

FOTE • REPORT

SAFETY ENGINEERING UPDATE

FOTE NOTES

At Russell Fote & Associates, our purpose is to provide our clients with the very best safety engineering and expert consulting services.

Since starting Russell Fote & Associates, Mr. Fote has given over **150 depositions** and has testified at **25 trials**. He has been recognized as an expert in the state courts of: Illinois, Wisconsin, Iowa, Kentucky, Tennessee, Nebraska, Oklahoma, and West Virginia, plus U.S. District Courts in Atlanta, GA and Central Islip, NY.

We have two offices to serve you. Our Chicago office is located at 8770 W. Bryn Mawr Ave., Suite 1300, Chicago, IL 60631, which is about three miles east of O'Hare International Airport. Our other office is located in Wisconsin at 3635 Stonebrook Ct., Brookfield, WI 53005. You may reach us using the contact information listed at the bottom of this newsletter.

At Russell Fote & Associates, we continue to remain current on all safety engineering-related issues.

We invite you to visit our "home page" on the Internet. You may access our web site at: www.fote-engineering.com or E-mail information to our office at: rfote@wi.rr.com.

Carbon Monoxide, an in-the-home killer

The NFPA (National Fire Protection Association) estimates 480 deaths occur annually from carbon monoxide (CO) poisoning relating to exposures from non-fire causes.

Those deaths relate to hazards involving motor vehicle exhaust, home heating equipment, cooking appliances and engine-driven equipment such as lawn mowers, generators, etc.

Annually, over 60,000 non-fire CO incidents are reported to responding fire departments, with nearly 90 percent of these incidents occurring in the home.

Carbon monoxide is formed as a result of an incomplete combustion process, which involves all carbon-based fuels, such as propane, oil, natural gas, wood and coal.

Under ideal combustion conditions, a fuel's carbon molecules mix with air's oxygen molecules to form carbon dioxide; however, if lack of oxygen is present, deadly carbon monoxide is formed.

CO and Oxygen Starvation

The molecules of the red blood cells, hemoglobin, which normally attach to the oxygen molecules to form oxyhemoglobin will combine instead with carbon monoxide to form carboxyhemoglobin. This process starves oxygen to the vital tissues, such as the brain.

Inhalation of carbon monoxide can affect one's memory and thinking, which in turn, leads to dizziness, fatigue and confusion. CO can kill within minutes.

Breathing air with only a 1.3 percent concentration of carbon monoxide will almost immediately cause unconsciousness and possible death in one to three minutes.

A concentration of carbon monoxide in air just below one-fifth of one percent can cause nausea within 20 minutes and death within an hour.

Serious non-fatal exposure to CO is marked by symptoms of memory loss and confusion, with possible resulting permanent brain damage and total disability.

The Occupational Safety and Health Administration (OSHA) requires a CO exposure limit based on an eight hour average day of no more than 50 parts per million or 5/1000 of one percent.

CO and its Attributes

CO is very difficult to detect since it is odorless, colorless and tasteless. Low levels of CO exposure generally result in headaches, dizziness, overall weakness, nausea and other flu-like symptoms.

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Prolonged exposure to low levels of CO can result in permanent brain damage and total disability.

Also, CO is only slightly lighter than air, with a specific gravity of 0.97. This allows CO to intermix with air and travel freely throughout the home and into second-floor bedrooms.

A Defective Venting System

A major cause of CO entering living spaces is a defective venting system. To discuss this danger, let's first look at the fundamentals of a venting system for gas-fired appliances.

A draft is defined as the flow of exhaust gases and air through a chimney or flue pipe to the outside.

Natural draft is developed by the temperature difference between the hot gases exiting the gas-fired appliance and the surrounding cooler, ambient air.

Hot gases are lighter than the surrounding air and that weight or density difference creates buoyancy, like a cork in water.

The heavier surrounding ambient air descends downward and around the appliance, which forces the hot vented gases upward through the flue pipe and/or chimney.

To facilitate these buoyant conditions effectively, sufficient amounts of cooler ambient air surrounding the appliance are necessary, both for proper combustion and draft. When the venting system is not functioning properly, vented gases are most

likely, backing up into the living space, a condition known as back drafting.

Combustion Air

For complete burning, a natural gas appliance requires 10 cubic feet of air for every one cubic feet of gas burned. During combustion, natural gas, CH₄, ignites with air containing oxygen, O₂, and nitrogen, N₂, to produce heat, light, water vapor, carbon dioxide, CO₂, and nitrogen. If insufficient air is available for combustion, CO is produced, instead of CO₂.

CO is a very deadly gas. Breathing air containing just over one percent CO causes almost immediate unconsciousness and death within minutes.

Along with the combustion requirement, additional ambient air is needed to surround the venting gases to produce a draft necessary to move the hot gases up the flue pipe and/or chimney.

The air required to produce both complete combustion and to facilitate adequate draft is referred to as combustion air.

Confined Space

The requirement for adequate combustion air is defined by NFPA 54, National Gas Code, which states a confined space is a space where its volume is less than 50 cubic feet per 1,000 Btu/hour of total input ratings of all appliances in the space.

If the space meets the criteria as a confined space, the Code requires two air openings be

provided for combustion air to enter the confined space. Each opening is to be sized based on the requirement of 1,000 Btu/hour of total input ratings of all appliances in the confined space.

The top opening is to be within 12 inches from the top of the space, and the lower opening is to be within 12 inches from the bottom of the space.

For example, let's assume a home's space contains an older 80 percent efficient gas-fired furnace with an input rating of 50,000 Btu/hour and a gas-fired water heater with an input rating of 30,000 Btu/hour. This space measures 24 feet by 24 feet by 8 feet high or 4,608 cubic feet of volume.

If 4,608 cubic feet is divided by 50 cubic feet/1,000 Btu/hour, this equals 92.16. Therefore, per Code, a total of 92,160 Btu/hour of input rating appliances may be installed in this space.

The furnace in this example has an input rating of 50,000 Btu/hour and the water heater has an input rating of 30,000 Btu/hour for a total of 80,000 Btu/hour, which is less than the maximum calculated amount of 92,160 Btu/hour.

(continued on next page)

A Thought
If you become wise, you will be the one to benefit. If you scorn wisdom, you will be the one to suffer.
..... Proverbs 9:12

Therefore, these two appliances may be installed in this space with no additional air openings required.

Now, assume we wish to install a gas-fired clothes dryer with an input rating of 20,000 Btu/hour into this space. The total input rating of all three appliances would be 100,000 Btu/hour, which is higher than the Code's limit of 92,160 Btu/hour.

Under these conditions, two combustion air openings would need to be provided for this space to allow air from the outside or from an adjacent inside room to enter.

To access air from an adjacent room, two openings would need to be installed, each providing 100 square inches (1 square inch for every 1,000 Btu/hour of input rating).

One 100 square inch-opening would need to be within 12 inches from the top of the space and the other 100 square inch-opening would need to be within 12 inches from the bottom of the space.

CO poisoning caused by lack of combustion air tends to involve very confined spaces, such as a closet or small utility room containing a gas-fired furnace and a gas-fired hot water heater. If these conditions are present, CO tends to be produced erratically and therefore, it may be difficult to measure CO levels using a CO meter.

One means to determine the extent of a CO problem involving a confined space having, for

example, gas-fired appliances inside a small utility room, such as a furnace and water heater, is to check the levels of CO in each appliance's vented gases.

Generally, a lack of combustion air will cause the appliance's burners to soot and clog resulting in poor combustion and high levels of CO in its vented gases.

Over 100 ppm (parts per million) of CO in the appliance's vented gases is a very suspect condition that the appliance is not operating properly. Therefore, more CO testing of the air in the confined space and in the home's living space is necessary.

A CO detector will assist in providing an advanced warning before very dangerous CO concentrations are incurred.

Our firm has been called upon for several CO poisoning matters involving gas-fired appliances being installed in confined spaces. Those matters were successfully investigated and resolved prior to trial.

Issues with Chimneys and Flue Stacks

Plugged or partially plugged chimneys or flue stacks can result in back drafting and CO entering the living space. One primary cause is animals, such as birds, squirrels and raccoons, nesting in the flue stack or chimney. The most effective preventative measure is installing flue or chimney caps.

Another cause of CO entering a living space is a chimney or vent pipe, which was constructed from single-wall galvanized sheet metal. Over time, the metal will rust and/or separate at its connections, resulting in cracks for CO to escape.

These flue pipes are especially dangerous if they were installed in concealed spaces, for example, between walls or nailed-off attics.

The National Gas Code, as far back as the 1960's, prohibited single-wall metal flue pipes from originating in any unoccupied attic or concealed space and passing through any attic, inside wall or floor that is concealed.

The Code cites the use of double-wall metal pipe for flue construction. That pipe has an inside pipe constructed of aluminum to prevent corrosion, and an outside pipe constructed of steel for strength.

Our firm has investigated two matters involving the use of single-wall vent pipes that were installed in concealed spaces. Those pipes had corroded and separated, resulting in CO entering the living spaces and killing the inhabitants. (continued on back page)

Quote Box

"The difference between what the most and the least learned people know is inexpressibly trivial in relation to that which is unknown."

..... Albert Einstein

Carbon Monoxide, an in-the-home killer (continued from page three)

CO Detectors

An excellent prevention tool is a CO detector, preferably installed in a hallway near the bedrooms. In the past, these detectors were prone to setting off false alarms.

Today's detectors meet current Underwriters Laboratory Standard, UL 2034, and are designed to sound an alarm only when detecting dangerous concentrations of CO.

A CO detector will assist in providing an advanced warning

before very dangerous CO concentrations are incurred. Their cost is usually less than \$50.

Summarizing

CO is a very deadly gas. Breathing air containing just over one percent CO causes almost immediate unconsciousness and death within minutes.

To prevent CO poisoning in your home involving your home's fuel heating equipment, annual checks need to be conducted. Such checks should include, for example, the

furnace, space heater, water heater, fireplace, wood stove, etc. and are recommended before the beginning of the winter heating season.

Also, these checks need to ensure the flue pipes are tight and not corroded, and the chimney is clear of any debris.

Also, if you do not have a CO detector in your home, please install one as soon as possible. □



Russell Fote, P.E.,
C.S.P., C.F.E.I.
Expert Safety Engineer

For Expert Testimony, Talk to an Expert

Russell Fote & Associates has over 30 years of safety engineering experience. The firm's field of expertise includes: **fires, explosions, carbon monoxide, scalds, flammable liquids/gases, water heaters, appliances, furnaces, slips/falls and motor vehicle collisions.**

- Investigations & Reconstructions
- Hazard Analysis & Evaluations
- Depositions & Trial Testimony

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Talk to an Expert**



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