Clearing up spills of metallic Mercury

1 INTRODUCTION:

The nature of the problem

Metallic Mercury can present a significant toxic challenge to those people who are exposed to it. Even though metallic mercury is relatively non-toxic if ingested (it normally passes through the digestive system, and little is absorbed), inhalation of mercury vapour poses the major hazard to health. The problem arises because of the vapour pressure of the liquid element at room temperature – significant amounts of toxic vapour are released into the atmosphere from even milligram quantities of metallic mercury, and this can have serious effects on the health of persons who may breathe in the vapour over a prolonged period of time.

Health effects include both acute and chronic effects. Acute effects are normally seen when exposures are high, and include kidney damage (produced when mercury is excreted from the body); lung damage (causing coughing, difficulties in breathing and pneumonitis) and central nervous system damage. Chronic exposure to significant quantities of mercury vapour can lead to dementia (e.g., as in the phrase “mad as a hatter”, dating from the time that mercury was used in the felting process for making hats.) In addition, chronic exposure can give rise to mercury deposits in the tissues (as oxidised and conjugated metabolites) which can take years to eliminate.

The vapour pressure of metallic mercury is low - approximately 0.002 mm Hg at 25°C, but increases with temperature. The saturated vapour concentration is 19 mg m⁻³ at 25°C, i.e., the maximum concentration of mercury vapour in air will be 19000 μg m⁻³ at 25°C [saturation]. At normal room temperature, therefore, spilt droplets of metallic mercury will slowly evaporate. A mercury-saturated atmosphere is however unlikely to be created in a ventilated room because of general ventilation removing mercury vapour, but this also has the effect of spreading around the contamination. However, if the room is poorly ventilated, or if the spill is large, there may be areas of the room adjacent to the site of the spill that approach saturation for mercury vapour.

The Health and Safety Executive (HSE) has approved an 8–hour (TWA) Occupational Exposure Standard (OES) of 25 μg per cubic metre for occupational exposure to the element.¹

Given that a 0.1 ml (100 μl) drop of mercury at 20°C weighs 1.36 g, if this were to evaporate, it would create a maximum vapour concentration of 19000 μg m⁻³ at 25°C [saturation]. For an average sized room, only 0.475 g (34μl) would need to evaporate to create a saturated atmosphere. As stated above, this is regarded as “unlikely”, but it should be noted that this concentration exceeds the OES by a factor of 760, and such a spill could locally give rise to exposures greatly in excess of the OES.

¹ The TWA (time-weighted average) OES is the amount of harmful substance that an average “fit” person could be exposed to, averaged out over an 8–hour working day, without suffering adverse effects to health.
Fortunately, because of the low vapour pressure, it would take several weeks for this amount of mercury to evaporate – but as a droplet of this size may not be easy to find (especially if the room has a wood-block floor, or wooden skirting boards not sealed to the floor) a mercury spill could give rise to chronic exposure over many years if it were not properly removed. **It is therefore imperative to clear up even the smallest spills of elemental mercury** – such as may be created by a broken mercury-in-glass thermometer.

It is recommended that all Areas that possess any equipment containing metallic mercury have a suitable clean-up kit, unless the equipment is unlikely to release mercury even when severely damaged. Thus any Area possessing mercury-in-glass thermometers should hold such a kit, and have staff trained in use of the kit. The Area should have a long-term aim of replacing such thermometers with mercury-free alternatives where possible.

Any event resulting in a spill of metallic mercury (thus requiring use of the clean-up procedure) should be recorded in the Area Safety Log-book and reported to Health & Safety Services as a “near miss”.

2 **CLEAN-UP PROCEDURE** *(for small spills of metallic mercury)*

This procedure has been devised by reference to the many protocols available via the world-wide-web, distilling these protocols into one (by incorporating common elements), and discarding those which appear to be of dubious value. There are also many commercial mercury clean-up kits available, for example from Sigma Chemicals and from Fisher Scientific; such a commercial kit may be advisable for “non-technical” departments to hold in stock in case of need. (Note that mention here does not represent an endorsement of these particular commercial products.)

**Equipment required:**
- Plastic [disposable] jar in which to collect waste; NB – the size required will depend on the size of the spill and the quantity of waste to be collected.
- Appropriate personal protective equipment – lab coat; suitable gloves (e.g., disposable vinyl or nitryl); safety glasses; disposable overshoes if there is any possibility of contaminating your shoes during clean-up procedure. Suitable respiratory protective equipment (r.p.e.) may be necessary for larger spills, or where the clean-up procedure is likely to be prolonged because of the size of the area contaminated. (If required, r.p.e. should be a half-mask respirator fitted with a P2 filter containing activated carbon to absorb any mercury vapour. Ordinary “dust masks” are NOT SUITABLE.)
- **Clean-up kit** – see below

The clean-up kit should contain:
- A disposable plastic syringe or a Pasteur pipette with a rubber teat, for collecting mercury droplets, or an absorber sponge;
- A small paint brush to help collect small droplets of mercury together;
- Powdered or granulated zinc (to trap elemental mercury in the form of an amalgam).

**Notes:**
1: Some commercial kits used powdered zinc with the addition of approximately 5% w/v citric acid, to speed up the amalgamation of the mercury, and it is recommended that this practice be followed.
2: Powdered zinc should be handled very carefully, as it represents a fire hazard, and should not be used in the presence of naked flames, or in combination with elemental sulphur, as this can create an explosion risk.
A roll of paper towel and a source of water (required only when citric acid added to zinc.)
A dustpan (plastic) and brush, to collect used zinc;
A large screw-top [disposable] plastic jar, for holding contaminated items for disposal
A supply of “Chemical waste” and “Toxic” labels;
Several large plastic bags, for holding contaminated items such as the dustpan and brush until next used.

Health and Safety Services keep a suitable clean-up kit which can be loaned out to those Areas which may have only a very occasional need for one. To borrow this kit, call the Secretary on ext. 8888. The clean-up procedure should only be undertaken by persons experienced in the technique, and with access to a clean-up kit.

**Procedure**

1. Isolate the area in which the spill has occurred, and prevent entry, using suitable warning notices. Make sure that there is adequate ventilation by opening the window as wide as is consistent with maintaining security.

2. Because metallic mercury is a good conductor of electricity, it may be necessary to switch off adjacent electrical equipment – this would depend on the size and location of the spill.

3. Don suitable personal protective equipment, if not already using them (lab. coat; impervious gloves; eye protection. Check suitability before use.)

4. Using the small paint brush and the syringe or Pasteur pipette, collect together and remove all visible globules of mercury. Dispose of the syringe or pipette into the screw-top plastic jar.

5. Collect any pieces of broken glass using the dustpan + brush, and place into the screw-top plastic jar.

6. Sprinkle powdered zinc liberally over the area affected by the spill, and brush into cracks and crevices using the paint brush. Note precautions above. Cover with damp tissue.

7. Leave overnight for the amalgam to form. Lock the room, and place a warning notice on the door – “Danger – Mercury spill. Do not enter”.

8. The following morning, collect up all the tissue and zinc powder (which will at this stage incorporate the mercury in the form of a crystalline amalgam) using the dustpan + brush, and empty into the screw-top jar. **Do not use a vacuum cleaner**, as this could become contaminated by any unreacted mercury; in addition, unless the cleaner is fitted with HEPA filters, it could discharge mercury-contaminated material into the room atmosphere.

9. Label the jar as “Mercury-contaminated waste” (also applying a “toxic” pictogram label), and store in a safe place to await disposal via the next annual waste chemical disposal (organised by Health and Safety Services in August of each year.)

10. Health and Safety Services possess a sensitive electronic “mercury sniffer” which can be loaned out to suitably experienced personnel. Switch on and allow the instrument to stabilise, then zero the reading in an area well away from the spill before using it to check for residual mercury vapour. (Health & Safety Services personnel may be able to undertake this monitoring for you.)

11. If the reading is greater than 5 μg m⁻³, it may indicate residual metallic mercury is present. Such areas should be re-treated with more powdered zinc, and then left for a further 24 hours before repeating the clean-up and monitoring.
Some protocols advocate the use of elemental sulphur to indicate the presence of residual mercury (which reacts to form Mercuric Sulphide, which shows up as a blackened area against the yellow sulphur.) This procedure should not be used if powdered zinc has been used, because of the potential explosion risk; in addition, it should not be necessary if the “sniffer” is used, as the instrument is sufficiently sensitive to detect even small amounts of mercury hidden in locations such as between floorboards or under skirting boards – when the sulphur would be of little use.

In the event that a second attempt at clean-up is not effective in removing all mercury contamination, it may be advisable to seal off the area if possible – for example, if mercury has apparently gone under floor boards or skirting boards, it would be better to seal any gaps with a suitable sealant (e.g., silicone rubber or acrylic) than to attempt to lift the boards to access residual spilt mercury.

Due to the difficulties in effectively decontaminating “soft furnishings” and carpets (etc), it is better to remove and dispose of contaminated items, rather than attempting to clean them. Contaminated areas should be cut out and bagged for disposal: appropriate labelling must be used, and the items stored as “chemical waste” to await disposal during the annual disposal. Note that this may require replacement of upholstery on chairs, etc.

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