



COMBUSTION APPLIANCE SAFETY INSPECTION FOR VENTED APPLIANCES*

*Vented appliances refer to natural draft appliances equipped with a barometric draft regulator or Category I appliances equipped with a draft hood or connected to a natural draft venting system.

The following combustion appliance safety inspection must be completed to determine if fossil fuel-fired appliances are operating safely under a depressurized condition.

MONITOR INDOOR AMBIENT CARBON MONOXIDE (CO)

Ambient CO must be monitored at all times during the test and actions taken as per the table below:

Required Actions in Response to Ambient CO Measurements (from ANSI/BPI-1200, Section 7.3.3.3)

70 ppm or greater	36 ppm-69 ppm	9 ppm- 35 ppm
<ul style="list-style-type: none"> • Terminate the inspection. • Notify the homeowner -occupant of the need for all building occupants to evacuate the building. • Leave the building and the appropriate emergency services shall be notified from outside the home. 	<ul style="list-style-type: none"> • Advise the homeowner -occupant that elevated levels of ambient CO have been detected. • Open windows and doors. Recommend that all possible sources of CO be turned off immediately. • Where it appears that the source of CO is a permanently installed appliance, recommend that the appliance be turned off and advise homeowner – occupant to contact a qualified professional. 	<ul style="list-style-type: none"> • Advise the homeowner - occupant that CO has been detected. • Recommend that all possible sources of CO be checked and windows and doors opened. • Where it appears that the source of CO is a permanently installed appliance, advise the homeowner - occupant to contact a qualified professional.

DEPRESSURIZE THE COMBUSTION APPLIANCE ZONE

Complete the following steps to place the CAZ under the greatest depressurization achievable given the weather/temperature conditions at the time of the inspection. Once you have determined that the greatest possible depressurization has been achieved, keep the CAZ in this depressurized state during all spillage assessment and CO measurements of vented appliances.

1. Place all combustion appliances located within the CAZ in their standby mode and prepare for operation.
2. Fires in woodstoves and/or fireplaces must be fully extinguished, with no hot coals or embers. Close fireplace dampers and any fireplace doors.
3. Close all building exterior doors and windows. Close all CAZ doors. Close the interior doors of all rooms except for rooms with an exhaust fan and rooms with a central forced air system return. Leave outdoor openings for combustion air open.
4. Turn off any mechanical ventilation and forced air cooling or heating system blowers.
5. Using a calibrated manometer or similar pressure measuring device intended for this purpose, **measure and record the baseline pressure in the CAZ with reference to (WRT) outside.** Compare this measurement with subsequent pressure measurements to determine the greatest negative pressure achievable in the CAZ.
6. Turn on the following exhaust equipment: clothes dryers (check and clean the dryer filter and look for blockage at the external vent damper prior to operation), range hoods, and other exhaust fans. If there are speed controls, operate the exhaust equipment at the highest speed setting. Do not operate a whole house cooling exhaust fan.
7. **Measure and record the pressure in the CAZ WRT outside.**
8. Turn on any central forced air system blowers and **measure and record the pressure in the CAZ WRT outside.**
 - If the pressure in the CAZ becomes more negative WRT outside after the blower is turned on, leave the blower ON during combustion appliance safety inspection.
 - If the pressure in the CAZ becomes more positive WRT outside after the blower is turned on, leave the central forced air system blowers OFF during the combustion appliance safety inspection.
9. Open interior door/s directly leading to the CAZ. **Measure and record the pressure in the CAZ WRT outside.**
 - If the pressure in the CAZ becomes more negative WRT outside after the door(s) are opened, leave the door(s) open during the combustion appliance safety inspection. *(Alternatively, pressure differential diagnostics may be used to determine proper door configuration to create the greatest CAZ depressurization. Pressure differential diagnostics may include manometer readings or a visual indicator, such as smoke.)*

SPILLAGE ASSESSMENT AND CO MEASUREMENT

Starting with the appliance with smallest BTU_h input rating, follow lighting instructions and place in operation. Adjust the thermostat or control so the appliance will operate continuously.

In Cold Vent (Except Domestic Water Heaters)

Cold vent pertains to an appliance for which the heat setting is turned to OFF.

1. Assess spillage at **5 minutes** of main burner operation.
 - Action levels for spillage occurring at 5 minutes of main burner operation: See Table D.1.A.
2. Measure CO in undiluted flue gas at **5 minutes** of main burner operation. Compare the CO measurement with the appropriate CO threshold from Table 1, below.
 - Action levels for CO exceeding the appropriate threshold in Table 1: See Table D.1.B.

In Domestic Water Heaters or Warm Vent

Warm vent pertains to an appliance for which the heat setting is turned to ON.

1. Assess spillage at **2 minutes** of main burner operation.
 - Action levels for spillage occurring at 2 minutes of main burner operation: See Table D.1.A.
2. Measure CO in undiluted flue gas at **5 minutes** of main burner operation. Compare the CO measurement with the appropriate CO threshold from Table 1, below.
 - Action levels for CO exceeding the appropriate threshold in Table 1: See Table D.1.B.

Multiple Combustion Appliances Sharing Chimney and/or Venting System

When a chimney and/or venting system is shared by multiple combustion appliances, use the following procedures to test combustion appliances for spillage and measure CO level in undiluted flue gases.

1. Test combustion appliances in order from lowest BTU_h input rating to highest BTU_h input rating.
2. Assess the appliance with the lowest BTU_h input rating for spillage and CO measurement in undiluted flue gas.
 - If the vent is cold, assess spillage and measure CO at 5 minutes.
 - If the vent is warm (and/or if the appliance is domestic water heater) assess spillage at 2 minutes and measure CO at 5 minutes.
3. Upon completion of spillage testing and CO measurement of the first appliance, place the next largest BTU_h combustion appliance in operation while the first appliance is still firing. Do not wait for the chimney to cool.
4. Retest the first appliance for spillage when the second appliance has reached 2 minutes of main burner operation. Test the second appliance for spillage immediately thereafter.
5. Measure CO level in the undiluted flue gas of the second appliance at 5 minutes of its main burner operation. Continue this process for each additional commonly-vented combustion appliance in order of BTU_h input rating until all are running simultaneously.
6. Action levels for spillage on each appliance: See Table D.1.A
7. Compare the CO measurement with the appropriate CO threshold from Table 1.
 - Action levels for CO exceeding the appropriate threshold in Table 1: See Table D.1.B.

**Table 1: CO Thresholds for Fossil Fuel-Fired Combustion Appliances
(from ANSI/BPI-1200, Section 7.95)**

Table 1 CO Thresholds for Fossil-Fuel Fired Combustion Appliances	
Appliance	Threshold Limit
Central Furnace (all categories)	400 ppm air free ⁴
Boiler	400 ppm air free
Floor Furnace	400 ppm air free
Gravity Furnace	400 ppm air free
Wall Furnace (BIV)	200 ppm air free
Wall Furnace (Direct Vent)	400 ppm air free
Vented Room Heater	200 ppm air free
Unvented Room Heater	200 ppm air free
Water Heater	200 ppm air free
Oven/Broiler	225 ppm as measured
Clothes Dryer	400 ppm air free
Refrigerator	25 ppm as measured
Gas Log (gas fireplace)	25 ppm as measured in vent
Gas Log (installed in wood burning fireplace)	400 ppm air free in firebox

**Table D.1.A: Action Levels for Spillage in Combustion Appliances
(from ANSI/BPI-1200, Annex D)**

TABLE D.1.A ACTION LEVELS FOR SPILLAGE IN COMBUSTION APPLIANCES The following actions shall be taken when spillage occurs under the specific circumstances detailed below.	
TEST RESULT	ACTION REQUIRED
Greatest CAZ depressurization occurs with the air handler on*	Conduct further analysis of the distribution system to determine if leaky ducts or other HVAC-induced imbalances are the cause of the spillage. If so, recommend distribution system repairs that will reduce or eliminate the CAZ depressurization.
Greatest CAZ depressurization occurs with door to CAZ closed, but is alleviated when door to CAZ is open*	Recommend measures to improve air transfer between the CAZ and the core of the house
The cause of spillage has been traced to excessive exhaust** independent of CAZ door position, air handler, or a problem with the flue†	Verify that sufficient combustion air is available per <i>ANSI Z223.1/NFPA 54</i> for gas-fired appliances and <i>NFPA 31</i> for oil-fired appliances or recommend verification by a qualified professional and/or Recommend further evaluation/service by a qualified professional to address the venting/combustion air issues

*In the case where both spillage and excessive CO are present, in addition to the specific recommendations above, recommend that the appliance be shut down until it can be serviced by a qualified professional.
 ** Refers to exhaust caused by mechanical ventilation and/or other means of exfiltration.
 †When a recommendation to replace atmospherically-vented combustion equipment inside the pressure boundary is made, and when cost-effective, recommend replacement with direct-vented, or power-vented equipment (or non-combustion equipment, such as a heat pump), which is ENERGY STAR®-labeled.

**Table D.1.B: Action Levels for Carbon Monoxide in Combustion Appliances
(from ANSI/BPI-1200, Annex D)**

TABLE D.1 B. ACTION LEVELS FOR CO IN COMBUSTION APPLIANCES	
TEST RESULT	ACTION REQUIRED
Unacceptable CO level	Advise the homeowner/occupant that the appliance should be serviced immediately by a qualified professional Note: If ambient CO levels do not exceed 70 ppm, testing of other appliances and other audit procedures may continue at the discretion of the auditor
Acceptable CO level	No action required

NOTE: The Action Levels in Tables D.1.A and D.1.B above are based on the following criteria:

- CO measured at 5 minutes of main burner operation
- Spillage assessed at 2 minutes of main burner operation for warm vent
- Spillage assessed at 5 minutes of main burner operation for cold vent
- CO level at or below threshold in Table 1 for the appliance being tested is ACCEPTABLE
- CO level exceeding threshold in Table 1 for the appliance being tested is UNACCEPTABLE

TERMS AND DEFINITIONS

Barometric Draft Regulator	A balanced damper device attached to a chimney, vent connector, breeching, or flue gas manifold to control chimney draft.
Carbon Monoxide (CO) Air Free	<p>Air free emission levels are based on a mathematical equation (involving carbon monoxide and oxygen or carbon dioxide readings) to convert an actual diluted flue gas carbon monoxide testing sample to an undiluted air free flue gas carbon monoxide level utilized in the appliance certification standards. For natural gas or LP gas, using as-measured CO ppm and O₂ percentage:</p> $CO_{AFppm} = \left(\frac{20.9}{20.9 - O_2} \right) \times CO_{ppm}$ <p>Where: CO_{AFppm} = Carbon monoxide, air-free ppm CO_{ppm} = As-measured combustion gas carbon monoxide ppm O₂ = Percentage of oxygen in combustion gas, as a percentage</p>
Category I Vented Appliance	An appliance that operates with a <i>non-positive</i> vent static pressure and with a vent gas temperature that <i>avoids</i> excessive condensate production in the vent.
Category II Vented Appliance	An appliance that operates with a <i>non-positive</i> vent static pressure and with a vent gas temperature that <i>can cause</i> excessive condensate production in the vent.
Category III Vented Appliance	An appliance that operates with a <i>positive</i> vent static pressure and with a vent gas temperature that <i>avoids</i> excessive condensate production in the vent.
Category IV Vented Appliance	An appliance that operates with a <i>positive</i> vent static pressure and with a vent gas temperature that can cause excessive condensate production in the vent.
Combustion Appliance Zone (CAZ)	Room and enclosed air volume that contains a combustion appliance. This may include, but is not limited to, a mechanical room, mechanical closet, or main body of the house.
Common Vent	That portion of a vent or chimney system that conveys products of combustion from more than one appliance.
Direct Vent Appliance	An appliance that is constructed and installed so that all air for combustion is derived directly from the outdoors and all flue gases are discharged to the outdoors.
Draft Hood	A draft hood acts as a pressure break between the vent system and the appliance and eliminates stack action. Without the draft hood, the vent could experience excessive draft, flame instabilities, and possibly pilot outage.
Spillage	Entry of combustion products into a building from dilution air inlets, vent connector joints, induced draft fan case opening, combustion air inlets, or other locations in the combustion or venting system of a vented combustion appliance (boiler, fireplace, furnace, or water heater), caused by backdrafting, vent blockage, or leaks in the venting system.
Vent	A passageway used to convey flue gases from appliances or their vent connectors to the outdoors.