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Mercury: Guidance on Safe Use and Management of Contamination in University Departments

Occupational Health and Safety Service
HSD037C (rev4)

UNIVERSITY OF CAMBRIDGE

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1. Introduction

Historically mercury has been used in many departments within the University. Latterly its use has been replaced by less toxic substances, processes and equipment. However traces of mercury can still be found in several buildings and laboratories because of earlier spillages, breakages, systems of work and methods of disposal.

The legacy of mercury contamination has both a potential human health cost and a potentially very considerable direct financial cost to the University.

As a general guide, any building with a history of scientific, medical or dental use up to the later 20th century should be regarded as a potential location of metallic mercury contamination.

The use of mercury thermometers or mercury containing equipment should be avoided unless it is the only viable scientific option. In the rare cases where its use can be scientifically justified, the mercury containing apparatus must be handled and stored under conditions to avoid breakage AND contain any loose / free mercury that could result from a breakage or spillage.

Equipment containing mercury has included arc lamps, vacuum pumps, switches, McLoed gauges, thermometers, barometers, hydrometers and fluorescent lamps etc.
It is also present as a trace contaminant in many other chemicals such as sodium hydroxide, hydrochloric acid etc…. and even some pharmaceuticals.

Mercury and all its compounds (inorganic and organic) are toxic to both humans and the environment. Their use should therefore be strictly controlled and limited to only those circumstances where a safer alternative chemical or piece of equipment is not available.

Many University sites are subject to very strict environmental controls with respect to what can and can not be present in their waste water (trade effluent consents). Therefore, **under absolutely no circumstances** should mercury or any of its compounds, be disposed of or otherwise be allowed to go down any drain (see Disposal of Chemical Waste Policy and Guidance: http://www.admin.cam.ac.uk/cam-only/offices/safety/publications/hsd018c/).

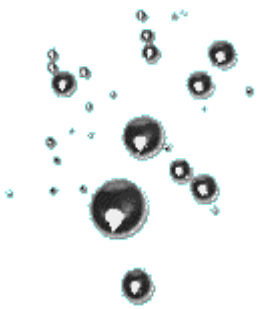
2. Metallic Mercury

Synonyms: quicksilver, colloidal mercury, liquid silver.

Molecular symbol: Hg Specific gravity 13.5

Metallic (elemental) mercury is a mobile silvery slightly volatile liquid at ordinary (room) temperatures, with the tendency to roll away and escape into cracks in floors, walls and equipment. Old wood block flooring is a highly likely location for mercury contamination. It can also be absorbed into the very fabric of the buildings such as plaster, brickwork, concrete and cement. Tests in highly contaminated buildings have shown mercury to be present in upholstery, curtains and uncoated timber products. Historically waste chemicals including mercury were disposed of via local sinks, and therefore drainage systems, sinks, traps and runs of waste pipe work can be particular hot spots of mercury contamination.

This guidance will focus on the issues relating to the management of liquid metallic (elemental) mercury in the University. The management of mercury containing compounds falls under the University Hazardous Chemicals guidance.



However, it MUST always be remembered that all mercury compounds are toxic. Some organic mercury compounds, such as DIMETHYLMERCURY and other organo-mercury compounds are EXTREMELY TOXIC and readily absorbed through the skin, the blood-brain barrier AND most types of laboratory gloves!

3. Potential Health Concerns of Metallic (Elemental) Mercury

Mercury metal is a potent neurotoxin and in low concentrations can damage the central nervous system, the kidneys, the liver and the developing fetus.

3.1 Mercury can be absorbed into the body:

- **As vapour it is readily absorbed via the respiratory tract if inhaled**.
- Absorbed via contact with the skin i.e. hands.
- Absorbed in the gastro-intestinal tract if swallowed.

3.2 Spilled and heated metallic mercury is an increased risk since mercury more readily vaporises into the air at temperatures above 25^{o}c.

3.3 Metallic Mercury has been assigned Risk phrases and since 2010 Hazard Statements in compliance with the Globally Harmonised System (GHS) of labelling and packaging.

H312/R21 – Harmful in contact with skin.

H302/R22 – Harmful if swallowed.

H331/R23 – Toxic by inhalation – the main risk from metallic mercury contamination in a building.

R33 – Danger of cumulative effects.

H400/H413/R 50/53 – Very toxic to aquatic organisms and long term aquatic toxin.

3.3.1 The Workplace Exposure Limit (WEL) for **inhalable metallic mercury vapour or airborne inorganic mercury compounds is 0.02 mg/m^3**, as a time weighted average (TWA) **over 8 hours** (see: HSE publication: EH40/2005 (as revised 2011, 2020), for use with the Control of Substances Hazardous to Health Regulations, COSHH, 2002).*

Since this is very low and difficult to detect without specialist monitoring (available from the University's Safety Office) the control measures identified in the risk assessment MUST be strictly observed.

It should also be noted that metallic mercury is corrosive and can have a dramatic effect on metals, especially aluminium, but also steel.

4. Legal requirements

A fundamental principle of Health and Safety is that a Risk Assessment must be completed and control measures put into place to eliminate or minimise the identified significant risks before any work is started. Where mercury is to be used or there is a possibility of mercury contamination this must include a COSHH assessment. In addition as a 'substance corrosive to metals' a Dangerous Substances Risk Assessment may also be required under DSEAR.

Additional guidance is provided by the University's

- Hazardous Substance Policy.
- Guide to Hazardous Substance Risk Assessment.
- Chemical Hazard Risk Assessment Form.
- Disposal of Chemical Waste Policy and Guidance.

See also section **7.5** below with respect to the Construction (Design and Management) Regulations (CDM Regs).

5. Managing the Use of Mercury

Departments are responsible for ensuring that, wherever reasonably practicable, the use of mercury in the University is phased out and avoided in the future.
The simplest way to achieve this is by the use of safer alternatives, i.e. alcohol or digital thermometers, aneroid barometers etc… thereby minimising personal exposure and preventing further accidental contamination.

However, it is recognised that there will be **rare occasions** in research where the unique properties of liquid metallic mercury make it the only practicable choice.

Whenever metallic Mercury is to be used its use **must** be justified by a **specific risk assessment** which should take into account not only the primary risk to health and safety of personnel, but secondarily the potential long term financial consequences of any spillage that results in contamination of the building or equipment.

Note: A simple broken mercury thermometer resulted in expensive University computer equipment having to be scrapped because of internal contamination that could not be decontaminated, but should have been avoided!

Following the risk assessment a specific safe working procedure should be developed for the use of **all** mercury, being especially rigorous for large or open liquid metallic mercury sources (don't heat open sources).

The safe working procedure must include detailed **emergency procedures to contain and control accidental spillages,** see below.

5.1 Working with Liquid Metallic Mercury

- Do not eat, drink, smoke, store food/drinks smoking materials or cosmetics where mercury is in use (Do NOT put mercury thermometers in any fridge especially one used to store food or drink!).
- Avoid skin and eye contact and **use appropriate PPE** including safety glasses, laboratory coat and gloves. Note: Disposable gloves tear easily and may contain 'pinholes', therefore they are **NOT suitable for immersion** in liquid metallic Mercury (or any other toxic liquid).
- Minimize the amount of mercury in use or in storage.
- **Always use secondary containment** to control potential spillages, pans and trays should have sides high enough to stop energetic droplets escaping over them. Note: vertical right angled sides are more effective than gentle slopes.
- Avoid working on surfaces with cracks, gaps or joints.
- Avoid working over porous surfaces such as wood, carpet or false floors.
- Avoid storing or using mercury near a sink and do NOT attempt to pour water off the top of mercury directly into a sink.
- **Do NOT heat an unsealed source of mercury** in an open environment under any circumstances.
- **Do NOT use mercury thermometers in ANY oven, hot box,** incubator, growth room or glasshouse; an accidental breakage could generate very significant toxic levels of mercury vapour in a hot / closed environment.
- **Wherever practicable work in a fume cupboard** and where not practicable then suitable and sufficient ventilation must be provided to ensure that the OES is not approached or exceeded.
- Check for spillage when work is finished and return the mercury to safe containment / storage.
- **Wash hands after working with 'open' mercury sources.**

5.2 Storage of Liquid Metallic Mercury

- Store in a cool place and if appropriate over-layer with water to contain vapour.
- Store in sealed, well labelled, strong impact resistant containers, of an appropriate size (not too big / heavy), capable of withstanding the weight and being handled safely.
- Use secondary containment; remember mercury is corrosive to many metals.
- Do NOT store with chemicals that can form explosive substances with mercury such as acetylene, ammonia, boron phosphodiiodide, chlorine dioxide, methyl azide and sodium carbide.

The above factors apply equally to waste mercury awaiting disposal.

Note: Mercury will corrode and weaken metals by amalgamation, especially aluminium (therefore it is particularly important that it is **not** carried on aircraft unless declared to the operator and suitably contained to their specification).

5.3 Liquid Mercury Spillage Cleanup

- **ALL metallic mercury spillages must be cleaned up immediately** by the person(s) responsible for it.
- The aim is to contain and seal the spillage as quickly as possible to minimise vapour release.
- Mercury can be cleaned up comparatively easily if it is contained and on a continuous (no cracks or joints) non-absorbent surface (see below).
- Restrict access to the area to prevent inadvertent spread and exposure.
- **Safely ventilate** the area i.e. open windows etc ….
- If mercury has been spilt on a hot surface, disconnect the heat source, safely ventilate the area if possible, evacuate the room and summon assistance.
- NEVER put Mercury down a drain.
- NEVER use a vacuum cleaner to clean up mercury as it will blow mercury into the air and also contaminate the cleaner, necessitating its disposal as hazardous waste!

- Never use an ordinary broom or brush to clean up mercury as it WILL break the mercury into smaller droplets, spreading them around and contaminating the broom or brush itself.
- If carpet, soft furnishings or clothing are contaminated they must be disposed off as hazardous waste (do NOT attempt to clean anything in a washing machine, thereby contaminating the inside of the machine).
- Report any mercury spillage to the person responsible for the area.

ALL work with mercury, including thermometers, should only be undertaken if an appropriate means of spillage control is immediately available i.e. a spill kit,

Either, one of a number of commercially available mercury spillage kits from suppliers such as Fisher, VWR, Jencons etc. OR a self assembled kit including items in the following list …….

Spill Kit Contents.

- A **robust plastic bottle** suitable for containing recovered mercury.
- A device to recover the bulk of liquid mercury such as **disposable plastic Pasteur pipettes**, disposable syringes (5, 10 or 25 ml), an eye dropper etc…. (but not an aspirator that could disperse the vapour).
- A **fine artists paint brush**, a small plastic scoop, or **piece of thin cardboard** to act as a scoop.
- Nitrile or neoprene **gloves** in different sizes.
- Zip-lock **plastic bags** to contain contaminated material.

- **Paper towels** or tissues.
- Disposable **fine sponge pad** or duct tape to pick up fine droplets.
- Plastic slip-on overshoe covers.
- Tweezers to safely retrieve sharps and small pieces of broken glass.
- Small torch with batteries.
- Marker pen.
- Commercially available mercury spillage absorbent cleanup paste or

Optionally: powdered sulphur / flowers of sulphur** and FFP3 dust mask***

Sulphur itself is toxic, however, it reacts with the mercury to yield **highly toxic mercuric sulphide, preventing the release of mercury vapour but creating a further decontamination problem.

***The simple FFP3 dust mask is for protection during the application of sulphur powder, **it does NOT provide any protection against mercury vapour** (see 7.2 below).

Cleanup Procedure for Small Spills:

1. Put on safety glasses, laboratory coat and appropriate gloves.

2. Do NOT kneel directly on a floor contaminated with mercury or stand directly in the contamination and when appropriate wear plastic slip-on overshoe covers.

3. Pick up any broken glass or sharps carefully, taking care so as not to disperse the mercury, placing the sharps on paper towel, then folding the towel so as to wrap up the sharps safely and place in labelled zip-lock bag for disposal as contaminated sharps.

4. Locate visible beads of mercury and recover by drawing them up with the Pasteur pipette, syringe or dropper and put the mercury in the labelled robust plastic bottle.

5. Use the fine artists paint brush, small plastic scoop, or a piece of cardboard to **gently** move small beads of mercury together with slow sweeping motions so that they coalesce and can be drawn up and placed in the waste bottle; as in 4. above. (The fine brush and/or the card will be hazardous waste and should be bagged for disposal).

6. A disposable fine sponge pad or duct tape can be used to ‘mop’ up fine droplets, before bagging them for disposal.

7. Use a torch to locate glistening beads of mercury in cracks and crevices or under furniture etc… (darken the room if necessary to aid the process).

8. Remember beads of dropped mercury break-up and can move great distances across hard flat surfaces, so check the entire floor / room.

9. A commercially available mercury spillage absorbent paste, or similar product, can be used to complete the cleanup, following the manufacturer’s instructions.

10. Alternatively, **if appropriate and if a safer alternative is not immediately available**, powdered sulphur can be gently, carefully and sparingly applied to a limited spill area (whilst wearing a face mask) to chemically bind very fine mercury deposits. However, the sulphur and mercuric sulphide mix is itself toxic and will require a careful clean up operation with dampened paper towels, before bagging for safe disposal.

11. Bag and label all waste for disposal via the University’s hazardous waste procedure (see OHSS web site) as mercury contaminated material.

12. Before removing gloves for disposal, check that they are intact, with particular reference to the finger tips (see below).

13. Thoroughly wash your hands when finished, ensuring that mercury has not become trapped under the fingernails. If the glove finger tips were damaged then carefully and thoroughly clean under the nails, but avoid aggressive scrubbing that might break the surface of the skin.

14. Continue to ventilate the room for at least 24hrs if practicable.

15. Depending on the scale of the spillage and your judgement of the recovery efficiency, consider asking the OHSS to carry out a survey of the area for residual mercury vapour.

16. Replenish the spill kit before further work with mercury is carried out.

17. Review the future use of mercury.

Clean up Procedure for Larger Spills:

Large uncontained spills of more than a few grams may require temporary evacuation of the immediate area whilst the spillage is removed and the use of specialised Respiratory Protective Equipment (RPE) for those carrying out the task. (i.e. a canister/cartridge face mask specifically designed to absorb mercury; consult with the Safety Office).

Large uncontained spills can be difficult to completely decontaminate and may require specialist services. Therefore it would be wise to arrange for the Safety Office to carry out mercury vapour monitoring of the area to confirm the effectiveness of the cleanup process.

6. Managing Mercury Contamination in an Occupied Building

A number of areas within the University are **known** to have historic metallic mercury contamination in the fabric of the building as a result of earlier spillages, breakages, systems of work and methods of disposal (i.e. in certain areas on the Downing and New Museums sites).

NB: If liquid metallic mercury is discovered it should be safely removed for disposal as per the guidance on mercury spillage in section 5. above.

The greatest risk to health and safety from metallic mercury contamination in a building is the **cumulative inhalation of the vapour in significant quantities**. Therefore it is important that the concentration of mercury vapour is regularly monitored and recorded in areas of **known contamination,** to both ensure the level remains well below the OES and to reassure those working in the area that it is so. This monitoring can usually be carried out by the OHSS.

Note: If low level contamination remains undisturbed within the fabric of the building, in a **cool and well ventilated** area, it is unlikely that the level of airborne mercury vapour in a person's breathing zone, either seated or standing, will exceed the OES (3.4).

However, if the routine monitoring reveals localised areas of unusually high mercury vapour concentrations at or above the OES i.e. at floor level, in corners, in sink traps; the OHSS will advise as to what actions, if any, are required. This advice will take into account the level of the risk, the vulnerability of those at risk and the practicability of removing all the contamination, balanced against the short term benefits of controlling the vapour by 'sealing in' the mercury contamination.

Examples include:

- Contaminated drainage pipe work in a laboratory which could be professionally pressure washed to remove contamination or completely replaced by approved contractors; with all mercury contaminated material disposed of as hazardous waste. However, if the 'downstream' underground pipe work is also contaminated, it may or may not be amenable to pressure washing in an environmentally friendly and safe way. Furthermore, the cost of removal and replacement of the underground pipe work may not be reasonable or proportionate to the residual risk to health or the environment.

- Contamination in the joints of old wood block flooring could be tackled by replacing the contaminated floor, or by sealing it in with a continuous and impervious covering such as vinyl, if the level of contamination is relatively low level.
- Low level contamination behind skirting boards etc. could in some circumstances be controlled by the use of silicone sealants, if the sealant could be reasonably be expected to perform adequately i.e. in the absence of any excessive movement and damaging physical or chemical attack.
- The location of the contamination could be of particular importance in certain areas i.e. if the breathing zones were in close proximity to the contamination and may thereby require complete decontamination.
- If those at risk are in a particularly vulnerable category, such as children, it would be anticipated that the increased duty of care owed to them would require complete decontamination of the area or relocation of the activity.
- Consideration should be given to the risks involved in removing contaminated material i.e. breaking up low level contaminated concrete to remove it. This may actually create a significant hazard (from the mercury laden dust generated) which is disproportionate to the risk of leaving it down and 'sealing in' the mercury with impervious membranes and flooring.

This is not an exhaustive list; each case is unique, always consult the OHSS.

7. Managing Mercury during Maintenance and Refurbishment

A risk assessment should be carried out for all such work, see section **4.** above.

7.1 The risk assessment should include consideration as to **whether or not** there is a **potential risk** to health from mercury for a task **before** any work commences; i.e.

7.1.1 Consider the area were the work is to be carried out, is there

- A known history of mercury contamination in the room or area of work,
- A known history of mercury contamination in a room or area adjacent to the work area, particularly rooms above or to the sides of the work area,
- A knowledge of the previous use of the work and adjacent areas i.e. "it was a Chemistry lab" or "it was a Physics lab" etc…..
- A good reason to be suspicious, related to the previous use of the work area i.e. "it was a building where scientific research was carried out in the past"

7.1.2 **If so**, then also consider the nature and extent of the maintenance or refurbishment and whether it could affect the fabric of the building in a way that could expose hidden metallic mercury contamination or release it, i.e.

- Are walls, floors, floor coverings, or ceilings to be altered or removed,
- Is panelling or skirting board to be altered or removed,
- Are fixtures, fittings or cupboards etc… to be moved or removed,
- Are old sinks, traps, gullies and drain pipes to be altered or removed,
- Are holes to be drilled or cut into voids,
- Are large hammer drills or other tools to be used that could **significantly vibrate** the fabric of the building, thereby releasing mercury,
- Are prolonged high temperatures to be used immediately adjacent to the fabric of the building which could affect it, i.e. welding, brazing and hot work.
- Is a significant heat source to be installed adjacent to the fabric of the building, i.e. hot water pipes, radiators or electrical heaters etc…

7.1.3 After weighing the above considerations; **if there is good reason to suspect** that metallic mercury contamination could present a risk to health,

- Check in the Department or at the OHSS to establish whether a survey has already been carried out and consider the results,
- If there are no records of survey results, then contact the OHSS at the earliest opportunity, before work commences, for advice. The OHSS may wish to carry out a survey of air borne mercury vapour in the proposed work area, which could include measurements before, during and after the program of work, as appropriate.
- Inform all relevant parties that work must not commence until the survey has been completed and appropriate control measures are in place if needed.

7.2 If the results of the survey indicate that there **is a potential risk** to health from metallic mercury i.e. mercury vapour has been detected, then

- Consult with and follow the advice of the OHSS.
- Carry out a written risk assessment of the proposed work, and write a safe operating procedure (SOP) **appropriate to the task and the level of contamination / risk**. The SOP should include measures that eliminate (remove the mercury) or control the potential exposure to metallic mercury vapour of the workers **and** anyone who might be affected by their actions.
- **Where indicated by the risk assessment**; ensure all work is carried out using the appropriate Personal Protective Equipment (PPE) and in particular using the appropriate **Respiratory Protective Equipment** (RPE), details of which are available from the OHSS.

  Note: A special respirator with a filter cartridge designed specifically to remove mercury vapour is required and this must be 'fit tested' to ensure efficient operation. These respirators serve no other function than to filter mercury vapour from otherwise breathable air for the active life of the cartridge and are not suitable for any other task.

- Ensure all workers in an area where metallic mercury contamination has been confirmed are made aware of,
  - the nature and extent of the risk i.e. the fact that mercury produces a toxic vapour.
  - the need to use any PPE / RPE that is required for the task to minimise inhalation.
  - the increased danger from mercury vapour in confined spaces and unventilated areas.
  - the value of good ventilation, especially in a warm / hot area.
  - the fact that vibration and / or heat can release mercury vapour.
  - what to look out for i.e. the presence of liquid metallic mercury.
  - the need to stop work and report the presence of liquid metallic mercury, so that it can be safely removed.

7.3 If the results of the survey **do not** indicate metallic mercury vapour in an area where it might reasonably have been expected, then

- Convey the negative result of the survey to all concerned.
- Ensure all workers in the area are made aware of,
  - the nature of the potential residual risk i.e. the fact that this liquid metal, **if it were to be present**, produces a toxic vapour.
  - what to look out for i.e. the presence of liquid metallic mercury.
  - the need to stop work and report the presence of metallic mercury, so that it can be safely removed and control measures introduced.
- Consider further mercury vapour monitoring if the nature and / or scale of the work warrants periodic reappraisal.

7.4 All waste mercury or material contaminated with mercury must be treated as **hazardous waste** and be disposed of via an approved hazardous waste contractor.

7.5 Construction (Design and Management) Regulations (CDM)

For the bulk of maintenance work carried out in departments, compliance with the COSHH regulations, implemented with the University's policies and guidance, will be adequate.

However, where refurbishments and building work come under the criteria of the **Construction (Design and Management) Regulations** and there is a potential of mercury contamination this must be considered as part of the Health and Safety Plan. A risk assessment and method statement must be completed by the contractor to identify how the proposed work is going to be carried out safely.

The **method statement** must include management procedures for:

- Ensuring no work commences until the risk assessment is completed.
- Contacting the OHSS environmental monitoring section enabling an initial air monitoring survey and visual inspection to be carried out.
- Notifying all the relevant parties if mercury is seen or detected.

Depending on the scale of the work and the potential mercury contamination, the following issues must also be included:

- Details of the provision of adequate ventilation, especially in hot weather.
- Using a Permit to Work system, (Details available from EM).
- "Passive" monitoring using colour change badges.
- Details of RPE (Details available from the OHSS).
- Details of PPE (Details available from the OHSS).
- The provision of adequate clean washing and messing facilities where appropriate

Under CDM regs the "Client", usually EM, is responsible for appointing a planning supervisor and a suitable competent contractor. They must ensure the Health and Safety Plan is in place and that the risk assessment includes a detailed method statement.

Other EM responsibilities include:

- Issuing Permits to Work as required.
- Setting up and managing a latent mercury risk register in consultation with Departments.
- Monitoring contractors' adherence to procedures to ensure that appropriate management actions such as air monitoring and recording are fulfilled.
- Advising departments and OHSS of work schedules.
- Working to Guidance and Safety Procedures.
- Ensuring PPE is used as advised.

The OHSS are responsible for advising Departments and EM of mercury contamination and carrying out mercury vapour monitoring as requested.
The OHSS can also advise on the correct and appropriate use of PPE and RPE.

Departments are responsible for ensuring that all persons carrying out maintenance or refurbishment activities in their department on their behalf are made aware of the areas where mercury contamination is a potential problem.

Summary

Mercury and all its compounds are toxic, therefore, in accordance with the COSHH Regulations and the principles of good practice, the use of Mercury should be eliminated or substituted by alternatives wherever reasonably practicable.

Where this is not possible its use must be risk assessed and control measures put in place to minimise potential exposure to well below the 8 hour Occupational Exposure Limit.

Control measures should be based on adequate primary and secondary containment of the liquid, as well as the vapour. They should also include suitable and sufficient procedures to ensure that any spillages are quickly and safely dealt with.

Mercury is a persistent environmental poison and as such must never be allowed to enter any drainage system or non-hazardous waste stream.

Mercury, its compounds and any object or device containing mercury must be treated as hazardous waste, and may only be disposed of via a hazardous waste approved contractor.

Remember that mercury deposits and contamination can be very small, hidden beneath floor coverings, skirting boards, cracks and joints, absorbed into the fabric of the building and in any or all parts of the drainage system.

It is key to the safety of all staff, students and contractors that a precautionary approach is adopted where there is a possibility of mercury contamination, especially if it is likely to be disturbed by maintenance, refurbishment or building work.

Further information

Further information can be downloaded from the Occupational Health & Safety Service website:

http://www.safety.admin.cam.ac.uk/

1. Hazardous Substances Policy
2. Guide to Hazardous Substance Risk Assessment
3. Chemical Hazard Risk Assessment form and examples
4. The Selection and use of Respiratory Protective Equipment
5. Disposal of Chemical Waste Policy and Guidance.

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