerances.

5.2.3 ACCEPTABLE DOCUMENTATION

a) Documented field data recorded on start up sheet
b) Documented field data recorded on service records
c) Written job documentation or checklist in job file

6.0 SYSTEM DOCUMENTATION AND OWNER EDUCATION ASPECTS

This section focuses on providing owners with job documentation, operation instructions, and education to assist them in properly operating and maintaining their systems.

6.1 PROPER SYSTEM DOCUMENTATION TO THE OWNER

The contractor shall document the HVAC installation as well as the operation and maintenance to be performed.

6.1.1 REQUIREMENTS

The contractor shall provide evidence of the following (relevant to the HVAC activity undertaken and information available to the contractor):

a) Placing copies of architectural drawings, as-built drawings, survey data, equipment submittals, equipment performance information, balance reports, equipment operation sequences, maintenance and

operating instructions, and equipment/contractor warranties within easy reach of the homeowner (e.g., at the air handling cabinet) or in the hands of the building owner/operator (or designated agent).
b) Recording model and serial numbers of all equipment installed and maintaining same at the contractor's place of business.

6.1.2 ACCEPTABLE PROCEDURES

The contractor shall confirm that all the listed requirements are met.

6.1.3 ACCEPTABLE DOCUMENTATION

a) Written job documentation or checklist in job file
b) Signed documentation from the customer that the listed requirements were offered/met

6.2 OWNER/OPERATOR EDUCATION

The contractor shall educate the owner and/or operator on how to both *operate* and *maintain* the installed equipment and will promote system maintenance to aid in the continuing performance of the installed equipment.

6.2.1 REQUIREMENTS

The contractor shall conduct the following:

a) Instruct customers on proper system operation of installed equipment
b) Explain to customers the maintenance requirements for the installed equipment
c) Explain to customers warranty procedures and responsibilities
d) Provide contact information for warranty, maintenance, and service requirements

6.2.2 ACCEPTABLE PROCEDURES

The contractor shall confirm that all the listed requirements are met.

6.2.3 ACCEPTABLE DOCUMENTATION

a) Written job documentation or checklist in job file
b) Signed documentation from the customer that the listed requirements were offered/met