RESNET Formal Interpretation 2006-002
Approved by the RESNET Board of Directors, February 26, 2006

Proponent:
RESNET Standing Technical Committee

Applies to:
2006 Mortgage Industry National Home Energy Rating Systems Standards
Table 303.4.1.(1), under "Thermal distribution systems"; footnote (n); and Appendix A, under "Air leakage (ducts)":

Interpretation: RESNET Duct Testing Procedure

Background
Table 2 in this document comprises a summary of a test procedure intended for use by Certified Raters in performing required field testing of the leakage of forced-air thermal distribution systems as part of a Confirmed Rating.

The *2006 Mortgage Industry National Home Energy Rating System Standards* specifies the use of ASHRAE Standard 152, with some exceptions (stated in Appendix A), for testing ducted distribution systems. The procedures outlined below and summarized in Table 2 are deemed by RESNET to be an approved implementation of the leakage testing procedures in ASHRAE 152 for the purpose of field testing of homes by Certified Raters to complete a confirmed HERS rating.

Rationale
The leakage testing procedures of ASHRAE Standard 152 were not necessarily designed for the practical application to field ratings, and some simplifications and default assumptions were necessary. There are requirements in 152 that, although appropriate for research purposes, can not always be met when testing homes in a production setting.

Buffer zones
For example, 152 requires that when pressurizing a house to 25 Pa, any unconditioned spaces containing ducts must be within 10 Pa of outside pressure. If this requirement isn't met, holes must be added between the space and outside until the requirement is met. This often can't be done in real houses. In addition it is not always possible to even measure the pressure in these spaces without cutting holes through finished surfaces. For these reasons it was decided that, whenever possible, these spaces should be opened to outside, but when not possible they should be left "as is" and no pressure measurement of these spaces would be required.

Plenum Pressure Measurements
The leakage to outside test procedure in ASHRAE 152 (Annex B) attempts to estimate the amount of duct leakage to outside and unconditioned spaces under normal operating conditions. This is done by first attempting to measure the leakage with a uniform pressure of 25 Pa across all the leaks to outside and unconditioned spaces. This leakage at 25 Pa is then adjusted for the fact that the pressure difference

between the ducts and unconditioned spaces was different than 25 Pa during the test (if it was). It is also adjusted to estimated actual operating conditions by measuring the supply and return plenum pressures and assuming that the effective leakage pressure is one half of the operating plenum pressures.

In the field, measuring plenum pressures is often problematic. It is common to get very different readings at different locations in the plenums due to turbulence. It is also sometimes impossible to get to the plenums, such as in a mobile home with down flow air handler and an evaporator coil directly between air handler and the floor; in these cases, there really is no supply plenum to measure in. There are also cases where the supply plenum really is a large diameter insulated flex duct that would have to be penetrated to make a measurement.

For these reasons, it is deemed acceptable to simplify Annex A by assuming that the effective leakage pressure is 25 Pa. Although there is not adequate data nation-wide to say that this is absolutely the best number to use, there is enough experience to say that it is reasonable. Because leakage flow is roughly proportional to the square root of the leakage pressure, a 20% error in the leakage pressure only causes about 10% error in the leakage flow.

Supply and Return Leakage

ASHRAE 152 specifies that the leakage of the supply and return sides of the system are measured separately. Splitting the system to measure supply and return leakage separately is often problematic. The "2006 Mortgage Industry National Home Energy Rating System Standards" allows testing the entire system for leakage and then includes a procedure for splitting this leakage between supply and return in two different ways, calculating the efficiency both ways, and using the lower of the two resulting efficiencies, as a conservative default. The procedure outlined in Table 2 uses this approach.

Although there are some differences between a strict interpretation of ASHRAE 152 testing requirements and the requirements in Table 2, we believe that it is reasonable for RESNET to deem the requirements of Table 2 as their interpretation of ASHRAE 152 testing for the purpose of determining a home energy rating.

Table 1, below, helps to explain where in the "2006 Mortgage Industry National Home Energy Rating System Standards" the various testing requirements come from. They originate in paragraph 303.4.1.2, which contains the specifications for the HERS Reference and Rated Homes used in the Calculation of the Rating. This section on thermal distribution systems specifies that the rated home should either use values from a default table, Table 303.4.1(3), which has some testing requirements; or use a calculation according to ASHRAE 152 (or equivalent verified computation), with testing conducted according to ASHRAE 152.

The Rating Methods 1, 2, and 3 in Table 1 are not designated as such in the actual standard, but are designated as such here because they have different requirements for testing. Method 2 (using "reduced leakage" defaults) is typically only used in calculating a Projected Rating, or may be used *when confirmed by the required duct tests,* if software uses simplified methods of determining duct system efficiency. At least one of the commonly used software tools, REM/Rate™, may use the default in the Projected Rating, but typically uses a calculated distribution system efficiency based on duct leakage testing for the Confirmed Rating, which puts the Confirmed Rating in the Method 3 category.

Method 1 (No Testing):	❑ Software uses "non-reduced leakage" values in Default Table 303.4.1(3) to determine duct efficiency. ❑ No duct leakage testing required by RESNET standards.[1] ❑ No air handler flow measurement is required.
Method 2 (Reduced Leakage):	❑ Software uses "reduced leakage" values in Default Table 303.4.1(3) to determine duct efficiency. This method is not typically used for confirmed HERS ratings. ❑ Outside Duct Leakage ≤ 3 CFM25 / 100 ft^2 of conditioned floor area. **And** ❑ Total Duct Leakage ≤ 9 CFM25 / 100 ft^2 of conditioned floor area.[2] ❑ No air handler flow measurement is required.
Method 3 (ASHRAE 152):	❑ Software uses ASHRAE 152-2004 (or verified equivalent computations) to calculate duct efficiency. ❑ Outside Duct Leakage is measured. **Or** ❑ Total Duct Leakage is measured. ❑ Air handler flow measurement is required **or** default value used.[3]

Table 1. Rating Methods for Determining Duct Efficiency

[1] ENERGY STAR now has its own mandatory duct leakage testing requirements unless all ducts are inside conditioned space and the building envelope is ≤ 3 ACH50 (or 0.25 CFM50 / ft^2 envelope area). ENERGY STAR requirements are: ≤ 4 CFM25 / 100 ft^2 conditioned floor area Outside Duct Leakage for BOP, or ≤ 6 CFM25 / 100 ft^2 conditioned floor area Outside Duct Leakage for Performance Path.

[2] If Total Duct Leakage is ≤ 3 CFM25 / 100 ft^2 conditioned floor area, then Outside Duct Leakage does not need to be measured.

[3] Some rating software (REM/Rate™) does not require an air handler flow estimate.

Duct Testing Procedures	The following procedures are deemed by RESNET to meet ASHRAE 152 duct testing requirements for the purpose of HERS ratings.
Outside Duct Leakage Test Procedure:	❑ This procedure is used to measure the duct leakage rate to outside of the building only, when the duct system is subjected to a uniform test pressure (25 Pa). During this procedure a blower door fan is used to pressurize[4] the building to the test pressure (with reference to outside), while a duct testing fan is used to pressurize the duct system to the same pressure as the building. ❑ Unconditioned zones containing ducts shall be opened to the outside, while conditioned zones containing ducts shall be opened to the building. If duct zones can not be opened to inside or outside as specified above, the duct system shall be tested with the building envelope in an "as is" (blower door) test condition. ❑ Measurement of duct buffer zone and duct plenum pressures is not required. Leakage pressures during system operation will be assumed to be 25 Pa if duct zone and plenum pressures are not measured. ❑ Separate measurement of supply and return leakage rates is not required. Leakage distribution will be assumed based on the method in Appendix A of the 2006 RESNET standards if the supply and return leakage are not separately measured. ❑ If the test is performed without the register grilles installed, then 2.5% of the air handler flow shall be added to the measured leakage rate. For purposes of this calculation, use either the measured air handler flow, or the default value found in Appendix A. If a final visual inspection determines that register boot to drywall and floor connections have been sealed, then this adjustment to the measured leakage may be omitted.
Outside Duct Leakage Test Procedure (Exception #1):	❑ If the following criteria are met, the measured outside duct leakage rate will be deemed to be 0 CFM25 for each duct system that meets the criteria. – 100% of the ducts and air handler are inside the conditioned space boundary; the ducts are 100% visible; and 100% of the ducts are not located in an enclosed space, such as a chaseway, interior or exterior roof, floor or wall cavity.

Table 2a. Leakage to Outside Test

[4] The term "pressurize" or "pressurization" throughout these procedures may be used equally to refer to either "pressurization" testing or "depressuriazation" testing of the duct system and/or the house.

Duct Testing Procedures	The following procedures are deemed by RESNET to meet ASHRAE 152 duct testing requirements for the purpose of HERS ratings.
Total Duct Leakage Test Procedure:	❑ This procedure is used to measure the total duct leakage rate (including outside duct leaks and inside duct leaks), when the duct system is subjected to a uniform test pressure (25 Pa). During this procedure, a duct testing fan is used to pressurize the duct system to the test pressure. <u>For purposes of duct efficiency calculations, all leakage measured with this procedure will be considered as Outside Duct Leakage.</u> ❑ Unconditioned or conditioned zones containing ducts shall be opened to either the outside or the inside, and at least one door or window between the conditioned space and outside shall be opened. If any duct zone(s) can not be opened to inside or outside as specified above, the duct system shall be tested with the buffer zone(s) in an "as is" test condition. ❑ Measurement of duct zone pressures and duct plenum pressures is not required. Leakage pressures during system operation will be assumed to be 25 Pa if duct zone and plenum pressures are not measured. ❑ Separate measurement of supply and return leakage rates is not required. Leakage distribution will be assumed based on the method in Appendix A of the 2006 RESNET standards if the supply and return leakage are not separately measured. ❑ If the test is performed without the air handler installed, then add 2.5% of the air handler flow to the measured leakage rate. For purposes of this calculation, use either the measured air handler flow, or the default value found in Appendix A. ❑ If the test is performed without the register grilles installed, then add 2.5% of the air handler flow to the measured leakage rate. For purposes of this calculation, use either the measured air handler flow, or the default value found in Appendix A. If a final visual inspection determines that register boot to drywall and floor connections have been sealed, then this adjustment to the measured leakage may be omitted.

Table 2b. Total Leakage Test