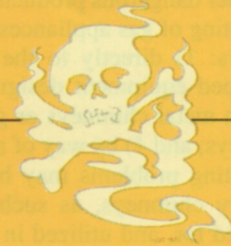


# CARBON MONOXIDE — THE SILENT KILLER

## Prevention of Incidents Through Enforcement Of Applicable Code Provisions

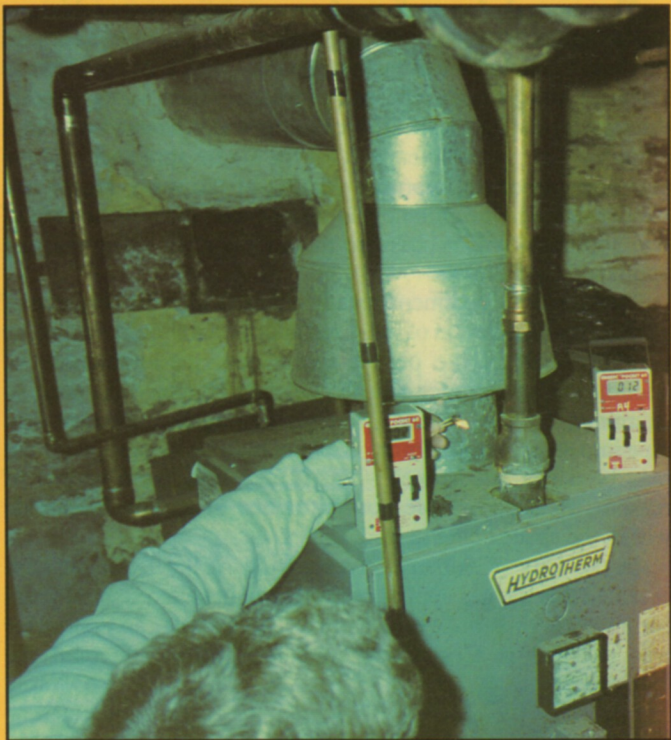


By Michael D. Haydock, CBO  
Building Commissioner, City of Albany, New York

Improper connection of heating devices to an existing chimney, and/or inadequate maintenance of the chimney, can lead to fatal exposure to carbon monoxide.

The author relates an incident that occurred recently in Albany, New York.

**BETSEY BELANGER** had come to the City of Albany, New York, from Long Island to share the joys of the Thanksgiving holiday with her family. Shortly after midnight on the day after Thanksgiving, Belanger was declared dead on arrival at Albany Medical Center Hospital (AMCH), a victim of a most insidious killer — carbon monoxide. Belanger was one of more than 3,800 individuals who die of carbon monoxide poisoning in the United States each year. Additionally, at least 10,000 others sustain injuries from this cause, as did three other victims in the Albany Thanksgiving incident. They were treated at AMCH and transferred to Bronx Municipal Hospital, where a hyperbaric chamber was available for removal of high levels of carbon monoxide from their blood.



Personnel of Niagara Mohawk Gas Corp. reigniting the boiler during investigation after a fatality. The CO meter placed on top of the heating unit read dangerous levels of CO within 10 seconds of re-ignition. (Photo courtesy of the City of Albany Building Dept.)

### What Is This Silent Killer?

Carbon monoxide (CO) is a poisonous gas that is colorless, tasteless and odorless. At low concentrations, its effects resemble other, more common, ailments such as flu, a cold, drowsiness or even mild depression. Diagnosis of carbon monoxide poisoning is often delayed or even missed because of this fact.

The effects of carbon monoxide poisoning may also result in subtle damage to the brain, heart, and other organs and tissues. Oxygen, which is necessary for survival, is transported from the lungs to all of the body's organs via the bloodstream. It is carried in the blood protein hemoglobin and, unfortunately, the blood hemoglobin has a greater chemical affinity for carbon monoxide than for oxygen. In other words, given exposure to carbon monoxide and oxygen, the hemoglobin will prefer to "pick up" the carbon monoxide and *not* the oxygen, thereby inhibiting the ability of the blood to carry oxygen. As the oxygen is prevented from reaching the necessary organs and tissues, the end result is asphyxiation from carbon monoxide (see Table).

Among the most common sources of carbon monoxide to which human beings are exposed are heating apparatus burning fossil fuels, as all combustion in any such devices is incomplete and carbon monoxide is a by-product. The installation of heating apparatus is regulated by building and related codes, and proper installation and maintenance of such equipment will prevent unnecessary exposure of the users to carbon monoxide. In Belanger's case, the cause of the carbon monoxide accumulation was traced to a chimney that served a water heater and a furnace. The chimney had become blocked with debris flaking from its interior. Evidence from the scene indicated that the chimney had neither been recently cleaned nor checked.

### Code Requirements

Sound regulatory practice requires code enforcement agencies to ensure that heating apparatus installation takes place in accordance with code requirements.

The *BOCA National Mechanical Code* covers the entire range of such installations, including the gas piping or other fuel system design and installation, equipment installation, and devoting considerable attention to the proper venting of such equipment — an essential to the conveying of carbon monoxide

(Continued on next page)

## THE SILENT KILLER

(Continued from preceding page)

and other dangerous products of combustion to the outside air.

Venting of gas appliances can be accomplished in a number of ways: 1) directly to the outside, in the case of recently developed equipment designed to operate in this manner; 2) through metal chimneys or gas vents; 3) through factory-built chimneys; and 4) by way of masonry chimneys.

Venting problems may be more readily encountered with masonry chimneys, as such chimneys were often originally designed for, and utilized in connection with, devices burning fuels other than gas. These other fuels burn with characteristics significantly different from gas. For example, exhaust gas temperatures may have been higher with earlier fuels, or the volume of exhaust gas produced would have been different. Another venting problem is that earlier exhaust gases may have contained products of combustion which have been deposited on the interior of the chimney and which may react with compounds present in the gases vented from a gas-burning appliance.

It is well-documented that the installation of a gas-burning appliance vented into an existing masonry chimney can lead to spalling of the interior of the chimney and a dislodgement of carbon deposits and masonry materials, which then fall to the



A view of a vent from a recently installed gas-fired furnace with the pre-existing cleanout open and soot and debris visible in the base of the chimney. (Photo courtesy of the City of Albany Building Dept.)

base of the chimney and accumulate there. Such accumulations can ultimately block the venting system, resulting in release of carbon monoxide within the area being heated. This scenario accounts for many of the nearly 4,000 fatalities that occur each year from carbon monoxide poisoning.

The *BOCA National Mechanical Code* requires the installation of a cleanout with a tight-fitting cover a minimum of 12 inches below the lowest inlet, in order to provide a sump for the collection of debris, and to provide homeowners and appliance service personnel with a means to inspect for and remove such debris before a potentially fatal circumstance occurs.

In addition to this particular phenomenon, an existing chimney may have suffered damage of one kind or another in the past, rendering it incapable of being a safe vent for a new gas appliance.

The accompanying figure from the *National Fuel Gas Code Handbook* contains a useful diagram illustrating the most commonly encountered chimney problems, the means of identifying them, and the recommended remedies. With respect to utilization of existing chimneys for the venting of new gas appliances, all existing chimneys must: 1) be examined for cracks, deterioration or other defects, and any identified defects be repaired; 2) be of the proper size to accommodate the exhaust gases from the new appliance; or 3) be relined with a properly sized liner.

Another potential problem is the use of existing chimneys to vent higher-efficiency gas-fired appliances. Such appliances produce lower temperature flue gases with less dilution air than would be introduced with draft-hood-equipped appliances. These operating characteristics can cause moisture vapor (a large component of flue gases) to condense on the interior walls of the chimney. The moisture is acidic and greatly accelerates the deterioration of chimney liners and mortar joints. To avoid chimney condensation problems, the appliance manufacturer's installation instructions must be strictly adhered to. In many instances, the chimney will need to be relined or used as a chase to allow the installation of a special vent pipe.

The removal of an appliance from an existing vent or chimney can also cause a serious venting problem. For example, a furnace that was vented into a common chimney with a water heater is replaced with a high-efficiency furnace which vents directly through an outside wall. The existing water heater vents to a chimney that is now oversized for the single appliance and the situation can cause improper venting of the water heater and condensation in the chimney. In many cases, the replacement of one appliance will necessitate the alteration of other existing appliance installations.

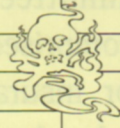
Each code enforcement agency charged with the issuance of permits for installation of gas-fired appliances should require, as a routine part of the permit application, the submission of documentation showing that the existing chimney has been so examined, sized or relined. Merely plugging the appliance vent pipe into an existing chimney may not only be inappropriate but may be dangerous as well — as it may lead, for a variety of reasons, to unacceptable concentrations of carbon monoxide within the space being heated.

In the City of Albany, investigation of the Belanger case revealed that the gas appliances had been installed several years earlier without benefit of a permit. The installation contractor was charged in City Court, pleaded guilty, and paid the maximum fine. ■

**Editor's Note:** The Commentary to the *BOCA National Mechanical Code/1993*, to be published later this year, will contain an extensive discussion of the installation of new gas-burning appliances with existing chimneys.

**TABLE**  
**Carbon Monoxide Levels and Symptoms**

SYMPTOM	CO CONCENTRATION Percentage of Hemoglobin Carrying Carbon Monoxide
Usually no sign	0 to 10
Headache, angina in heart patients	10 to 20
Throbbing headache, nausea, irritability, difficulty concentrating	20 to 30
Severe headache, dizziness, fatigue, confusion	30 to 40
Rapid breathing and heartbeat, fainting	40 to 50
Respiratory failure (collapse), seizures (collapse)	50 to 60
Severe respiratory failure, low blood pressure, fatal coma	60 to 70
Rapidly fatal coma	Above 70



**FIGURE**  
**Some Common Chimney Troubles — How to Detect and Remedy Them**

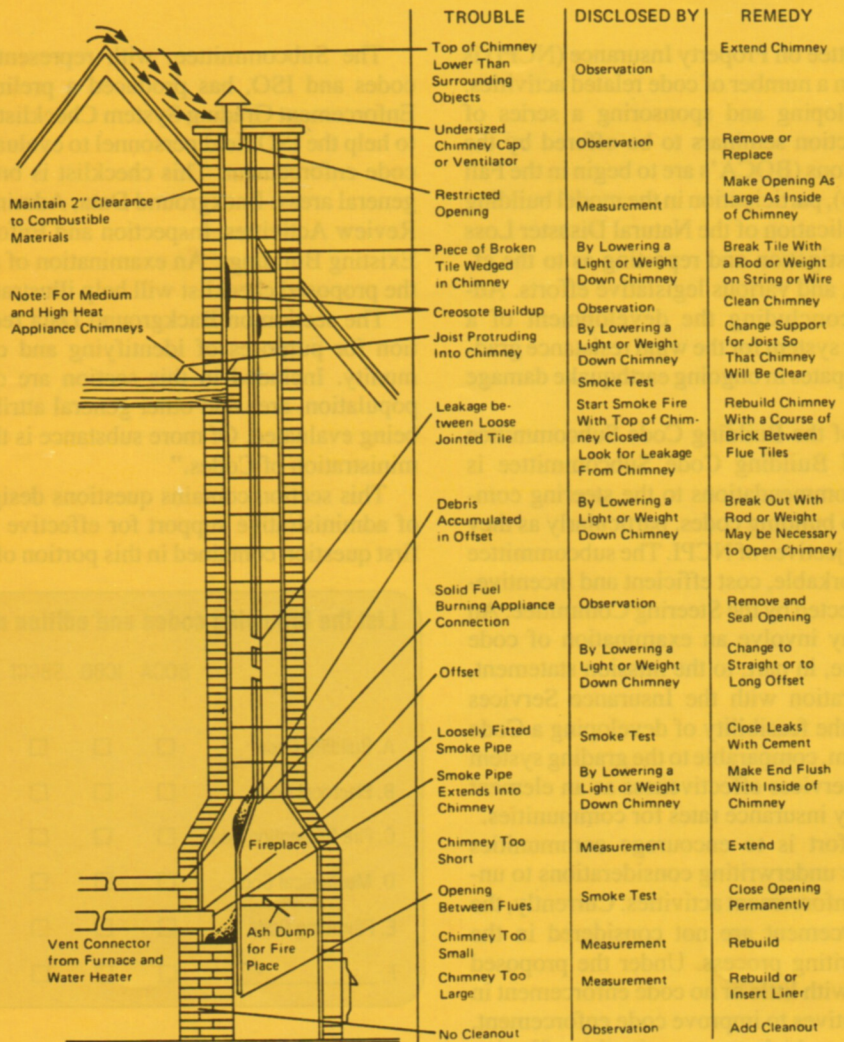


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