Planning, Development & Transportation Services

City of Fort Collins

Community Development & Neighborhood Services
281 North College Avenue
P.O. Box 580
Fort Collins, CO 80522.0580

970.416.2740
970.224.6134- fax
fcgov.com

Combustion Safety Test Guide

Replacing Natural-Draft Appliances or Altering Natural Draft Venting in Existing Homes

City of Fort Collins Building Code Amendments
Effective January, 2012

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City of Fort Collins Building Services
Fort Collins Utilities

Overview

In natural-draft appliances, there is no isolation of the combustion process from the surrounding space. This raises the potential for health and safety problems. Depressurization of the area in which the appliance is located can cause flame rollout or spillage of combustion products (including carbon monoxide) into the house.

A Fort Collins building code amendment effective January 1, 2012 (IRC G2408.1) requires a combustion safety test (CST) to be performed when a natural-draft appliance is replaced in an existing building.

Combustion safety testing is required in these situations:

- All new installations of draft-hood appliances (example: replacement of conventional, natural-draft water heaters with like equipment).
- Replacement of any combustion appliance that alters the venting of a draft-hood appliance (example: an induced-draft furnace, commonly vented with a natural-draft water heater, is replaced with a sealed-combustion furnace with separate venting; the water heater is the only appliance left on the formerly common vent).

Combustion safety testing not required in these situations:

- Replacement of an induced-draft furnace, commonly vented with a draft-hood water heater, with another induced-draft furnace, resulting in no change to the venting system of the draft-hood appliance.
- Replacement of any separately vented appliance which does not alter other venting of other draft-hood appliances.

Documentation regarding combustion safety testing under this code requirement will only be accepted from "Approved Agencies." The City provides training for those individuals who wish to obtain this designation.

This protocol is a shortened version of the Building Performance Institute (BPI) "Combustion Safety Test Procedure for Vented Appliances." Spillage and carbon monoxide tests will be performed; combustion appliance zone pressures and draft pressures will not be measured.

It is assumed that the worst case will always be with the furnace running because of the poorly sealed return air ducts located in and near the Combustion Appliance Zone (CAZ).
If supply ventilation is being used in a newer home, perform a full combustion safety test to determine worst case, not this shortened test.

Performing the Combustion Safety Test

Tools + Forms

You will need the following equipment

- Timer (watch or cell phone that can measure seconds)
- Carbon monoxide (CO) measuring device
- Smoke pencil
- Record measurements on the "Combustion Safety Test Compliance Form."

Determine Which Appliances Must be Tested

The typical appliances you will need to test are natural-draft water heaters (sometimes there are two), older furnaces with draft hoods, older boilers with draft hoods.

The appliance you replaced may not be the appliance that must be tested. For example:
if you replaced the existing natural or induced draft furnace with a sealed combustion furnace and the water heater is natural draft, you will need to perform a combustion safety test on the water heater. The water heater by itself may have difficulty obtaining a draft in the existing vent with depressurization in the CAZ.

Your Safety

There is a chance that, during these tests, CO could spill into the space in which you're working. Always monitor ambient CO concentration and abort the testing if it exceeds 35 ppm.

Worst-Case Condition - CAZ Depressurization

In this test, you will use the home's exhaust fans, air handler and clothes dryer along with selective door closures to approximate "worst-case" depressurization in the combustion appliance zone (CAZ). If appliances can successfully perform under this condition, it increases confidence that venting systems will exhaust combustion products under all conditions.

Initial Setup

1) Start with all exterior doors, windows, and fireplace dampers closed.
2) Set all draft-hooded appliances that must be tested to Pilot. Turn off all other combustion appliances.
3) Turn On the CO tester outdoors to zero the instrument. Leave it running and bring into the CAZ.

Establish Worst-Case Condition - CAZ Depressurization

4) Turn on all exhaust fans. These typically include bath and laundry fans, vented kitchen hood and clothes dryer. (Do NOT operate whole-house fans.)
5) Use the thermostat to turn on the furnace fan to highest speed; typically "fan-only" or "cooling" setting (if operating at "cooling" setting when outdoor temperature is below 60 F, first turn off power to the AC outdoor unit).
6) Close the doors to all rooms. Standing in the core of the house, outside each room, check whether the CAZ will be more negative with the door open or closed by puffing smoke at door bottom. If the smoke blows back at you, leave door closed; if the smoke is pulled into room, open the door. Repeat for all interior doors.

7) If the mechanical equipment is in a mechanical room or a basement with a door, determine worst-case CAZ setup with the door open or closed. Stand inside the mechanical room and close the door. Puff the smoke at the door bottom; if the smoke blows back at you, leave the door closed. If it is pulled out of the room, leave the door open.

The house is now set up in worst-case conditions. Leave it this way and begin testing.

Measure Spillage and CO Under Worst-Case Condition Depressurization
Repeat this sequence of tests for each appliance that must be tested. Test each appliance individually, beginning with the appliance with the smallest Btuh capacity. If there are two appliances of the same capacity (for example, two water heaters), first test the unit located furthest from the common vent.

Measure Spillage at the Draft Hood

1) Fire the appliance and start your timer.
2) Using the smoke pencil or mirror, note whether combustion products spill out of the draft hood and, if so, record how long spillage continues after firing.
   PASS = Spillage duration 60 seconds or less. Record duration and proceed to measure draft.
   FAIL = Spillage duration exceeds 60 seconds. Turn off the appliance. If there are other appliances to test, proceed to test the next one under worst-case conditions. Otherwise proceed to test spillage and CO under Natural Conditions.

Measure Undiluted Flue Gas CO Level

3) If the appliance passed worst case spillage, let it run for at least 5 minutes (or until the vent temperature is constant).
4) Insert CO test probe into the baffle in the water heater internal flue below the draft hood to measure undiluted flue gases.
5) Measure CO concentration and record on the Form.
   PASS = CO level not exceeding 100 ppm. (Adjustment / repairs are recommended for CO levels between 25 and 100 ppm.)
   FAIL = CO level exceeds 100 ppm.

If there are other appliances to test, proceed to test the next one (next smallest Btuh capacity or closer to the common vent) under worst-case conditions.

If you have tested all appliances under worst-case conditions and they all passed the spillage and CO tests, you are done. Record results on the “Combustion Safety Test Compliance Form” and sign it.

If any appliance failed the worst case spillage or CO tests, proceed to test it under natural conditions. If an appliance fails the worst case spillage test, do not continue on to test for undiluted flue gas CO with combustion products spilling into the CAZ. In this case the undiluted flue gas CO will be tested only under Natural Conditions

Natural Conditions Performance Test

These tests are conducted only for appliances that failed spillage or CO tests under worst-case condition-CAZ depressurization.

Initial Setup
1) Turn off the furnace air handler and all exhaust fans.
2) Open all interior doors. Leave door to mechanical open or closed depending on what is a natural condition.
3) Wait for the appliance vent to cool (to touch).

Measure Spillage and CO Under Natural Conditions
Measure Spillage and undiluted CO in the vent using the same sequence of testing outlined above. Record results on the form. Pass/Fail limits are identical to those for worst-case depressurization testing.

If any appliance fails the spillage test, turn the appliance off; you are not required to measure CO level with combustion products spilling into the CAZ.

Results of the Combustion Safety Test

Compliance Form

Record results on the "Combustion Safety Test Compliance Form" and sign it. Retain a copy for your own records, leave a copy with the homeowner, and submit the original to Building Services as part of final approval.

What if an Appliance Fails?

Appliances that fail testing under natural conditions shall be turned off and not be operated until the reason for the failure has been diagnosed and repaired. All corrections shall be verified with passing results on the natural conditions test sequence.

Make recommendations to the homeowner how to correct any worst case failure. All CO level failures or spillage under natural conditions MUST be corrected.
Common causes of worst case spillage failures include oversized vents, poorly sealed return air ducts or filter openings, large exhaust fans and/or a clothes dryer located within the CAZ. A licensed HVAC contractor may need to be involved with some types of repairs.

Appliances that pass tests under natural conditions but fail under worst-case conditions are permitted to operate. In this scenario, a Combustion Safety Compliance Form must be completed and signed by the homeowner to acknowledge their awareness of the risks.
Give the homeowner the Combustion Safety Information sheet to help provide guidance about possible next steps and answer questions.