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buildup. (There should be a portable air scrubber in use for this level of mold clean-up anyway.)

- The dry ice granules must hit any surface to be cleaned. They are not like a mist that penetrates around corners and into tiny cracks. However, this "line of sight" process is still far superior to sanding or grinding at cleaning not only open surfaces but also cracks and crevices.
- Dry ice cleaning can also be used on any of the equipment such as portable air scrubbers, fans or the dry ice cleaning unit itself before the equipment is moved to another job.
- Finally, compared to sanding or grinding, dry ice cleaning does a much better job in much less time. Less cleaning time and more thorough cleaning quickly translates to a better bottom line.

This technology seems very promising for extensive mold clean-up of structural surfaces. For more information:

- Wickens Industrial Limited at www.wickens.com
- RSG-Technologies at www.rsg-technologies.com
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Carbon Monoxide "A Clear and Present Danger"



George Kerr, CO-Experts, at Affordable Comfort 2005

At the 2005 Affordable Comfort Conference held in Indianapolis in May, Bob Dwyer, the Director of the Bacharach Inc. Institute of Technical Training, delivered an evening session on carbon monoxide (CO) safety.

Thomas Greiner of Iowa State University, who attended the session, conducted a small study of emergency room visitors in Iowa and found that 5.7% of them suffered from CO poisoning. Checking for CO poisoning using a simple breath monitor is not a common emergency room practice. In a UK study, 77 confirmed cases of CO poisoning were studied in depth. The 77 cases included

12 where those exposed became unconscious and 65 where symptoms were severe but did not cause loss of consciousness (termed "chronic cases"). Two thirds of those who suffered chronic exposure were women, most commonly between 30-45 years of age. The average length of exposure for the chronic cases was four years. Around 70% of cases occurred in houses, 20% in apartments and 10% at work. Less than 10% of the incidents were discovered through regular combustion appliance servicing.

In North America, automobile

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exhaust is thought to be the number one cause of accidental CO poisoning and is reported as the reason for 60% of carbon monoxide alarm responses. Concern about warming up cars in attached garages is apparently well-founded. Unvented gas or oil appliances (more common in the US than in Canada) or poorly installed, maintained or operated gas and oil appliances are the second leading causes and are responsible for about 20% of CO alarm responses. Backdrafting of vented natural draft combustion appliances is third at 19% of responses. Cracked heat exchangers are a distant fourth at less than 1% of CO alarm responses. Although cracked heat exchangers are often targeted as a concern by the HVAC industry, the statistics show that this is not a frequent problem.

Although there are definitely regional differences in the use of unvented combustion appliances and awareness of combustion safety across North America, there is strong evidence to suggest that the symptoms of carbon monoxide poisoning are often either undiagnosed completely or are confused with influenza or other health problems. Adults exposed to low levels of CO may complain

of headaches, memory loss, muscular pain, fatigue and dizziness. The very young, the very old and those with pre-existing health conditions may be more likely to suffer ill effects from exposure to low concentrations of CO over long periods. They may experience symptoms similar to those who have been exposed to higher concentrations for brief periods.

It is also not widely recognized that CO poisoning can have permanent, long-term effects including memory loss, constant pain and fatigue. Over 70% of both the "chronic" and "unconscious" groups in the UK study continued to suffer neck, back and deep muscle pain long after the CO exposure ceased. Over 45% of the members of the "chronic" group were still unable to work 4 years after exposure ceased. 75% of the members of the "unconscious" group were unable to work at the time of the survey, which was done 2 1/2 years after exposure ceased.

How much carbon monoxide is too much? ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers) states that 9 PPM (parts per million) should be the maximum allowable concentration in ventilation air for continuous (24 hour) exposure. This is related to the US EPA

(Environmental Protection Agency) outdoor ambient air quality goal of 9 PPM averaged over 8 hours. Outdoor air in urban areas often exceeds this goal due to automobile exhaust. Most local authorities having jurisdiction in the US specify 9 PPM or more in buildings above what is measured outside as the most common action level at which further testing is specified.

Health Canada states that the acceptable short-term exposure ranges for carbon monoxide in residential indoor air are not more than 11 PPM for an eight hour average concentration and 25 PPM for a one hour average concentration. Health Canada reports that typical outdoor urban levels are 1-10 PPM although levels of 50 PPM have been measured. Indoor levels usually follow outdoor levels except in houses where there are unvented or poorly vented combustion appliances or tobacco smoking. CO levels of 100 PPM have been found in some kitchens immediately after use of gas stoves for cooking.

BPI (Building Performance Institute) advises that 10-35 PPM is the level at which occupants should be informed of potential problems, especially for the very young, very old

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and persons suffering from respiratory or heart problems. BPI considers this level “unacceptable” when caused by vented combustion appliances, a reason to document CO in any attached garages and “normal” where unvented appliances are in use (which seems to be an unfortunate definition of “normal”). BPI advises that 36-99 PPM is excessive and conditions must be mitigated. BPI further advises that a level of 100-200 PPM of CO is dangerous and medical attention is required. Anyone discovering levels in this range should not be exposed for more than 15 minutes. Over 200 PPM is extremely dangerous and is universally accepted as an evacuation action level.

The EPA ambient air quality goal averaged over one hour is set at 35 PPM. Most occupational health and safety legislation in the US and Canada has the goal of not more than 35 PPM averaged over an 8 hour workday. The US OSHA (Occupational Health and Safety Administration) has set 50 PPM as the maximum allowable concentration averaged over 8 hours.

Underwriters Laboratories (UL) 2034 is the accepted standard for home carbon monoxide alarms referenced in

the US and by CSA in Canada. A concentration of 30 PPM present for at least 30 days is the minimum concentration for UL listed alarms to sound, although UL recognizes that people of vulnerable health may require alarms that trigger at lower CO concentrations. A concentration of 70 PPM is required for UL 2034-98 listed alarms to sound when that concentration is present for no more than 4 hours or as early as one hour. A concentration of 150 PPM is required for UL 2034-98 alarms to sound if that concentration is present for no more than 50 minutes or as early as 10 minutes. A concentration of 400 PPM is required for UL 2034-98 alarms to sound if concentration is present for no more than 15 minutes or as early as 4 minutes.

The 1992 UL 2034 listing requirements for home CO alarms were changed in 1995 and in 1998. One of the major reasons for changes was to minimize false alarms. However, the listing requirements can now be met with an alarm that does not sound until exposure to a concentration of 70 PPM for up to 4 hours, exposure to a concentration up to 150 PPM for up to 50 minutes or exposure to a concentration up to 400 PPM for up to 15 minutes. These listing requirements are hopefully stringent enough to

protect occupants in a life and death situation. They are not stringent enough to protect long-term health, particularly of those most vulnerable.

Compared to no CO alarm at all, a UL 2034-98 listed CO alarm is certainly a wise investment in any home, particularly one with combustion appliances or an attached garage. However, there is an alternative: the low level carbon monoxide “health” monitor available from CO-Experts. The CO-Experts alarm/detector displays constant readings from 10 PPM to 70 PPM to “HI”. It can also display the peak reading since last reset, the duration of that peak and elapsed time since that peak occurred. It provides a visual warning at 10 PPM, an audible and visual warning at 25 PPM and more intense warnings at 35 PPM, 50 PPM and 70 PPM. Suggested responses for each level are provided in the product literature.

There are some preventative measures that can be taken to minimize exposure to CO at home. Avoid tobacco smoking in the house. Choose not to live on busy streets or near large highways. Open garage doors before starting vehicles and drive the car out of the garage immediately. Never operate any

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barbecue grills, kerosene space heaters or gasoline powered tools inside the garage or house. Have combustion appliances serviced regularly, including a check of chimneys and vents.

Although inspectors or home performance professionals often recommend regular appliance service, not all service visits identify the real problems related to CO. Bob Dwyer recommends that the heating contractor be asked to do something specific related to the nameplate specifications on the combustion appliance, not just be asked to “tune it up”. Visual flame inspection is very unreliable. Properly conducted tests are required. In the Bacharach manual “Carbon Monoxide: A Clear and Present Danger”, there are test protocols and sample inspection reports available.

Finally, as a part of good work safety practice, weatherization programs in the US who send many home performance inspectors into a large number of houses annually are looking at equipping every crew with personal CO alarms. Checking CO with a reliable, calibrated instrument may soon become an automatic first step for any housing professional visiting any house.

Sources:

Canada Mortgage and Housing Corporation. “Carbon Monoxide”, About Your House fact sheet CE 25 available at www.cmhc-schl.gc.ca.

CO-Experts. “Low-Level Carbon Monoxide “Health” Monitor”, product literature, link available from IAQRC directory.

ESCO Press. *Carbon Monoxide: A Clear and Present Danger*, available through Bacharach Inc, 2003.

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Infrared Thermography: The Trend at Affordable Comfort 2005

Last year at the Affordable Comfort Conference, it was clear that crawl space problems were big business. That has not changed. Trainers like John Tooley are still crossing the United States preaching the benefits of properly closed crawl spaces over vented crawl spaces. Building research and

resource organizations such as Advanced Energy from North Carolina are delivering the same message. Basement Systems Incorporated continues to expand their franchise network – fixing wet crawl spaces and basements using their patented products and application systems.

At this year’s Affordable Comfort Conference in Indianapolis, the most noticeable industry trend was the increasing use of infrared thermography to test building envelope systems. There were several booths in the trade show offering infrared cameras or thermography training. Several seminars featured the use of thermography to locate conduction heat loss, air leakage and moisture intrusion. Many other seminars mentioned the use of thermography. Since many of the weatherization programs are large and publicly funded to some extent, they are able to invest in infrared cameras. One session by John Snell of Snell Infrared in Vermont was entitled “Using & Interpreting Infrared”. A show of hands indicated that over half the audience used thermography regularly.

How does thermography work? Any surface radiates invisible heat energy. Feeling

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