

# Combustion Appliance Testing

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## Train the Trainer

### Learning Objectives

By attending this session, participants will:

- Learn the basic principles of combustion, distribution, and venting.
- Be able to recognize safety-related problems.
- Learn the basics of diagnostic combustion appliance testing.
- Become familiar with the test procedures for vented and non-vented appliances.
- Understand the relationship between combustion safety problems and poorly designed or non-code-compliant vent systems.
- Understand worst case combustion appliance zone testing.

## Key Terminology

Action levels	Inches of Water Column (IWC)
Air-free CO content	Indoor Air Quality (IAQ)
Ambient	Induced draft furnace
As-measured CO content	Inspection mirror
Atmospheric	Manometer
Backdrafting	Minimum Ventilation Requirement (MVR)
Baffle	Natural draft
Barometric damper	Natural gas
British Thermal Unit (BTU)	National Fire Protection Association's Standard for the Implementation of Oil-Burning Equipment (NFPA 31)
B-vent	National Fire Protection Association's National Fuel Gas Code (NFPA 54)
Carbon Dioxide (CO <sub>2</sub> )	National Fire Protection Association's Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances (NFPA 211)
Carbon Monoxide (CO)	Over-fired
Clearance	Oxidation
Combustion analyzer	Parts per million (ppm)
Combustion Appliance Zone (CAZ)	Pascals (Pa)
Combustion byproducts	Primary air
Combustion efficiency	Propane (liquefied petroleum gas, or LPG)
Condensing furnace	Secondary air
Depressurization	Smoke tester
Digital probe thermometer	Spillage
Dilution air	Steady-state efficiency
Draft	Sulfur Dioxide (SO <sub>2</sub> )
Draft diverter	Under-fired
Draft gauge	U.S. DOE Hot Climate Initiative
Draft hood	Vent
Draft reversal	Worst case Combustion Appliance Zone (CAZ) testing
Excess air	
Flame impingement	
Flame roll-out	
Furnace blower	
Heat exchanger	

## Supplemental Materials

### Handouts & Resources

Combustion Analysis Quick Sheet

CO Probe Locations illustration

DOE Hot Climate Initiative. Combustion Appliance Safety & Efficiency Testing.

DOE. WAP. “WPN 08-4 Space Heater Policy.” 3 Mar. 2008. [www.waptac.org](http://www.waptac.org).

DOE. EERE. “Combustion Equipment Fact Sheet.” Oct. 2000.

“INCAP Daily Safety Test-Out Procedure Checklist.” Download from field guide at [www.incap.org](http://www.incap.org).

OSHA. “Carbon Monoxide Poisoning” QuickCard™ and Factsheet.  
[www.osha.gov/pls/publications/publication.athruz?pType=Types&pID=6](http://www.osha.gov/pls/publications/publication.athruz?pType=Types&pID=6).

DeKieffer, Rob. “Combustion Safety Checks: How Not to Kill Your Clients.” *Home Energy* Mar./Apr. 1995. [www.homeenergy.org](http://www.homeenergy.org).

EPA. “EPA Carbon Monoxide Fact Sheet.” Oct. 1996.  
[www.epa.gov/iaq/pubs/coftsht.html#CO%20Poisoning%20Symptoms](http://www.epa.gov/iaq/pubs/coftsht.html#CO%20Poisoning%20Symptoms).

Moffatt, Sebastian. “Backdrafting Causes and Cures.” *Home Energy* May/June 1991. [www.homeenergy.org](http://www.homeenergy.org).

Applicable sections of the NFPA 54: National Fuel Gas Code

Applicable sections of NFPA 211: Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances; esp. Table 2-2.1, “Chimney Selection Chart”

### Classroom Props & Activities

Various types of vent connectors

Gas leak detector

Soap solution

Mirror and flashlight

Combustion analyzer

Manometer and hose

**Gas Input Rating Demonstration** – Bring the students to the building’s gas meter. Using a calibration card or table and a timer, have a pair of students determine the gas consumption of the building. Discuss the procedure for testing the fuel input of appliances at client homes.

## **Hands-on Props**

**Combustion appliances for inspection and testing** – Point out the appliance components and have students name them. In groups, have students inspect wiring and fans, looking for proper vent materials and cracked or corroded heat exchangers. Test for fuel leaks, safety shut-off, draft, free oxygen (combustion air), CO, and combustion efficiency.

### **Tools:**

CO detector	Lighter
Combustion analyzer	Manometer and hose
Cordless drill and 5/8” bits	Mirror
Flashlight	Pipe tape and wrenches (to repair leaks)
Gas leak detector	Soap solution
High-temp caulk (if re-sealing holes)	

## **Class Overview**

- Introduce the concepts of combustion and combustion appliance testing with the classroom presentation. Break up the presentation by demonstrating how to use combustion inspection tools. Demonstrate the sensitivity of the gas leak detector by drawing a thick line on a piece of paper with a permanent marker, then showing the detector go off as it approaches the line.
- Refer to DOE’s “Combustion Appliance Safety & Efficiency Testing” when discussing proper testing locations for CO, efficiency, and draft on various appliances. Toward the end of the presentation, refer to the table of acceptable draft readings for worst case CAZ testing.
- Break into groups and have students conduct hands-on inspection and testing of combustion appliances. During hands-on testing, ask leading questions to build on concepts introduced in the classroom section, including appliance components, draft, spillage, and CO testing.