**Building Science Education Solution Center – Combustion Safety**

Proficiency Level 2: Understand

**Learning Objective 2.1:**

* Summarize the main approaches to evaluating combustion safety.

**Lecture Notes: 2.1:**

References:

Energy.gov. *Combustion Safety Webinar*. Accessed 2024.  
 <https://www.energy.gov/sites/prod/files/2015/12/f27/BA%20Combustion%20Safety%20Webi nar%20r3.pdf>

Energy.gov. *Combustion Safety Simplified Test Protocol Field Study*. Accessed 2024.  
 <https://www1.eere.energy.gov/buildings/publications/pdfs/building\_america/combustion- safety-protocol-field.pdf>

Several approaches to evaluating combustion safety for gas-fired water heaters, boilers, and furnaces are to:

* Inspect vents and heat exchangers for corrosion or cracking.
* Assess whether the vent is installed according to code.
* Measure draft hood spillage time.
* Evaluate the amount of carbon monoxide (CO) present in both the appliance flue and in the occupied space.

Most combustion safety incidents are related to poor sizing or installation practices. These can be mitigated by following the venting tables present in the National Fuel Gas Codes. These tables have been around since the 1950’s, updated in the 1980’s, and are still a useful resource that helps to solve most problems even today.

**Problem Set 2.1:**

1.) Which of these is not a proper approach for evaluating combustion safety for gas-fired water heaters, boilers, and furnaces?

a) Evaluate CO concentrations in both the appliance flue and in the occupied space.

b) Assess whether the vent is installed according to code.

c) Operate appliances at low settings to prevent buildup of ambient CO.

d) Inspect vents and heat exchangers for corrosion or cracking.

**Learning Objective 2.2:**

* Explain the harmful effects of CO spillage and what can be done to prevent backdrafting of CO.

**Lecture Notes 2.2:**

Reference:

Pacific Northwest National Laboratory. *CCHRC: Combustion Safety Test*. Accessed 2024.   
 <https://basc.pnnl.gov/videos/cchrc-combustion-safety-test>

Combustion appliances that use indoor air take air from the living space and release carbon monoxide (CO) as a byproduct. Ideally, appliances should vent all flue gases to the outside, but under certain conditions backdrafting of the flue gases occurs and causes spillage, releasing combustion exhaust gases back out into the living space instead.

This CO spillage can cause health issues, including CO poisoning, which may not be detected immediately as CO is a colorless, odorless, tasteless gas. The symptoms of CO poisoning include headache, dizziness, nausea, and confusion.

The following table consists of thresholds of CO air concentration and related symptoms according to the Environmental Protection Agency (EPA) and the National Institute for Occupational Safety and Health (NIOSH):

|  |  |
| --- | --- |
| **CO Air Concentration** | **Safety Limits and Symptoms** |
| 9 ppm | No ill side effects for 8 hours. |
| 35 ppm | No ill side effects for 1 hour. |
| 200 ppm | A slight headache can occur within 2-3 hours. The safety health limit by NIOSH is 15 minutes at this concentration of CO. |
| 400 ppm | A headache occurs within 2-3 hours. |
| 800 ppm | Sickness and twitching of limbs within 1-2 hours, and unconsciousness within 2 hours. |
| 1,600 ppm | Headache within 20 minutes, and death within 2 hours. |
| 3,200 ppm | Death can occur within 30 minutes. |

It is recommended that a CO detector is placed on every floor of one’s residence, and to regularly inspect the chimneys and test CO levels in the house. Backdrafting of CO can occur regardless of the age of the residence and is more likely to occur in the winter, when homes are tightly closed to protect against colder temperatures. It is recommended to conduct a combustion safety test whenever there is a change to the heating and ventilation system, or after air sealing.

**Problem Set 2.2:**

1) At what ambient level of CO can harmful side effects occur?

a) 9 ppm CO

b) 35 ppm CO

c) 70 ppm CO

d) 200 ppm CO

e) All of the above

2) How often should you conduct a combustion safety test?

a) Once every 3 months.

b) Every time there is a change to the heating and ventilation system, or after air sealing.

c) Any time a part of the heating and ventilation system is changed out due to damage.

d) Once every year.