



Proposed Standards Revision

Date: June 20, 2012

Amendment #2012-06

Title: Revising Chapter Eight Sections 806-808

Proponent: Performance Testing Subcommittee :

Organization: RESNET Technical Subcommittee

Proposed Revision:

806 GAS LEAKAGE TEST

The Auditor shall use a gas detector upon entry into the home to detect the presence of natural gas. If there is a noticeable odor indicating gas buildup within the home, the occupants and Auditor shall leave the house and the appropriate authorities and utility providers shall be notified from outside the home. ~~<The Auditor should use a gas detector upon entry into the home to detect the presence of natural gas.>~~ If gas is suspected or confirmed, ensure that switches are not operated while exiting and no ignition concerns are present. The audit shall not proceed until the proper authorities have deemed it safe to re-enter the home. If there is no noticeable odor indicating gas buildup within the home, the Auditor shall determine if there are gas leaks in the fittings and connections of natural gas appliances within the home and natural gas/liquid propane supply lines as follows following these protocols.

~~<Inspect all fittings and joints in supply lines and appliance connectors and confirm suspected leaks with leak detection fluid. Identify for repair or replacement any kinked, corroded or visibly worn flexible gas lines and any flexible connectors manufactured prior to 1974.>~~

806.1 Equipment needed

- Combustible gas detector ~~eapable of measuring 20 ppm~~
 - Must be intrinsically safe. It is essential that the instrument being used to detect gas leaks will not cause a spark.
 - Must have an adjustable tick rate. The tick rate provides the indication of concentration. Gas leak detectors are prone to false positive signals from humidity and it is essential to have the ability to zero ambient conditions to trace the location of a leak.
 - Must be capable of detecting 0.1% of the lower explosive limit (LEL)
 - Must provide an alarm when detecting the LEL exceeds 10%. This is the alarm condition for evacuating the building.
 - Must be calibrated in accordance with the manufacturers recommendations, or at least annually, whichever is the greater frequency.
 - Must be labeled with a calibration sticker, noting at a minimum the date of last calibration.
- Leak detection fluid (non-corrosive)
- MSDS Sheet for the leak detection fluid

806.2 Leak Inspection

Inspect all fittings and joints in supply lines and appliance connectors and confirm suspected leaks with leak-detection fluid. Identify for repair or replacement any kinked, corroded or visibly worn flexible gas lines and any flexible connectors manufactured prior to 1974.

807 ~~<WORST CASE>~~ APPLIANCE VENTING (STANDARDIZED DEPRESSURIZATION) TEST

This test procedure measures the pressure in the Combustion Appliance Zone (CAZ) and provides ~~visual~~ evidence of ~~spillage~~ venting potential. A CAZ is an enclosed space inside or outside the building envelope that contains a combustion device that uses air from the CAZ for combustion and shares a common wall, floor, ceiling or duct system with the conditioned space. Combustion devices include (but are not limited to): furnaces, boilers, water heaters, solid fuel stoves and fireplaces.

Vented combustion appliances that use indoor air to vent combustion gases and which are classified as a category I or II according to NFPA standard 54 (see Table 807.1 below) shall require a appliance venting (standardized depressurization) test to be performed using the protocol in Section 807.

~~<If there are any vented combustion appliances that use indoor air to vent combustion gases and which are not classified as a category 3 or 4 according to NFPA standard 54, then a worst case depressurization test shall be performed using the following protocol.>~~

Table 807.1: NFPA 54 venting categories

Vented Appliance, Category I. An appliance that operates with a nonpositive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

Vented Appliance, Category II. An appliance that operates with a nonpositive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

Vented Appliance, Category III. An appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

Vented Appliance, Category IV. An appliance that operates with a positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

807.1 Equipment Needed

- manometers with a resolution of 0.1 Pa or better and an accuracy of +/- 0.2 Pa or better
- smoke pencils or other smoke visualization equipment
- an exhaust fan and flow meter system that can control exhaust flows with an accuracy of +/- 10 cfm or better (only required for homes with fireplaces and/or solid fuel stoves)

807.12 Visually inspect the CAZ ~~<Check the combustion appliance zone>~~ for the presence of flammable or explosive material near a combustion source and these materials shall be removed if present.

807.23 Visually inspect ~~<venting system for proper size and horizontal pitch and determine there is no blockage or restriction, leakage, corrosion or other deficiencies that could cause an unsafe condition.>~~ the combustion appliance for safe operation. If an unsafe condition exists the Auditor shall not complete the tests in Sections 807 and 808. The unsafe condition shall be corrected before tests in Sections 807 and 808 are performed.

807.3.1 Inspect the venting system for proper size and horizontal pitch and determine there is no blockage or restriction, leakage, corrosion or other deficiencies that could cause an unsafe condition.

807.2-13.2 Inspect burners and crossovers for blockage and corrosion.

807.3.3 During all depressurization testing measure the CO level in the CAZ. Halt testing if CO rises above 35 ppm in the CAZ using the equipment and test procedures in sections 808.2 and 808.3. ~~807.2.2~~ Inspect furnace heat exchangers for cracks, openings or excessive corrosion.

807.4 Put the home into BASELINE conditions by:

807.34.1 Clos~~e~~ing all the exterior doors and windows of the home.

807.4.2 Clos~~e~~ing fireplace damper(s) if fireplace is present.

807.54.3 Clos~~e~~e Opening <any> all interior doors, ~~between the CAZ and the remainder of the house,~~ ensuring that all vented appliances and exhaust fans have been turned off. If the CAZ is in a closet or an enclosed utility room, then the CAZ door shall be closed.

807.65 Measure the ~~baseline~~BASELINE pressure difference between the CAZ with respect to (WRT) outside. ~~(ambient) and baseline CO levels. Set the gauge to read pressure and record the baseline pressure.~~

807.76 Turn on all exhaust fans in the home¹ (kitchen range hood, bath exhaust, clothes dryer, etc.) that exhaust air outside the building envelope.

807.7 If one or more fireplaces or solid fuel stoves are present that are not direct vent appliances, then operate an auxiliary exhaust fan¹ to exhaust 300 cfm for an open hearth fireplace, or to exhaust 100 cfm for a solid fuel stove or fireplace with glass doors.

807.7.1 As an alternative to the auxiliary exhaust flows specified in 807.6 the target CAZ pressure in 807.10 may be adjusted as follows:

807.7.2 For an open hearth fireplace the pressure adjustment P_{adj} shall be calculated using Equation 807.1 using the envelope leakage CFM50 from Section 802 of this standard or use Table 807.2.

$$P_{adj} = 330,000 \times CFM50^{-1.54} \quad \text{Equation 807.1}$$

Table 807.2 CAZ Pressure Adjustments for open hearth fireplaces²

<u>CFM50</u>	<u>P_{adj} (Pa)</u>
500	<u>23</u>
1000	<u>7.8</u>
1500	<u>4.3</u>
2000	<u>2.7</u>
2500	<u>1.9</u>
3000	<u>1.4</u>
3500	<u>1.1</u>
4000	<u>0.9</u>
4500	<u>0.8</u>
5000	<u>0.7</u>

¹ An auxiliary exhaust fan is a fan installed by the Auditor to exhaust and measure the air flow specified in this section. Typically, this is a fan installed in a doorway or open window. Fans used for other purposes, such as envelope air leakage testing, are often ideal for this application.

² In the shaded areas of Table 807.2 the home fails the CAZ test and no further testing is required.

807.7.3 For a solid fuel stove or fireplace with glass doors the pressure adjustment P_{adj} shall be calculated using Equation 807.2 using the envelope leakage CFM50 from Section 802 of this standard or use Table 807.3.

$$P_{adj} = 60,000 \times CFM50^{-1.54} \quad \text{Equation 807.2}$$

Table 807.3 CAZ Pressure Adjustments for solid fuel stoves or fireplaces with glass doors

CFM50	P_{adj} (Pa)
500	4.2
1000	1.4
1500	0.8
2000	0.5
2500	0.4
3000	0.3
3500	0.2
4000	0.2
4500	0.1
5000	0.1

~~<807.8 Record pressure in CAZ with respect to Outside.>~~

~~<807.9 Turn on the air handler. Record pressure in CAZ with respect to outside. If air handler makes the CAZ more positive (or less negative), turn it off. If the air handler is kept on, close interior doors to any rooms that have no return registers.>~~

~~<807.10 If fireplace is present install blower door and set to exhaust 300 CFM to simulate fireplace in operation.>~~

~~<807.11 Record net change in pressure difference within the CAZ WRT outside between baseline and worst case depressurization conditions. Record the position of doors and conditions of fans and air handler. When the net change in CAZ pressure is lower (more negative) than the limits specified below, the work scope shall specify remediation through pressure balancing, duct sealing, and/or other pressure relief measures, as applicable.>~~

~~<807.12 Turn on vented combustion appliance with the smallest Btu capacity. Operate appliance for 5 minutes then measure CO levels according to the carbon monoxide test procedure below, and check appliance draft using a smoke pencil at the draft diverter. If the smoke is not fully drawn up the flue, the appliance has spillage under worst case depressurization. Record if there is any spillage and record CO level. When spillage occurs or CO exceeds the limits specified below in section 9, the work scope shall specify remediation, including equipment repair or replacement, and/or building pressure remediation, as applicable. If both spillage and high CO are found during the test, the homeowner should be notified of the conditions and that it needs immediate remediation.>~~

~~<807.13 Turn on all the other combustion appliances, one at a time, within the CAZ and repeat step 1.12 on each of them.>~~

~~<807.14 If spillage or high CO occurs in any appliance(s) under worst case depressurization, retest that appliance(s) under natural conditions.>~~

~~<807.14.1 Turn off the combustion appliances.>~~

~~<807.14.2 Turn off the exhaust fans.>~~

~~<807.14.3 Open the interior doors.>~~

~~<807.14.4 Let the vent cool.>~~

~~<807.14.5 Test CO and spillage under natural conditions. If the test failed under worst case, but passes under natural conditions, the work scope shall specify building pressure remediation, as applicable.>~~

~~<807.14.6 If an appliance fails under natural conditions, the Auditor shall inform the homeowner of the problem, and the work scope shall specify remediation, including equipment or vent system repair or replacement, as applicable.>~~

~~<CAZ Pressure Limits~~

~~-15 Pa for pellet stoves with exhaust fans and sealed vents~~

~~-5 Pa for Atmospheric vented oil or gas system (classified as a category 1 or 2 according to NFPA standard 54, such as oil power burner; fan assisted or induced draft gas; solid fuel burning appliance other than pellet stoves with exhaust fans and sealed vents)~~

~~If ambient CO levels exceed 35 ppm at any time, stop any testing and turn the combustion appliances off. Open all the exterior doors and windows. No one should enter the home until the CO levels drop below 35 ppm. The combustion appliance causing the increase in CO levels must be repaired by a qualified technician prior to completing the combustion appliance tests, unless the work scope calls for replacement of the appliance(s).>~~

807.8 If there is a Forced Air system (FAS) turn it off and close all interior doors to rooms without exhaust fans. For rooms without exhaust fans that are between a room with and exhaust fan and the CAZ leave the door open³.

807.9 Starting with the room furthest from the CAZ, for each room with an exhaust fan, measure the pressure difference between the CAZ and outside with the door open and closed. Leave the door in the configuration that makes the CAZ more negative. As an alternative, it is permissible to measure the pressure difference across the closed door or use flow visualization smoke with the door closed. If the room is depressurized or the smoke indicates air flow into the room then open the door. Repeat this procedure for all interior doors and the CAZ door. Measure the CAZ depressurization.

807.10 If there is a forced air system (FAS), turn on the FAS blower and open all interior doors. Starting with the room furthest from the CAZ, close each interior door one at a time. For each door closing measure the pressure difference between the CAZ and outside. If the pressure difference between the CAZ and outside is more negative, leave the door closed. If it is more positive or zero, open the door. Repeat this

³ For example: a master suite bedroom doors when the bathroom has an exhaust fan, or basement doors if there is a room with an exhaust in the basement.

procedure for all interior doors and the CAZ door. If there is more than one FAS, then repeat this procedure for each FAS blower and all combinations of FAS blowers.

807.11 Put the house doors, CAZ door and FAS blower into the condition that gave the most negative pressure in 807.9 or 807.10. The Appliance Venting (Standardized Depressurization) Test conditions have now been created. Record the Appliance Venting (Standardized Depressurization) Test pressure difference between the CAZ and outside.

807.12 Record the position of all doors (open or closed), the condition (on or off) of fans (including the FAS) and vented combustion appliances. Subtract the BASELINE pressure from the Appliance Venting (Standardized Depressurization) Test depressurization pressure from 807.11 to determine the net change in CAZ pressure. When the net change in CAZ pressure is lower (more negative) than the CAZ depressurization limit given in Equation 807.3, the work scope shall specify remediation through pressure balancing, duct sealing, and/or other pressure-relief measures.

$$\text{CAZ depressurization limit} = -5\text{Pa} + P_{\text{adj}} \quad \text{Equation 807.3}$$

807.13 With the doors and FAS in the configuration for the Appliance Venting (Standardized Depressurization) Test, turn on the vented combustion appliance with the smallest Btu capacity, operate for 5 minutes.

807.13.1 Check appliance draft using a smoke pencil all the way around the draft diverter's perimeter.

807.13.2. If the smoke is not fully drawn up the flue, the appliance has spillage under depressurized conditions.

807.13.3 Record the results of the spillage test and the highest observed CO level.

NOTE: When spillage occurs or CO exceeds the limits specified below in section 808, the work scope shall specify remediation (e.g., equipment repair, equipment replacement, and/or building pressure remediation). If both spillage and high CO are found during the test, the homeowner shall be notified of the recorded results and need for remediation.

807.14 Testing additional combustion appliances.

807.14.1 For combustion appliances that are not commonly vented (sharing the same flue), turn on other combustion appliances (with other smaller appliances still operating within the CAZ) one at a time, in order of increasing capacity, and repeat 807.13.1 through 807.13.3 for every appliance that is on after each one is turned on.

807.14.2 For combustion appliances that are commonly vented (sharing the same flue), test combustion appliances one at a time, in order of increasing capacity, and repeat 807.13.1 through 807.13.3 for every appliance. Do not leave on an appliance after it has been tested.

807.15 If spillage or high CO occurs in any appliance(s) under appliance venting depressurization, retest that appliance(s) under natural conditions, as follows:

807.15.1 Turn off the combustion appliances.

807.15.2 Turn off the exhaust fans.

807.15.3 Turn off air handler.

807.15.3 Open all interior doors.

807.15.4 Let the vent cool.

807.16 Test CO and spillage under natural conditions. If the test failed under worst-case, but passes under natural conditions, the work scope shall specify building pressure remediation.

NOTE: If an appliance fails under natural conditions, the Auditor shall immediately inform the homeowner of the problem, and the work scope shall specify remediation, including equipment or vent system repair or replacement and pressure remediation. The work scope may not commence until the problem is remediated.

807.17 If more than one CAZ is present, repeat procedures for each CAZ separately.

808 CARBON MONOXIDE (CO) TESTING

~~<Test all spaces (including attached garages, crawlspaces, basements) containing combustion appliances for carbon monoxide using the following protocols. Ambient CO shall be measured continuously during the energy audit.~~

~~808.1 CO testing of ambient air shall be performed continuously while performing a Worst Case Depressurization Test and/or under natural conditions, as required by paragraph 807.14>: Ambient CO shall be measured continuously during the energy audit.~~

~~808.2 Equipment required: <used shall:>~~

808.2.1 Equipment used for testing ambient air for carbon monoxide (CO) shall:

- Be certified as suitable for personal safety
- Be capable of measuring carbon monoxide (CO) levels from 0 to 2,000500 ppm (parts per million)
- Have a resolution of 1 ppm
- Have an accuracy rate of + 5 ppm
- Have an audible alarm at 35 ppm
- Be calibrated in accordance with the manufacturers recommendations or annually whichever is the greater frequency <by the manufacturer (or using manufacturer's instructions)> and evidence of the calibration shall be submitted to the Rating Provider Quality Assurance Designee.
- Must be labeled with a calibration sticker indicating at a minimum the date of last calibration.
- A combustion analyzer may NOT be used for personal safety unless it is certified by the manufacturer as suitable for personal protection.

808.2.2 Equipment used for testing CO in the flue of combustion appliances

- Must be suitable for combustion gas analysis
- Have a resolution of 1 ppm
- Have an accuracy rate of +/- 5 ppm or better
- Have an operating range of at least 0 – 2000 ppm

- Be calibrated in accordance with the manufacturers recommendations or annually whichever is the greater frequency and evidence of the calibration shall be submitted to the Rating Provider Quality Assurance Designee
- Must be labeled with a calibration sticker indicating at a minimum the date of last calibration.

808.3 Zero the carbon monoxide meter outside the building away from any combustion outlets or automobile traffic areas, or in accordance with manufacturer's instructions.

808.4 ~~Take a measurement of CO levels within the home upon entering to establish a baseline. Do not measure near combustion appliances while they are operating.~~ If ambient CO levels are higher than 35 ppm, immediately communicate the concern to the occupants ~~during normal appliance operation, turn off the appliance, ventilate the space,~~ and evacuate the building. The building may be reentered once ambient CO levels have gone below 35 ppm.

808.5 In sections 808.6, 808.7 and 808.8 the CO concentrations are shall be "air free" measurement. All CO measurements, with the exception of ambient air measurements, shall be adjusted to air free values either using the built-in capabilities of the test equipment or using the following equation and O₂ measurement (in ppm).

$$\text{CO Air Free} = \text{CO} \times \frac{20.9}{20.9 - \text{O}_2}$$

808.56 For atmospherically-vented appliances:

808.56.1 Take a measurement of vent gases upstream of (before they reach) the draft diverter.

808.56.2 ~~Appliance must operate for at least 5 minutes before taking sample.~~ CO readings should be taken at after at least 5 minutes of operation.

808.56.3 Take sample during worst-case depressurization test and/or under natural conditions, as required by paragraphs ~~4.14~~ 807.12, 807.13 and 807.14. Record the CO level.

808.67 For direct- or power-vented appliances:

808.67.1 Sample must be taken at vent termination.

808.67.2 ~~Appliance must operate for~~ CO readings should be taken after at least 5 minutes ~~before taking sample.~~ of operation and at steady state.

808.67.3 Take sample during worst-case depressurization test and/or under natural conditions, as required by paragraphs ~~4.14~~ 807.12, 807.13 and 807.14. Record the CO level.

808.<7> 8 >For LP- or natural gas ovens:

808. <7> 8.1 Open a window or door to the outside.

808.<7> 8.2 Remove any foil or cooking utensils within the oven.

808. <7> 8.3 Verify that the oven is not in self-cleaning mode.

808. <7> 8.4 Turn oven on to highest temperature setting.

808. <7> 8.5 Close the oven door and begin monitoring the CO levels in the kitchen, 5 feet from the oven at countertop height. Record CO levels.

808. <7> 8.6 Measure the CO levels within the oven vent.

808. <7> 8.6.1 Samples must be taken while burner is firing.

808. <7> 8.6.2 Operate burner for at least 5 minutes while sampling flue oven vent gases.

808. <7> 8.6.3 If CO levels are higher than ± 200 ppm, repeat the flue gas sampling until the CO levels stop falling.

808. <7> 8.6.4 Record the steady state CO reading in ppm and turn off oven.

808.8 If measured CO levels are higher than ± 200 ppm (± 2400 for oven), or an appliance fails to meet manufacturer's specifications for CO production (whichever is higher), the work scope shall specify replacement or repair of the appliance, and the homeowner shall be notified of the need for service by a qualified technician.

808.9 If ambient CO levels exceed 35 ppm at any time during combustion appliance testing, stop any testing and turn the combustion appliances off. Open all the exterior doors and windows. No one should enter the home until the CO levels drop below 35 ppm. The combustion appliance causing the increase in CO levels must be repaired by a qualified technician prior to completing the combustion appliance tests, unless the work scope calls for replacement of the appliance(s).

Modify Appendix B Glossary of Terms as follows:

Add the following new definitions:

Direct Vent Appliance-- Method of venting appliance whereby all air for combustion is derived directly from the outside atmosphere and all flue gases are discharged directly to the outside atmosphere.

Effective Date: This amendment shall become effective 90 days following final approval by the RESNET Board of Directors.

Justification:

When the simulation testing software was developed, several scenarios occurred that were inadequately addressed by the interim combustion guidelines. Those same scenarios were replicated in field trials, and the guidelines have been amended to improve clarity and comprehensiveness.