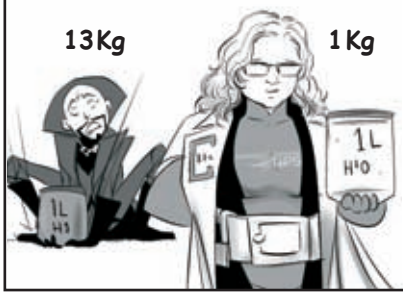
Dr Christina Baxter, of EmergencyResponseTIPS.com and Hazard3.com, offers helpful advice for first responders

Keeping you safe!

The column is intended to provide operational guidance to the hazmat/CBRNE community regarding the selection and performance of equipment and tactics. This time around, we are focussing on mercury spills as there have been several recent incidents where mercury was recovered during clandestine explosives and drug laboratory operations.

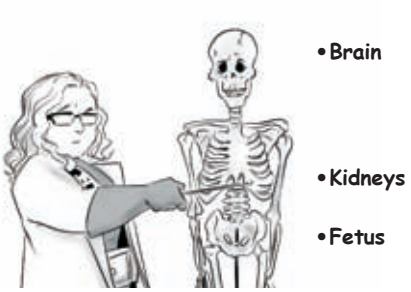
Most of the mercury used in commercial operations is required to produce chlorine and caustic soda, electric equipment, thermometers, thermostats, dental amalgams, fluorescent lights and more. Mercury is also used in the production of mercury fulminate, a primary explosive which is sensitive to friction, heat, and shock, and which is often used in illicit detonators. Additionally, it is required to produce stimulants including a variety of amphetamines and cocaine as well as in illicit gold mining.



Physical properties

Elemental mercury, or quick silver, is a white-to-silver liquid with a vapour that is much heavier than air, so it accumulates close to the floor indoors and in low-lying areas outside. As the temperature increases, the amount of mercury in the air also increases. A 3mm drop of mercury with a mass of 0.2g would last three years indoors. Mercury spreads easily like water but is 13 times denser; 1millilitre of water weighs 1g while 1millilitre of mercury weighs 13g. When spilt, mercury can be expected to splash and 'roll' long distances. It is corrosive and will attack metals like aluminium. Water floats on mercury and can be used to prevent vapour generation.

Toxicology



Mercury exposure can occur via inhalation, ingestion, or dermal exposure, however mercury vapour poses the greatest risk to human health via inhalation. The OSHA (USA) permissible exposure limit (PEL) for mercury is 0.1mg/m3 and the immediately dangerous to life and health (IDLH) level is 10mg/m3. In addition, the OSHA limits exposure to metallic mercury vapour to 0.05mg/m3 for eight hour work shifts and 40 hour work weeks; the American Conference of Governmental Industrial Hygienists (ACGIH) recommends a lower value of 0.025mg/m3. Note that these levels are an order of magnitude below the IDLH levels as they are focusing on continuous exposure to mercury vapour. Chronic mercury exposure can permanently damage the brain, kidneys, and developing foetuses.

Response considerations

First, establish the areas of concern, including spill points, etc. Control zones often use the standard approach of occupational exposure standards and IDLH values for hot, warm, and cold zone demarcations. A more conservative approach following the US Agency for Toxic Substances and Disease Registry (ATSDR) guidance levels may be adopted when dealing with sensitive populations like children and elderly people with the cold zone being less than 0.001mg/m3, the warm zone being between 0.001 and 0.010mg/m3, and the hot zone being greater than 0.010mg/m3. While this is a very conservative approach, it takes into consideration the evolving changes in mercury exposure guidance.

Detection

Mercury vapour detection in field operations is generally performed using colorimetric tubes, gold film sensor technology, cold vapour atomic absorption spectrometry, or fluorescence spectroscopy. As with all detection technologies, each has its pros and cons. Colorimetric tubes tend to be lowest in cost but are subject to cross-sensitivities, long collection times, and limits of detection are often higher than occupational exposure standards. Gold film sensor technology-based instruments tend to have fast start up times but there are significant issues with changes in temperature and humidity as well as ammonia and sulphur interferences. The newer cold vapour atomic absorption spectrometry and fluorescence spectroscopy instruments can manage wider temperature and humidity ranges and have little interference from ammonia or sulphur; however, both types of instruments tend to lose their accuracy at high temperature and humidity extremes.

Protection

Respiratory protection should be used when mercury is observed or when mercury vapour levels are detected at or above 0.025mg/m3 based upon the American Conference of Governmental Industrial Hygienists (ACGIH) recommendation unless a lower level is recommended by your local jurisdiction. In most cases, a combination mercury vapour and particulate cartridge is recommended in an air-purifying respirator configuration, otherwise adopt SCBA. Direct skin contact should also be avoided as mercury can be slowly absorbed through the skin. Chemical protection clothing meeting NFPA 1994 Class 3, or its equivalent, is recommended.

Decontamination

Check individuals with a suitable detector if available to determine if they have been contaminated and the extent of contamination. If there is evidence of contamination, remove the affected clothing and footwear. Obvious contamination can be removed from skin by gentle blotting. This should be followed by gently washing the skin using warm water and a non abrasive soap; the rinse water should be contained to minimise the spread of mercury. The US EPA has successfully used sulfur-based dandruff shampoos to enhance decontamination of people and pets during the early stages of the response.

If eye contact occurs, be sure to flush the contaminated eyes with a continuous flow of warm water for at least five minutes. If SCBA is used, be sure to measure the cloth straps for potential mercury contamination following decontamination. Remember to always follow up decontamination with monitoring to ensure that levels have been reduced as low as reasonably achievable. For outdoor screening, remember that false negatives can occur with colder temperatures as the production of mercury vapour can be limited. In addition, measure with the probe no further than six inches (15cm) away from the person to minimise wind effects.

Clean up

Consider the basic principles – prevent further spread, contain the material and then clean it up. A flashlight will help to identify small droplets. Using a mercury detector during this phase is critical for identifying droplets so they can be captured. Commercial amalgam kits are the preferred method to bind the mercury. If amalgam powders are not available, consider suphur, dirt, or a clay absorbent to encapsulate the mercury, noting that this approach does not bind mercury to prevent vapour production. Pick up the absorbed material, double bag and dispose of as hazardous waste. In many instances, it will be more effective to cut out affected materials like carpet, and double bag. Be sure to never sweep up or vacuum a mercury spill unless using a mercury-specific vacuum. Mercury vacuums contain the appropriate adsorbents and filters to ensure that material is not further aerosolised. Finally, use detection to ensure that the contamination has been removed.

Images are courtesy of Phil Buckenham
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