SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC.

Technical Resources Bulletin

December 13, 2011

TRB #6-11

To: SMACNA Members
SMACNA Chapter Executives

From: Technical Resources Department

Subject: Technical Paper on HVAC Air Duct Leakage

SMACNA published the HVAC Air Duct Leakage Test Manual in conjunction with the SMACNA HVAC Duct Construction Standards. Research proved that duct leakage could be well defined as a function of the static pressure and the surface area of the duct. This allowed for the introduction of leakage classes that could be used to calculate and accurately represent the leakage of air from ducts of various sizes and configurations.

For over three decades SMACNA has provided both a method of test and pass fail criteria for air duct leakage.

All of the following industry standards and codes follow the SMACNA method of duct air leakage testing in the same basic fashion, varying only slightly with respect to the pass/fail criteria, and other minor variances for these tests.

ASHRAE 90.1 2010:

6.4.4.2.2 Duct Leakage Tests. Ductwork that is designed to operate at static pressures in excess of 3 in. w.c. and all ductwork located outdoors shall be leak-tested according to industry-accepted test procedures (see Informative Appendix E). Representative sections totaling no less than 25% of the total installed duct area for the designated pressure class shall be tested. All sections shall be selected by the building owner or the designated representative of the building owner. Positive pressure leakage testing is acceptable for negative pressure ductwork.

The maximum permitted duct leakage shall be $L_{max} = CL \times P^{0.65}$ where:

L_{max} = maximum permitted leakage cfm/100 ft^2 duct surface area;

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CL = 4, duct leakage class, cfm/100 ft2 duct surface area at 1 in. w.c.; and

P = test pressure, which shall be equal to the design duct pressure class rating, in. w.c.

The International Energy Conservation Code 2012

C 403.2.7.1.3 High-pressure duct systems. Ducts designed to operate at static pressures in excess of 3 inches w.g. (750 Pa) shall be insulated and sealed in accordance with Section C403.2.7. In addition, ducts and plenums shall be leak tested in accordance with the SMACNA *HVAC Air Duct Leakage Test Manual* with the rate of air leakage *(CL)* less than or equal to 6.0 as determined in accordance with Equation 4-5.

$CL=F/P^{0.65}$ (Equation 4-5)

where:

F -The measured leakage rate in cfm per 100 square feet of duct surface.

P -The static pressure of the test.

Documentation shall be furnished by the designer demonstrating that representative sections totaling at least 25 percent of the duct area have been tested and that all tested sections meet the requirements of this section.

The International Green Construction Code V2

607.4.1 Duct Air Leakage Testing. Ductwork that is designed to operate at static pressures exceeding 3 inches water column and all ductwork located outdoors shall be leak-tested in accordance with the SMACNA *HVAC Air Duct Leakage Test Manual.* Representative sections totaling not less than 25% of the total installed duct area for the designated pressure class shall be tested. Positive pressure testing is acceptable for negative pressure ductwork. Duct systems with pressure ratings in excess of 3 inches water column shall be identified on the construction documents. The maximum permitted duct leakage shall be in accordance with Equation 6-7.

$F = C_L P^{0.65}$ **(Equation 6-7)**

Where

F = maximum permitted leakage in cfm/100 ft² duct surface area;

C_L = 4, duct leakage class, cfm/100 ft² at 1 inch water column.

P = test pressure, which shall be equal to the design duct pressure class rating inches of water column.

IAPMO's Green Plumbing and Mechanical Code Supplement (2010)

703.4.4.2.2 Duct Leakage Tests. Ductwork that is designed to operate at static pressures in excess of 3 inches Water Column (0.75 kPa) shall be leak-tested according to the SMACNA HVAC Air Duct Leakage Test Manual. Representative sections totaling no less than 25 percent of the total installed duct area for the designated pressure class shall be tested. Duct systems with pressure ratings in excess of 3 inches Water Column (0.75 kPa) shall be identified on the drawings. The maximum permitted duct leakage shall be:

$Lmax = C_L P^{0.65}$

Where:

Lmax = maximum permitted leakage in $(ft^3/min)/100\ ft^2$ ($0.05\ L/s/m^2$) duct surface area;

C_L = duct leakage class, $(ft^3/min)/100\ ft^2$ ($0.05\ L/s/m^2$) at 1 inch Water Column (0.24 kPa)

Six for rectangular sheet metal, three for round/flat oval sheet metal.

None of the above codes or standards requires that all of the duct be tested. Typically, 25% of duct designed to operate in excess of 3 in. wg is sufficient, some include test required for all duct located outdoors. Also note that the pass/fail in each case is a leakage class, not a percentage of total fan airflow. The pass/fail criteria vary slightly from 3 to 6 depending on the code or standard.

It is not uncommon for SMACNA's HVAC Air Duct Leakage Test Standard to be misapplied in specifications by requiring duct leakage tests to include various pieces of equipment. Or, for the specifier to select the pass/fail criteria impractically low. This practice of attempting to extend a duct-only test to other portions of the HVAC system shows that the industry needs a standard that can address the entire HVAC system and that pass/fail criteria must be determined from research.

With greater focus on commissioning and energy conservation it is no longer sufficient to simply test individual components of each building's systems and assume that if each component performs in an acceptable manner the entire system works as intended. Construction practices and the model building codes have evolved to look at the total building as a system. SMACNA is addressing the issue by developing a standard for system air leakage tests and, through research, will provide research-developed pass/fail criteria.

Developing a standard intended to evaluate the equipment and distribution system requires a wide range of expertise. Recognizing this, ASHRAE has decided to co-develop the SMACNA-initiated ANSI standard (HVAC Total System Air Leakage Standard). SMACNA and ASHRAE have worked together for decades and have jointly developed other standards.