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Standard Practice for Investigation of Investigating Carbon Monoxide Poisoning Incidents¹

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1. Scope

1.1 This practice covers guidelines for collecting and preserving information and physical evidence related to incidents involving the poisoning of individuals by carbon monoxide.

1.2 This practice is not intended to be a guide for investigating carbon monoxide poisoning caused by hostile fires, or contamination in closed air systems. Guidance on the investigation of carbon monoxide poisonings related to fire can be found in NFPA 921, *Guide for Fire and Explosion Investigations*.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

E678 Practice for Evaluation of Scientific or Technical Data

E860 Practice for Examining And Preparing Items That Are Or May Become Involved In Criminal or Civil Litigation

E1020 Practice for Reporting Incidents that May Involve Criminal or Civil Litigation

2.2 NFPA Standards:

NFPA 54 National Fuel Gas Code³

NFPA 921 Guide for Fire and Explosion Investigations³

3. Significance and Use

3.1 Carbon monoxide poisoning is responsible for approximately 300 deaths annually in the U.S., (excluding fire deaths)

¹ This practice is under the jurisdiction of ASTM Committee E58 on Forensic Engineering and is the direct responsibility of Subcommittee E58.05 on Industrial Processes.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, <http://www.nfpa.org>.

and carbon monoxide poisoning causes thousands of individuals to seek medical attention.

3.2 This practice is intended for use by individuals who investigate incidents involving carbon monoxide poisoning. If this procedure is followed, the cause for the carbon monoxide poisoning incident may be determined, and steps can be taken to prevent future incidents.

4. Equipment

4.1 *Electronic Carbon Monoxide Monitor*—A properly calibrated direct reading electronic monitor having a range of 0 to 1000 ppm is useful in that its output provides almost instantaneous concentration data, and it therefore has the capability to warn the investigator if carbon monoxide levels are reaching dangerous concentrations.

4.2 *Reagent Tube Indicator*—Several types of reagent tube indicators are available for measuring carbon monoxide, carbon dioxide, and fuel gases. Reagent tubes capable of responding to concentrations of 0 to 100 ppm, 0 to 1000 ppm, and 0 to 1 % carbon monoxide in air are recommended.

4.3 *Ventilation Equipment*—A fan or similar device should be available to allow flushing the air space around equipment between tests.

4.4 All equipment shall be calibrated at least annually.

5. Safety

5.1 Testing equipment suspected of causing carbon monoxide poisoning can yield definitive results that cannot be obtained any other way. Testing equipment that may have injured individuals; however, is a potentially dangerous undertaking, in that the investigator runs the risk of becoming exposed to carbon monoxide being produced by improperly functioning equipment.

5.2 Safe testing procedures are of the utmost importance. Before any testing is planned, a safety officer shall be identified. The safety officer's responsibilities shall be to protect the safety and health of the investigator and any individuals who may be affected by the testing.

5.3 Stable communications should be assured between the site and emergency service providers.

5.4 Until its safe operation has been verified, only one person at a time should be allowed into any space where a piece of equipment is being tested for carbon monoxide output. That person should remain within sight of the safety officer or another individual capable of rescuing that individual from the space.

5.5 All testing shall be discussed in detail with all individuals involved in the testing, prior to the beginning of any test.

6. Procedure

6.1 *Scene Security*—the first priority is to evacuate the scene and prevent further injuries or loss of life.

6.1.1 After evacuation, the scene should be secured, and if possible, a field measurement of carbon monoxide levels in various locations around the scene should be taken.

6.1.2 The fuel supply to the scene should be turned off. This may require the switching off of internal combustion engines, or the closing of valves for gaseous or liquid fuels.

6.2 *Documentary Information*—collect information related to the poisoning event, including emergency phone line recordings, and medical records, particularly those that describe the blood gas analysis of the victims. Obtain statements as early as feasible from all individuals associated with the incident.

6.3 Identify all fuel-burning equipment in the site.

6.3.1 A partial list of equipment that might be a potential source of carbon monoxide includes gas appliances (furnaces, ranges, ovens, water heaters, and clothes dryers), fireplaces, wood and coal stoves, space heaters, charcoal grills, camp stoves, automobiles, gas-powered lawnmowers, and gas powered tools.

6.4 Once all of the fuel-burning equipment has been identified, establish and document the condition of the valves and/or switches on each piece of equipment at the time of the incident.

6.5 Determine the source of fuel, air, and ventilation of each piece of equipment.

6.5.1 Determine whether any of the equipment is located in an enclosure that can be defined as a “confined space.”

6.5.1.1 Confined spaces are defined in NFPA 54 as, “a space whose volume is less than fifty cubic feet per 1000 btu per hour (4.8 m³ per kW) of the aggregate input of all appliances installed in that space.”

6.5.2 Determine whether the equipment has an adequate supply of air for combustion and ventilation as specified in NFPA 54, chapter 5.

6.5.3 Determine whether the equipment, if venting is required, is vented to safely carry the products of combustion outside, as required by NFPA 54, chapter 7.

6.5.4 Determine whether any temporary obstructions of the equipment ventilation, including obstructions of the return air vents have been moved.

6.6 *Planning the Test*—Develop a plan for safely testing the potential sources of carbon monoxide in the scene. In most cases, this planning will involve preparation of a written protocol for tests to be carried out. Refer to Practice E678 in planning any tests.

6.6.1 This plan will typically include the turning on of equipment and observing its performance using the carbon monoxide monitoring devices described in Section 5.

6.6.2 Identify the individuals who will be conducting the tests, including the safety officer.

6.6.3 Identify any individuals who may have an interest in the outcome of the testing.

6.6.3.1 Such individuals may include the property owner, representatives of the victim(s), equipment manufacturers, equipment service personnel, law enforcement officers, code enforcement officers, and the insurance carrier for any of the parties listed above.

6.7 Notify individuals who have been identified as possibly having an interest in the testing of the time that the tests are going to take place. For additional guidance on notification, see Practice E860.

6.7.1 Keep a record of individuals who have been notified of the proposed testing.

6.7.2 Notification of other interested parties may not be necessary if the investigation is going to be limited to observations that do not change the condition of any of the structures or equipment.

6.8 Operate each piece of equipment that has been identified as a potential source of carbon monoxide in the manner in which it is designed to be operated, and, using the equipment described in Section 5, measure the carbon monoxide output, if any.

6.8.1 Attempt to reconstruct temporary obstructions to the return air or combustion air vents or to the flues or chimneys.

6.8.2 If abnormal operation of any piece of equipment is suspected, operate that equipment in the abnormal fashion, if possible, changing only one operating parameter at a time, and record the results.

6.8.3 Operate equipment or appliances in combination, only if the combination of equipment is suspected of contributing to the cause of the carbon monoxide buildup.

7. Collection of Physical Evidence

7.1 Once all parties to the investigation are satisfied that sufficient testing has been accomplished, items of physical evidence pertinent to the conclusions may be secured.

7.2 Label according to Practice E1859.

7.3 Frequently, the device that is identified as having produced the carbon monoxide can be restored to a safe operating condition, and left in place after the condition that led to the poisoning event has been sufficiently documented.

8. Report

8.1 The investigative report should include the following information.

8.1.1 Location, date and time of the incident.

8.1.2 Extent of the victim’s injuries, including carboxyhemoglobin (COHb) level in the victim’s blood.

8.1.3 Identification of the source of the carbon monoxide.

8.1.4 Identification of conditions that caused the source of the carbon monoxide to produce the carbon monoxide.