Miller, Jeff@Energy

From: Steve Baden [sbaden@resnet.us]
Sent: Friday, April 27, 2012 4:36 PM
To: Brehler, Pippin@Energy; Miller, Jeff@Energy; sbaden@natresnet.org
Cc: Pennington, Bill@Energy; Ware, David@Energy; Brook, Martha@Energy; Shirakh, Maziar@Energy; Yasny, Ron@Energy
Subject: Re: CA Energy Code: authorization to reference Chapter 8 of the RESNET Mortgage Industry National Home Energy Rating Standards

Pipin C. Brehler,

I apologize for not responding sooner. I have been in Washington, DC.

This is to confirm my message of November 7, 2011 that the California Energy Commission is authorized to reference Chapter 8 of the RESNET Mortgage Industry National Home Energy Rating Standards in its proposed energy code guidelines for residential building >leakage.

RESNET does not have any issues with your proposed language.

Steve Baden

----- Original Message -----
From: Brehler, Pippin@Energy
To: Miller, Jeff@Energy ; sbaden@natresnet.org ; sbaden@resnet.us
Cc: Ware, David@Energy ; Brook, Martha@Energy ; Shirakh, Maziar@Energy ; Pennington, Bill@Energy ; Yasny, Ron@Energy
Sent: Friday, April 27, 2012 3:42 PM
Subject: RE: CA Energy Code: authorization to reference Chapter 8 of the RESNET Mortgage Industry National Home Energy Rating Standards

Dear Mr. Baden:

We greatly appreciate RESNET's permission to reference in the Energy Commission's regulations the RESNET Mortgage Industry National Home Energy Rating Standards, Chapter 8 (per your 11/7/2011 email to David Ware of the Energy Commission, below). As you may be aware, the Energy Commission is preparing to issue very shortly proposed regulations that were developed considering language from Chapter 8. Obviously, we do not believe the proposed regulations present any issue for RESNET, but in an abundance of caution have asked for confirmation. We have not heard any response (Jeff's message below on this matter) and time is running short. Please contact us as soon as possible so that we can say with confidence that this is not an issue, or we will assume that is the case.

Best regards,

Pippin C. Brehler
Senior Staff Counsel
Chief Counsel's Office
California Energy Commission
1516 9th Street, MS-14
Sacramento, CA 95814
Main: (916) 654-3951
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The information in this e-mail (including attachments, if any) may be considered confidential and intended only for the recipient(s) listed above. Any review, use, disclosure, distribution or copying of this e-mail is prohibited except by or on behalf of the intended recipient. If you have received this email in error, please notify me immediately by reply email, delete this email, and do not disclose its contents to anyone. Thank you.

From: Miller, Jeff@Energy
Sent: Wednesday, April 25, 2012 5:59 PM
To: sbaden@natresnet.org; sbaden@resnet.us
Cc: Brehler, Pippin@Energy; Ware, David@Energy; Brook, Martha@Energy; Shirakh, Maziar@Energy; Pennington, Bill@Energy; Yasny, Ron@Energy
Subject: RE: CA Energy Code: authorization to reference Chapter 8 of the RESNET Mortgage Industry National Home Energy Rating Standards

Steve,
Did you have a chance to review the draft we sent to you?

(see previous message below in the string for description)

Would you please reply to advise us as to whether the CA Energy Commission is authorized to utilize Chapter 8 of the RESNET Mortgage Industry National Home Energy Rating Standards as shown in the draft of CA 2013 Reference Residential Appendix Section RA3.8 attached to this message?

sincerely,

Jeff R. Miller, PE
Mechanical Engineer
California Energy Commission
High Performance Buildings & Standards Development Office
1516 9th Street, MS 37
Sacramento, CA 95814-5512
voice: 916-651-6182
fax: 916-654-4304
Jeff.Miller@energy.ca.gov

From: Miller, Jeff@Energy
Sent: Monday, April 23, 2012 6:05 PM
To: 'sbaden@natresnet.org'; 'sbaden@resnet.us'
Cc: Brehler, Pippin@Energy; Ware, David@Energy; Brook, Martha@Energy; Shirakh, Maziar@Energy
Subject: CA Energy Code: authorization to reference Chapter 8 of the RESNET Mortgage Industry National Home Energy Rating Standards

Steve Baden
Executive Director
RESNET

Steve,

We are in the final stages of preparing the 2013 update to the CA Title 24, Part 6, Building Energy Efficiency Standards.

With regard to the permission extended to the CA Energy Commission described at the bottom of this email string, would you please review the attached extract from our current working draft of Reference Residential Appendix RA3.8 that we intend to propose for 15-day language. The language from Chapter 8 of the RESNET Mortgage Industry National Home Energy Rating Standards has been included in Reference Residential Appendix Section RA3.8, but with a few modifications. We would like to know if this method of use of the RESNET Standard is acceptable.

<<2013 RA3 - HERS procedures -15day20120417BlowerDoorRA3.8Reviewb-Resnet.pdf>>

A link to the source for the RESNET Standard information we used is shown below, and a copy of the RESNET Standard is attached for reference.

http://www.resnet.us/standards/DRAFT_Chapter_8_July_22.pdf

<<Standards_for_Performance_Testing-Chapter8.pdf>>

Would you please reply to advise us as to whether the CA Energy Commission is authorized to utilize Chapter 8 of the RESNET Mortgage Industry National Home Energy Rating Standards as shown in the draft of CA 2013 Reference Residential Appendix Section RA3.8 attached to this message?

Sincerely,

Jeff R. Miller, PE
Mechanical Engineer
California Energy Commission
High Performance Buildings & Standards Development Office
1516 9th Street, MS 37
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voice: 916-651-6182
fax: 916-654-4304
Jeff.Miller@energy.ca.gov

****

>From: Steve Baden <sbaden@resnet.us>
>To: David Ware <DWare@energy.state.ca.us>
>Date: 11/7/2011 3:28 PM
>Subject: Re: CA Energy Code: Use of Chapter 8, Draft
>Standard for BlowerDoor Testing of Buildings
>
>David,
>
>This is to grant the California Energy Commission authorization to reference
>Chapter 8 of the RESNET Mortgage Industry National Home Energy Rating
>Standards in its proposed energy code guidelines for residential building
>leakage as long as you identify the chapter as being RESNET's standards.
>
>Steve Baden

>Executive Director
>
>
>
>-----Original Message-----
>From: David Ware
>Sent: Monday, November 07, 2011 3:18 PM
>To: Steve Baden
>Subject: CA Energy Code: Use of Chapter 8, Draft Standard for BlowerDoor
>Testing of Buildings
>
>Steve:
>The California Energy Commission (CEC) is proposing revisions to its energy
>code and would like to include specific guidelines for required HERS
>verification of residential building leakage. We'd like to reference the
>latest version of RESNET's Chapter 8: STANDARD FOR PERFORMANCE TESTING AND
>WORK SCOPE: ENCLOSURE AND AIR DISTRIBUTION LEAKAGE TESTING.
>
>I can fill in any gaps you may need regarding our revision process. I'm
>requesting your authorization to reference and/or publish this procedure as
>our requirement for verification of building leakage in our standards.
>
>Thanks for your help.
>
>DAVE
>
>
>David W Ware
>High Performance Buildings & Standards Development Office
>California Energy Commission
>dware@energy.state.ca.us
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>916-654-4168
>530-308-3460 mobile
>

Residential Appendix RA3

Appendix RA3 – Residential Field Verification and Diagnostic Test Protocols

RA3.1 Procedures for Field Verification and Diagnostic Testing of Air Distribution Systems 1
RA3.2 Air Conditioners and Heat Pumps Without a Charge Indicator Display 1
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RA3.1 Procedures for Field Verification and Diagnostic Testing of Air Distribution Systems
Air Conditioners and Heat Pumps Without a Charge Indicator Display

RA3.3 Field Verification and Diagnostic Testing of Forced Air System Airflow Rate, Fan Watt Draw, and Determination of Fan Efficacy.

RA3.4 Procedures for Field Verifying Installed HVAC System Components and Devices

RA3.5 Quality Insulation Installation Procedures

RA3.6 Field Verification and Diagnostic Testing of Photovoltaic Systems

RA3.7 Field Verification and Diagnostic Testing of Mechanical Ventilation Systems

RA3.8 Field Verification and Diagnostic Testing of Building Air Leakage

RA3.8.1 Purpose and Scope

The purpose of this test procedure is to measure the air leakage rate through a building enclosure measured in cubic feet per minute at a 50 Pa pressure difference (CFM50). The measurement procedure described in this section is derived from Residential Energy Services Network's (RESNET) Mortgage Industry National Home Energy Rating Standards, Standard 800, which is based on ASTM E779 air tightness measurement protocols. This procedure requires the use of software consistent with ASTM E779. This test method is intended to produce a measure of the air tightness of a building envelope for determining the energy credit allowance for reduced building air leakage.

These procedures shall be used to verify the building air leakage rate before the building construction permit is finalized when an energy credit for reduced air leakage is being claimed on compliance documentation.

- The Home Energy Rating System (HERS) rater shall measure the building air leakage rate to ensure measured air leakage is less than or equal to the building air leakage rate stated on the Certificate of Compliance, CF-1R and CF-6R. HERS verified building air leakage shall be documented on form CF-4R-ENV-20.
- For purposes of this procedure *Conditioned Space Boundary* is defined as: building envelope

RA3.8.2 On-Site Inspection Protocol

There are three acceptable air leakage test procedures:

RA3.8.2.1 Single-Point Test:

Measuring air leakage one time at a single pressure difference as described in Section RA3.8.6.

RA3.8.2.2 Multi-Point Test:

Measuring air leakage at multiple induced pressures differences as described in Section RA3.8.7.

RA3.8.2.3 Repeated Single-Point Test:

This test is similar to the single-point test, but the test is done multiple times for improved accuracy and estimating uncertainty as described in Section RA3.8.8.

The building shall be tested by applying a negative pressure. Follow all manufacturers' instructions for set up and operation of all equipment. If certain requirements of this standard cannot be met, then all deviations from the standard shall be recorded and reported.

Note: Use caution when deciding how and whether to test homes with potential airborne contaminants (e.g. fireplace ash, mold or asbestos) and refer to local, state and national protocols/standards for methods to deal with these and other contaminants.

RA3.8.3 Protocol for Preparing the Building Enclosure for Testing

RA3.8.3.1 Doors and Windows:

Doors and windows that are part of the conditioned space boundary shall be closed and latched.

RA3.8.3.2 Attached Garages:

All exterior garage doors and windows shall be closed and latched unless the blower door is installed between the house and the garage, in which case the garage shall be opened to outside by opening at least one exterior garage door.

RA3.8.3.3 Crawlspaces:

If a crawlspace is inside the conditioned space boundary, interior access doors and hatches between the house and the crawlspace shall be opened and exterior crawlspace access doors, vents and hatches shall be closed. If a crawlspace is outside the conditioned space boundary, interior access doors and hatches shall be closed. For compliance testing purposes, crawl-space vents shall be open.

RA3.8.3.4 Attics:

If an attic is inside the conditioned space boundary, interior access doors and hatches between the house and the conditioned attic shall be opened; and attic exterior access doors and windows shall be closed. If an attic is outside the conditioned space boundary, interior access doors and hatches shall be closed and exterior access doors, dampers or vents shall be left in their as found position and their position during testing shall be recorded on the test report.

RA3.8.3.5 Interior Doors:

Interior doors shall be open within the Conditioned Space Boundary. See the definition of "Conditioned Space Boundary" for clarification.

RA3.8.3.6 Chimney Dampers and Combustion-Air Inlets on Solid Fuel Appliances:

Dampers shall be closed. Take precautions to prevent ashes or soot from entering the house during testing. Although the general intent of this standard is to test the building in its normal operating condition, it may be necessary to temporarily seal openings to avoid drawing soot or ashes into the house. Any temporary sealing shall be noted in the test report. f

RA3.8.3.7 Combustion Appliance Flue Gas Vents:

Combustion appliance flue gas vents shall be left in their normal appliance-off condition.

RA3.8.3.8 Fans:

Any fan or appliance capable of inducing airflow across the building enclosure shall be turned off including, but not limited to, clothes dryers, attic fans, kitchen and bathroom exhaust fans, outdoor air ventilation fans, air handlers, and crawl space and attic ventilation fans. Continuously operating ventilation systems shall be turned off and the air openings sealed, preferably at the exterior terminations.

RA3.8.3.9 Non-Motorized Dampers Which Connect the Conditioned Space to the Exterior or to Unconditioned Spaces:

Dampers shall be left as found. If the damper will be forced open or closed by the induced test pressure, that fact shall be reported in the test report. Clothes dryer exhaust openings should not be sealed off even if there is no dryer attached but this fact should be noted in the test report.

RA3.8.3.10 Motorized Dampers Which Connect the Conditioned Space to the Exterior (or to Unconditioned Spaces):

The damper shall be placed in its closed position and shall not be further sealed.

RA3.8.3.11 Undampered or Fixed-Damper Intentional Openings Between Conditioned Space and the Exterior or Unconditioned Spaces:

Undampered or fixed damper intentional openings between conditioned space and the exterior or unconditioned spaces shall be left open or fixed position; however, temporary blocking shall be removed. For example: fixed-dampered ducts supplying outdoor air for intermittent ventilation systems (including central-fan-integrated distribution systems) shall be left in their fixed-damper position. Exception: Undampered supply-air or exhaust-air openings of continuously operating mechanical ventilation systems shall be sealed (preferably seal at the exterior of enclosure) and ventilation fans shall be turned off as specified above.

RA3.8.3.12 Whole Building Fan Louvers/Shutters:

Whole building fan louvers/shutters shall be closed. If there is a seasonal cover, it shall be installed.

RA3.8.3.13 Evaporative Coolers:

The opening to the exterior shall be placed in its off condition. If there is a seasonal cover, it shall be installed.

RA3.8.3.14 Operable Window Trickle-Vents and Through-The-Wall Vents:

Operable window trickle vents and through-the-wall vents shall be closed and/or sealed.

RA3.8.3.15 Supply Registers and Return Grilles:

Supply registers and return grilles shall be left open and uncovered.

RA3.8.3.16 Plumbing Drains With P-Traps:

Plumbing drains with P-traps shall be sealed, or filled with water if empty.

RA3.8.3.17 Combustion Appliances:

Combustion appliances shall remain off during the test. Maintain the above conditions throughout the test. If during the test, induced pressures affect operable dampers, seasonal covers, etc., reestablish the set-up and consider reversing direction of fan flow.

After testing is complete, return the building to its as found conditions prior to the test. For example, make sure that any combustion appliance pilots that were on prior to testing remain lit after testing.

RA3.8.4 Accuracy Levels for Enclosure Leakage Testing

RA3.8.4.1 Standard Level of Accuracy:

Level of accuracy that produces test results that can be used in approved modeling software to determine performance compliance with the Standards.

RA3.8.4.2 Reduced Level of Accuracy:

During adverse testing conditions or in certain applications where testing time and costs are a factor, a test with a reduced level of accuracy may be used. Measurements made with a reduced level of accuracy may require surpassing the threshold value by an amount which will account for the added uncertainty as defined in the sections below. Software the uses test results with a reduced level of accuracy shall internally adjust the calculation in accordance with these procedures.

RA3.8.5 Installation of the Blower Door Air Tightness Testing System and Preliminary Recordings

RA3.8.5.1

Install the blower door system in an exterior doorway or window that has unrestricted access to the building and no obstructions to airflow within five feet of the fan inlet and two feet of the fan outlet. Avoid installing the system in a doorway or window exposed to the wind.

RA3.8.5.2

It is permissible to use a doorway or window between the conditioned space and unconditioned space as long as the unconditioned space has an unrestricted air pathway to the outdoors. For example, an attached garage or porch can be used as the unconditioned space. In this case, be sure to open all exterior windows and doors of the unconditioned space to the outdoors.

RA3.8.5.3

Install the pressure gauge(s), fans and tubing connections according to the equipment manufacturer's instructions.

RA3.8.5.4

Record the indoor and outdoor temperatures in degrees F to an accuracy of 5 degrees F.

RA3.8.5.5

Record the elevation of the building site within 1000 feet for buildings at elevations above 5000 feet above sea level.

RA3.8.5.6

For ACH50 (i.e., air changes per hour @ 50 Pa), record the *building volume*.

RA3.8.6 Procedure for Conducting a Single-Point Air Tightness Test

RA3.8.6.1

Choose and record a *time averaging period* of at least 10 seconds to be used for measuring pressures. With the blower door fan sealed and off, measure and record five (5), independent, *average baseline building pressure readings* with respect to outside to a resolution of 0.1 Pa.

RA3.8.6.2

Subtract the smallest baseline measurement from the largest recorded in Step RA3.8.6.1 and record this as the *baseline range*.

RA3.8.6.3

Air tightness tests with a baseline range less than 5.0 Pa, will be considered a *Standard Level of Accuracy Test*. Air tightness tests with a baseline range between 5.0 Pa - 10 Pa will be considered a *Reduced Level of Accuracy Test* and the results will be adjusted using Section RA3.8.4.2. A Single-Point test cannot be performed under this standard if the baseline range is greater than 10.0 Pa. Record the level of accuracy for

the test as *Standard* or *Reduced*. The baseline test may be repeated employing a longer time averaging period in order to meet the desired level of accuracy.

RA3.8.6.4

Re-measure the baseline building pressure using the same time averaging period recorded in Section RA3.8.6.1 or use the average of the baseline pressures measured in Section RA3.8.6.1. This measurement is defined as the *Pre-Test Baseline Building Pressure*. If desired for greater accuracy, a longer time averaging period may be used. Record the *Pre-Test Baseline Building Pressure*.

RA3.8.6.5

Unseal the blower door fan. Turn on and adjust the fan to create an induced building pressure of approximately 50 Pa. Induced building pressure shall be defined as the (unadjusted) building pressure minus the pre-test baseline building pressure. If a 50 Pa induced building pressure cannot be achieved because the blower door fan does not have sufficient flow capacity, then achieve the highest induced building pressure possible with the equipment available.

RA3.8.6.6

A single-point test may only be performed if the maximum induced building pressure is at least 15 Pa and greater than four times the baseline pressure. If the maximum induced building pressure is less than 15 Pa, recheck that the house set up is correct and determine if any basic repairs are needed prior to further testing. A multi-point test may be attempted, or multiple fans may be used. If using multiple fans, follow the manufacturer's instruction for measurement procedures.

RA3.8.6.7

Measure and record the unadjusted building pressure and nominal (not temperature and altitude corrected) fan flow using the same averaging period used in Section RA3.8.6.4. Record the unadjusted building pressure (with 0.1 Pa resolution), nominal fan flow (with 1 CFM resolution), fan configuration (i.e., rings, pressurization or depressurization, etc), fan and manometer models and serial numbers.

RA3.8.6.8

Turn off the fan.

RA3.8.6.9

If the equipment's pressure gauge has the capability to display the induced building pressure (i.e., "baseline adjustment" feature) and adjust the fan flow value to an induced building pressure of 50 Pa (i.e., "@50 Pa" feature), then follow the manometer manufacturer's procedures for calculating the results of a single-point test and record the following values: induced building pressure, nominal CFM50, fan configuration, fan and manometer model and serial numbers. If needed calculate the following values:

- *Induced Building Pressure* = measured building pressure minus the *Pre-Test Baseline Building Pressure*

Note: If a "baseline adjustment" feature of the manometer was used, the induced building pressure is displayed on the pressure gauge.

- *Nominal CFM50* = (50 / induced building pressure)$^{0.65}$ x recorded fan flow

Note: If both a "baseline adjustment" feature and an "@50 Pa" feature were used, the nominal CFM50 is displayed directly on the pressure gauge.

If the altitude is above 5,000 feet or the difference between the inside and outside temperature is more than 30 degrees F, calculate the corrected CFM50 as defined below:

- *Corrected CFM50* = nominal CFM50 x altitude correction factor x temperature correction factor

Where: *Altitude correction factor* = 1 + .000006 x altitude. Note: altitude is in feet, temperature correction factors are listed in Tables RA3.8B and RA3.8C.

RA3.8.7 Procedure for Conducting a Multi-Point Air Tightness Test

RA3.8.7.1

Equipment that can automatically perform a Multi-Point Test may be used to perform the steps below.

RA3.8.7.2

With the blower door fan sealed and off, measure and record the pre-test baseline building pressure reading with respect to outside. This measurement shall be taken over a time-averaging period of at least 10 seconds and shall have a resolution of 0.1 Pa. Record the pre-test baseline building pressure measurement.

RA3.8.7.3

Unseal the blower door fan. Turn on and adjust the fan to create an induced building pressure of approximately 60 Pa. If a 60 Pa induced building pressure cannot be achieved because the blower door fan does not have sufficient flow capacity, then adjust the fan to achieve the highest induced building pressure possible.

RA3.8.7.4

Measure the *unadjusted building pressure* (not baseline adjusted) and nominal fan flow (neither temperature nor altitude corrected) using the same time-averaging period used in Section RA3.8.7.2. Record the unadjusted building pressure (with 0.1 Pa resolution), nominal fan flow (with 1 CFM resolution), fan configuration, fan model and fan serial number. Assure that the fan is being operated according to the manufacturer's instructions.

Note: Since both pre- and post-test baseline measurements are required, do not use any baseline-adjustment feature of the manometer. In addition, do not use an "@50 Pa" feature because the nominal fan flow shall be recorded.

RA3.8.7.5

Take and record a minimum of seven (7) additional unadjusted building pressure and nominal fan flow measurements at *target induced pressures* which are approximately equally-spaced between 60 Pa (or the highest achievable induced building pressure) and 15 Pa. In very leaky buildings, the low end of this range may be reduced to as little as 4 Pa plus the absolute value of the baseline pressure.

RA3.8.7.6

Turn off and seal the blower door fan.

RA3.8.7.7

Measure and record the *post-test baseline building pressure* reading with respect to outside. This measurement shall be taken over the same time-averaging period used in Section RA3.8.7.2and shall have a resolution of 0.1 Pa. Record the post-test baseline building pressure measurement.

RA3.8.7.8

Enter the recorded test values, temperatures and altitude into software that can perform the necessary calculations in accordance with ASTM E779-10, Section 9.

- The software program shall calculate and report: corrected CFM50 and the percent uncertainty in the corrected CFM50, at the 95% confidence level, as defined in ASTM E779-10, Section 9.

Note: To avoid a higher percent uncertainty than desired, the HERS rater may choose a larger, time-averaging period and start over at Section RA3.8.7.2.

RA3.8.7.9

If the reported uncertainty in the corrected CFM50 is less than or equal to 10.0%, the air tightness test shall be classified as a *Standard Level of Accuracy Test*. If the reported uncertainty in the corrected CFM50 is greater than 10%, the air tightness test shall be classified as a *Reduced Level of Accuracy Test* and the results shall be adjusted using Section RA3.8. 12.

RA3.8.8 Procedure for Conducting a Repeated Single-Point Test

RA3.8.8.1

With the blower door fan sealed and off, measure and record the pre-test baseline building pressure reading with respect to outside. This measurement shall be taken over a time-averaging period of at least 10 seconds and shall have a resolution of 0.1 Pa. Record this value as the pre-test baseline building pressure measurement.

RA3.8.8.2

Unseal the blower door fan. Turn on and adjust the fan to create an induced building pressure of approximately 50 Pa. If a 50 Pa induced building pressure cannot be achieved because the blower door fan does not have sufficient flow capacity, then achieve the highest induced building pressure possible with the equipment available.

RA3.8.8.3

If during any single repeat of this test, the induced building pressure is less than 15 Pa, recheck that the house set up is correct and determine if any basic repairs are needed prior to further testing or modeling of the building. Following any repairs or changes to the set up, the test shall be restarted from the beginning. If at least 15 Pa cannot be reached every time, then use the procedures in Sections RA3.8.6 or RA3.8.7.

RA3.8.8.4

Measure and record the *unadjusted building pressure* and nominal (not temperature and altitude corrected) *fan flow* using the same time-averaging period used in Section RA3.8.7.2. Record the *unadjusted building pressure* (with 0.1 Pa resolution), *nominal fan flow* (with 1 CFM resolution), *fan configuration* (i.e., *rings*, *pressurization* or *depressurization*, etc), *fan model* and fan *serial number*.

Note: If the equipment's pressure gauge has the capability to display the induced building pressure (i.e. baseline adjustment feature) and the capability to adjust the fan flow value to an induced building pressure of 50 Pa (i.e. “@50 Pa” feature), then follow the manufacturer’s procedures for calculating the results of a Single-Point Test and record the following values: *induced building pressure*, *nominal CFM50*, *fan configuration*, *fan model* and *fan serial number*.

RA3.8.8.5

Turn off the fan.

RA3.8.8.6

Calculate the following values:

- *Induced Building Pressure* = unadjusted building pressure (Pa) minus pre-test baseline building pressure (Pa).

Note: If a baseline adjustment feature was used, then the induced building pressure is displayed on the pressure gauge.

- *Nominal CFM50* = (50 Pa / Induced building pressure)$^{0.65}$ x nominal fan flow.

Note: If both a baseline adjustment feature and an "@50 Pa" feature were used, the nominal CFM50 is displayed directly on the pressure gauge.

RA3.8.8.7

Repeat Sections RA3.8.8.1 through RA3.8.8.7 until a minimum of 5 nominal CFM50 estimates have been recorded. The same fan configuration shall be used for each repeat.

RA3.8.8.8

Calculate the *Average Nominal CFM50* by summing the individual nominal CFM50 readings and dividing by the number of readings.

RA3.8.8.9

If the altitude is above 5,000 feet or the difference between the inside and outside temperature is more than 30 degrees F, calculate the corrected CFM50 as defined below:

- *Average Corrected CFM50* = *Average Nominal CFM50* x altitude correction factor x temperature correction factor

Where: *Altitude correction factor* = 1 + .000006 x altitude. Note: altitude is in feet, temperature correction factors are listed in Tables RA3.8B and RA3.8C.

RA3.8.8.10

Estimate the precision uncertainty using one of the two following methods.

RA3.8.8.10.1

Standard Statistical Process – Use a calculator or computer to compute the Standard Deviation of the repeated Nominal CFM50 readings. Divide this Standard Deviation by the square root of the number of readings. Multiply the result by the t-statistic in Table RA3.8A corresponding to the number of readings taken. Convert this result to a percentage of the Average Nominal CFM50.

Table 3.8A Precision Uncertainty: Values of t-statistic

Number of Readings	t-statistic
5	2.78
6	2.57
7	2.45
8	2.37
9	2.31

RA3.8.8.11

If a software program is used, it shall at minimum calculate and report:

- *Average CFM50*, corrected for altitude and temperature.
- *Record the percent uncertainty of the measured CFM50* at the 95% confidence level, as calculated in Section RA8.8.9.

- *ACH50 (air changes per hour @ 50 Pa)* = (CFM50 x 60) / building volume (in cubic feet).

RA3.8.8.12

If the reported uncertainty of the CFM50 is less than or equal to 10.0%, then the air tightness test shall be classified as a *Standard Level of Accuracy Test* as defined in Section RA3.8.4.1. If the reported uncertainty in the CFM50 is greater than 10.0%, the air tightness test shall be classified as a *Reduced Level of Accuracy Test* as defined in Section RA3.8.4.1.

RA3.8.9 Application Results

RA3.8.9.1

Adjusting CFM50 for tests with a *Reduced Level of Accuracy*. When using results of a Reduced Level of Accuracy Test, an adjustment shall be used to improve the probability that the tested building meets the required performance threshold. The adjusted CFM50 in these situations is defined as:

- *Adjusted CFM50* = extending factor x corrected CFM50

Where:

For a single-point test at Reduced Level of Accuracy: extending factor = 1 + 0.1 x (50 / the induced pressure)

For a multi-point test at Reduce Level of Accuracy: extending factor = 1 + (% uncertainty / 100)

RA3.8.8.12.2 Adjusted CFM50 value shall be used when:

- Determining whether a building meets an air tightness threshold as stated on compliance forms

RA3.8.8.12.3 Adjusted CFM50 value shall NOT be used when:

- Calculating the air tightness of a retrofit building
- Calculating an energy audit
- Assessing the air tightness of a group of buildings

RA3.8.10 Other Leakage Metrics:

ELA may be calculated by: *ELA* = 0.055 x CFM50

Where: ELA is in square inches

ACH50 = corrected CFM50 x 60 / building volume (in cubic feet)

Specific Leakage Area may be calculated by: *SLA* = 69.4 x ELA/ building floor area (square feet)

Where: ELA is in square inches

Normalized Leakage Area may be calculated by: *NLA* = SLA x $(S)^{0.3}$

Where: S is the number of stories above grade

RA3.8.11 Equipment Accuracy and Requirements

Blower door fans used for building air leakage testing shall measure airflow (after making any necessary air density corrections) with an accuracy of +/- 5%. Pressure gauges shall measure pressure differences with a resolution of 0.1 Pa and have an accuracy of +/- 1% of reading or 0.5Pa, whichever is greater.

Blower door and associated pressure testing instruments shall be tested annually for calibration by the HERS Provider or HERS Rater. The HERS Provider or HERS Rater shall use a standard for field testing of calibration provided by the equipment manufacturer. Magnehelic Gauges cannot be field tested and shall be recalibrated by the Blower Door manufacturer annually. Fan and flow measuring systems for shall be regularly field checked for defects and maintained according to manufacturers' recommendations. The HERS Provider or HERS Rater

shall maintain a written log of the annual calibration check to verify all equipment accuracy for a period of three (3) years. These records shall be made available to the Commission.

RA3.8.12 Air Leakage Reporting

The HERS rater shall compare the measured air leakage rate determined by Section RA3.8.8.12 to the building air leakage rate specified on the Certificate of Compliance, CF-1R and CF-6R. HERS verified building air leakage shall be documented on form CF-4R-ENV-20.

Where: *Measured air leakage rate = Adjusted CFM50*

Table RA3.8B Temperature Correction Factors for Pressurization Testing- Calculated according to ASTM E779-10

		Inside Temperature (F)								
		50	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**
Outside Temp (F)	**-20**	1.062	1.072	1.081	1.090	1.099	1.108	1.117	1.127	1.136
	-15	1.056	1.066	1.075	1.084	1.093	1.102	1.111	1.120	1.129
	-10	1.051	1.060	1.069	1.078	1.087	1.096	1.105	1.114	1.123
	-5	1.045	1.054	1.063	1.072	1.081	1.090	1.099	1.108	1.117
	0	1.039	1.048	1.057	1.066	1.075	1.084	1.093	1.102	1.111
	5	1.033	1.042	1.051	1.060	1.069	1.078	1.087	1.096	1.105
	10	1.028	1.037	1.046	1.055	1.064	1.072	1.081	1.090	1.099
	15	1.023	1.031	1.040	1.049	1.058	1.067	1.076	1.084	1.093
	20	1.017	1.026	1.035	1.044	1.052	1.061	1.070	1.079	1.087
	25	1.012	1.021	1.029	1.038	1.047	1.056	1.064	1.073	1.082
	30	1.007	1.015	1.024	1.033	1.041	1.050	1.059	1.067	1.076
	35	1.002	1.010	1.019	1.028	1.036	1.045	1.054	1.062	1.071
	40	0.997	1.005	1.014	1.023	1.031	1.040	1.048	1.057	1.065
	45	0.992	1.000	1.009	1.017	1.026	1.035	1.043	1.051	1.060
	50	0.987	0.995	1.004	1.012	1.021	1.029	1.038	1.046	1.055
	55	0.982	0.990	0.999	1.008	1.016	1.024	1.033	1.041	1.050
	60	0.997	0.986	0.994	1.003	1.011	1.019	1.028	1.036	1.045
	65	0.973	0.981	0.989	0.998	1.006	1.015	1.023	1.031	1.040
	70	0.968	0.976	0.985	0.993	1.001	1.010	1.018	1.026	1.035
	75	0.963	0.972	0.980	0.988	0.997	1.005	1.013	1.022	1.030
	80	0.959	0.967	0.976	0.984	0.992	1.000	1.009	1.017	1.025
	85	0.955	0.963	0.971	0.979	0.988	0.996	1.004	1.012	1.020
	90	0.950	0.958	0.967	0.975	0.983	0.991	0.999	1.008	1.016
	95	0.946	0.954	0.962	0.970	0.979	0.987	0.995	1.003	1.011
	100	0.942	0.950	0.958	0.966	0.970	0.982	0.990	0.998	1.007
	105	0.938	0.946	0.954	0.962	0.970	0.978	0.986	0.994	1.002
	110	0.933	0.942	0.950	0.952	0.966	0.974	0.982	0.990	0.998

Table RA3.8C Temperature Correction Factors for Depressurization Testing- Calculated according to ASTM E779-10

		Inside Temperature (F)								
		50	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**
Outside Temp (F)	**-20**	0.865	0.861	0.857	0.853	0.849	0.845	0.841	0.837	0.833
	-15	0.874	0.870	0.866	0.862	0.858	0.854	0.850	0.846	0.842
	-10	0.883	0.879	0.874	0.870	0.866	0.862	0.858	0.854	0.850
	-5	0.892	0.887	0.883	0.879	0.875	0.871	0.867	0.863	0.859
	0	0.900	0.896	0.892	0.887	0.883	0.879	0.875	0.871	0.867
	5	0.909	0.905	0.900	0.896	0.892	0.888	0.883	0.879	0.875
	10	0.918	0.913	0.909	0.905	0.900	0.896	0.892	0.888	0.884
	15	0.927	0.922	0.918	0.913	0.909	0.905	0.900	0.896	0.892
	20	0.935	0.931	0.926	0.922	09.17	0.913	0.909	0.905	0.900
	25	0.944	0.939	0.935	0.930	0.926	0.922	0.917	0.913	0.909
	30	0.952	0.948	0.943	0.939	0.934	0.930	0.926	0.921	0.917
	35	0.961	0.956	0.952	0.947	0.943	0.938	0.934	0.930	0.926
	40	0.970	0.965	0.960	0.956	0.951	0.947	0.942	0.938	0.934
	45	0.978	0.974	0.961	0.964	0.960	0.955	0.951	0.946	0.942
	50	0.987	0.982	0.977	0.973	0.968	0.963	0.959	0.955	0.950
	55	0.995	0.990	0.986	0.981	0.976	0.972	0.967	0.963	0.958
	60	1.004	0.999	0.994	0.998	0.985	0.980	0.976	0.971	0.967
	65	1.012	1.008	1.003	0.998	0.993	0.988	0.984	0.979	0.975
	70	1.021	1.016	1.011	1.006	1.001	0.997	0.992	0.988	0.983
	75	1.029	1.024	1.019	1.015	1.010	1.005	1.000	0.996	0.991
	80	1.038	1.033	1.028	1.023	1.018	1.013	1.009	1.004	0.999
	85	1.046	1.041	1.036	1.031	1.026	1.022	1.017	1.012	1.008
	90	1.055	1.050	1.045	1.040	1.035	1.030	1.025	1.020	1.016
	95	1.063	1.058	1.053	1.048	1.043	1.038	1.033	1.028	1.024
	100	1.072	1.066	1.061	1.056	1.051	1.046	1.041	1.037	1.032
	105	1.080	1.075	1.070	1.064	1.059	1.054	1.050	1.045	1.040
	110	1.088	1.083	1.078	1.073	1.068	1.063	1.058	1.053	1.048

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