

## Appendix RA / Procedure for Worst-Case Testing of Combustion Appliances

(This appendix is informative and is not part of the code.)

The testing guidelines outlined in Appendix RA stands as an alternative for compliance with the requirement for gasketed doors on solid fuel burning appliances outlined in **Section R305.4**:

**R305.4.1 Gasketed doors.** All solid fuel-burning appliances and fireplaces shall have tight-fitting (defined as gasketed doors with compression closure or compression latch system) metal glass or ceramic doors.

**Exception:** Any home certified to have passed the Appendix RA – Recommended Procedure for Worst-Case Testing of Atmospheric Venting Systems” is not required to have tight-fitting doors.

Appendix RA also outlines the procedure for verifying draft of chimney-vented combustion appliances under worst-case conditions as outlined in Section R305.4.2

**R305.4.2 Spillage testing.** All chimney-vented equipment shall establish complete draft without spillage under “worst-case” conditions within two minutes. If any chimney-vented equipment fails this requirement, mechanically induced pressure relief shall be provided such that the requirement is met.

Appendix RA is a referenced procedure and is based on industry standards for worst-case combustion spillage testing developed by the Building Performance Institute (BPI). More information and full detail of the *Combustion Appliance Safety Inspection for Vented Appliances* procedure is available for download @: <http://www.bpi.org/sites/default/files/COMBUSTION%20APPLIANCE%20SAFETY%20INSPECTION%20FOR%20VENTED%20APPLIANCES.pdf>

For more information and support contact the Energy Code Assistance Center @ 885-887-0673 or Efficiency Vermont @ 888-921-5990

# APPENDIX RA RECOMMENDED PROCEDURE FOR WORST-CASE TESTING OF ATMOSPHERIC VENTING SYSTEMS UNDER R402.4 OR R405 CONDITIONS < 5ACH<sub>50</sub>

## SECTION RA101 | SCOPE

### RA101.1 General.

This appendix is intended to provide guidelines for worst-case testing of atmospheric venting systems. Worst-case testing is recommended to identify problems that weaken draft and restrict combustion air.

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## SECTION RA201 | GENERAL DEFINITIONS

**COMBUSTION APPLIANCE ZONE (CAZ).** A contiguous air volume within a building that contains a Category I or II atmospherically vented appliance or a Category III or IV direct-vent or integral vent appliance drawing combustion air from inside the building or dwelling unit. The CAZ includes, but is not limited to, a mechanical closet, a mechanical room, or the main body of a house or dwelling unit.

**DRAFT.** The pressure difference existing between the *appliance* or any component part and the atmosphere that causes a continuous flow of air and products of *combustion* through the gas passages of the *appliance* to the atmosphere.

**Mechanical or induced draft.** The pressure difference created by the action of a fan, blower or ejector that is located between the *appliance* and the *chimney* or vent termination.

**Natural draft.** The pressure difference created by a vent or *chimney* because of its height and the temperature difference between the *flue* gases and the atmosphere.

**SPILLAGE.** Combustion gases emerging from an appliance or venting system into the combustion appliance zone during burner operation.

## SECTION RA301 | TESTING PROCEDURE

### **RA301.1 Worst-case testing of atmospheric venting systems.**

Buildings or dwelling units containing a Category I or II atmospherically vented appliance; or a Category III or IV direct-vent or integral vent appliance drawing combustion air from inside of the building or dwelling unit, shall have the Combustion Appliance Zone (CAZ) tested for spillage, acceptable draft and carbon monoxide (CO) in accordance with this section. Where required by the *code official or other authority having jurisdiction, where one exists*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official or other authority having jurisdiction, where one exists*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope* and prior to final inspection.

**Exception:** Buildings or dwelling units containing only Category III or IV direct-vent or integral vent appliances that do not draw combustion air from inside of the building or dwelling unit.

The enumerated test procedure as follows shall be complied with during testing:

1. Set combustion appliances to the pilot setting or turn off the service disconnects for combustion appliances. Close exterior doors and windows and the fireplace damper. With the building or dwelling unit in this configuration, measure and record the baseline ambient pressure inside the building or dwelling unit CAZ. Compare the baseline ambient pressure of the CAZ to that of the outside ambient pressure and record the difference (Pa).
2. Establish worst case by turning on the clothes dryer and all exhaust fans. Close all interior doors that make the CAZ pressure more negative. Turn on the air handler, where present, and leave on if, as a result, the pressure in the CAZ becomes more negative. Check interior door positions again, closing only the interior doors that make the CAZ pressure more negative. Measure net change in pressure from the CAZ to outdoor ambient pressure, correcting for the base ambient pressure inside the home. Record "worst case depressurization" pressure and compare to Table RA301.1(1).

Where CAZ depressurization limits are exceeded under worst-case conditions in accordance with Table A301.1(1), additional combustion air shall be provided or other modifications to building air-leakage performance or exhaust appliances such that depressurization is brought within the limits prescribed in Table RA301.1(1).

3. Measure worst-case spillage, acceptable draft and carbon monoxide (CO) by firing the fuel-fired appliance with the smallest Btu capacity first.
  - a. Test for spillage at the draft diverter with a mirror or smoke puffer. An appliance that continues to spill flue gases for more than 60 seconds fails the spillage test.
  - b. Test for CO measuring undiluted flue gases in the throat or flue of the appliance using a digital gauge in parts per million (ppm) at the 10-minute mark. Record CO ppm readings to be compared with Table RA301.1(3) upon completion of Step 4. Where the spillage test fails under worst case, go to Step 4.
  - c. Where spillage ends within 60 seconds, test for acceptable draft in the connector not less than 1 foot (305 mm), but not more than 2 feet (610 mm) downstream of the draft

diverter. Record draft pressure and compare to Table RA301.1(2).

- d. Fire all other connected appliances simultaneously and test again at the draft diverter of each appliance for spillage, CO and acceptable draft using procedures 3a through 3c.
4. Measure spillage, acceptable draft, and carbon monoxide (CO) under natural conditions—without clothes dryer and exhaust fans on—in accordance with the procedure outlined in Step 3, measuring the net change in pressure from worst case condition in Step 3 to natural in the CAZ to confirm the worst-case depressurization taken in Step 2. Repeat the process for each appliance, allowing each vent system to cool between tests.
5. Monitor indoor ambient CO in the breathing zone continuously during testing and abort the test where indoor ambient CO exceeds 35 ppm by turning off the appliance, ventilating the space, and evacuating the building. The CO problem shall be corrected prior to completing combustion safety diagnostics.
6. Make recommendations based on test results and the retrofit action prescribed in Table RA301.1(3).

**TABLE RA301.1(1)  
CAZ DEPRESSURIZATION LIMITS**

<b>VENTING CONDITION</b>	<b>LIMIT (Pa)</b>
Category I, atmospherically vented water heater	-2.0
Category I or II atmospherically vented boiler or furnace common-vented with a Category I atmospherically vented water heater	-3.0
Category I or II atmospherically vented boiler or furnace, equipped with a flue damper, and common vented with a Category I atmospherically vented water heater	-5.0
Category I or II atmospherically vented boiler or furnace alone	-5.0
Category I or II atmospherically vented, fan-assisted boiler or furnace common vented with a Category I atmospherically vented water heater	-5.0
Decorative vented, gas appliance	-5.0
Power-vented or induced-draft boiler or furnace alone, or fan-assisted water heater alone	-15.0
Category IV direct-vented appliances and sealed combustion appliances	-50.0

**TABLE RA301.1(2)  
ACCEPTABLE DRAFT TEST CORRECTION**

<b>OUTSIDE TEMPERATURE (°F)</b>	<b>MINIMUM DRAFT PRESSURE REQUIRED (Pa)</b>
< 10	-2.5
10 - 90	(Outside Temperature ÷ 40) - 2.75
> 90	-0.5

**TABLE RA301.1(3)  
ACCEPTABLE DRAFT TEST CORRECTION**

<b>CARBON DIOXIDE LEVEL (ppm)</b>	<b>AND/OR</b>	<b>SPILLAGE AND ACCEPTABLE DRAFT TEST RESULTS</b>	<b>RETROFIT ACTION</b>
0 – 25	and	Passes	Proceed with work
25 </= 100	and	Passes	Recommend that CO problem be resolved
25 </=100	and	Fails in worst case only	Recommend an appliance service call and repairs to resolve the problem
100 </= 400	or	Fails under natural conditions	Stop! Work shall not proceed until appliance is serviced and problem resolved
> 400	and	Passes	Stop! Work shall not proceed until appliance is serviced and problem resolved
> 400	and	Fails under any condition	Emergency! Shut off fuel to appliance and call for service immediately