Environment, Health and Safety Committee [EHSC]

Note On

WASTE MANAGEMENT IN CHEMICAL LABORATORIES

Dealing correctly with laboratory wastes is an important issue for all who manage or are employed in chemical laboratories.

This Note outlines best practice in managing wastes from chemical laboratories in the context of relevant statutory controls. It stresses both the need to assess the risks to health or safety in handling wastes, and the need to protect the wider environment. Laboratory waste management is a broad subject. This Note does not pretend to be a full or definitive guide nor does it address issues such as microbiological or medical wastes. Readers are urged to obtain more detailed information relevant to their particular circumstances.

1. TYPES OF LABORATORY WASTE

A wide range of wastes arise in chemical laboratories. Examples include:

- Liquids, such as aqueous solutions, oils and solvents
- Sludges, which can be both aqueous and non-aqueous
- Solid materials, such as chemicals, glass, packaging, paper, samples and equipment.

Gaseous emissions, such as those from laboratory fume cupboards, may be described as waste in its widest definition. However, emissions control technology is a specialist activity. Each installation requires reasonable estimates of chemical composition, frequency and duration of emissions. This is outside the scope of this paper.

Managers who require advice on disposal of radioactive wastes should contact their local Environment Agency (EA) or in Scotland, the Scottish Environmental Protection Agency (SEPA), or the Nuclear Industry Radioactive Waste Executive (NIREX).

2. REGULATORY FRAMEWORK AND GENERAL WASTE HANDLING

2.1 Waste other than Discharged to Drain

The Special Waste Regulations in England will be replaced by two sets of new Hazardous Waste Regulations: The List of Wastes Regulations which will transpose the European Waste Catalogue into UK domestic legislation and the Hazardous Waste Regulations which will introduce new and simpler procedures for hazardous waste, while meeting the requirements of the European Hazardous Waste Directive.

The Hazardous Waste Regulations are expected to come into force in two stages: some sections, mainly on notification, come into force on 16 April 2005, with the remaining bulk of the regulations coming into force on 16 July 2005.

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Employers have duties under the Environmental Protection (Duty of Care) Regulations 1991, and the Environmental Protection (Special Waste) Regulations 1996, both of which are amended from time to time.

The Duty of Care requires the employer to act in a responsible manner to ensure that waste is properly described on a waste transfer form and only transferred to a person who possesses an appropriate licence or permit to handle or dispose of it in an environmentally acceptable manner. It is advisable for the responsible person to carry out an occasional audit, e.g. by following the carrier to the destination identified. Reputable waste handlers and disposers will not uplift waste materials which are not properly described or which do not give relevant handling precautions with the waste transfer form. Waste containers must be correctly labelled. They must be robust and chemically resistant to ensure that the waste consignment will not escape in storage or transit.

A significant proportion of the waste from a laboratory and its support areas is likely to consist of paper, packaging waste etc., which are non-hazardous entries in the consolidated EWC. A fairly general description will suffice for this, and disposal/recycling will be generally as for household waste.

Hazardous waste is any waste that has an 'Absolute' entry in the EWC or has a 'Mirror' entry *and* contains a significant proportion of a substance(s) with any hazard classification under the CHIP (Chemicals Hazard Information and Packaging for Supply) Regulations. The EWC contains a number of 'Absolute' or 'Mirror' entries covering things not previously considered to be hazardous, for example fluorescent tubes and computer monitors, which are now considered as hazardous waste.

Enterprises that generate hazardous waste are required to register with the Environment Agency and meet the requirements of the Hazardous Waste Regulations.

Hazardous waste must be segregated according to its chemical properties to prevent the likelihood of reactions occurring in storage or transit, which could cause danger to persons or property, or environmental pollution. It is also possible that the proposed Hazardous Waste Regulations will include the requirement for waste producers not to mix hazardous and non-hazardous wastes or mix different categories of hazardous waste for disposal.

A COSHH assessment for handling and transporting waste is required and must be communicated to whoever may carry out these tasks.

Reputable waste licensees may dispose of most chemical waste fairly easily, if at some expense. However by law cadmium, mercury and certain pesticide wastes in any form require special treatment. Only a few companies undertake this treatment and therefore disposal of these substances is likely to be considerably more expensive.

2.2 Waste Discharged to Drain

Aqueous waste sent to drain from laboratories must be controlled in the same way as that from industry i.e. trade waste. Most laboratories are connected to a public sewer and "consent to discharge" must be negotiated with the local sewerage undertaker and/or the EA or SEPA under the Water Industry Act 1991. Details of rates of discharge, together with likely constituents, concentrations, acidity and suspended solids must be provided, and charges are levied according to the treatment necessary by the undertaker.

Negotiation with the EA or SEPA is necessary if cadmium, mercury, or pesticides are possible constituents of the discharge. In such cases it is likely that the laboratory effluent will need to be treated and purified on-site in an appropriate effluent treatment plant.

3. LIQUID WASTES

3.1 Aqueous Waste

Most aqueous solutions in relatively small quantities, i.e. of the order of a litre or two will be covered by the consent agreement noted above. Certain substances, which are more toxic or environmentally unacceptable due to the possibility of hazardous fumes in sewers or contamination of sewerage treatment plants, must either be treated in the laboratory, or if in large quantities, disposed of as special waste. Some of the more common ones are identified below.

3.1.1 Cyanide

Small quantities of cyanide waste should be converted to carbonate, by mixing it in a large beaker in a fume cupboard with a slight excess of Sodium hypochlorite solution. The reaction is normally complete in a couple of days. When the cyanide has been destroyed, (test a few drops occasionally), the resultant waste may then be sent to drain after heavy dilution with water.

3.1.2 Chromium VI

Waste containing Chromium (VI) should be reduced to Chromium (III) with an appropriate agent, Iron (II) solution or Sodium Sulfite for example, which will be more acceptable for effluent treatment.

3.1.3 Sulfide

The addition of zinc sulfate to a solution of sulfide will precipitate zinc sulfide, which may be collected in a suitable container, and stored for ultimate disposal, with other redundant chemicals. The solution remaining can be sent to drain.

3.1.4 Spent Photographic Solutions

These solutions can obtain significant quantities of silver, the majority of which may be recoverable by the installation of a relatively low-cost low voltage electrolysis cell in the laboratory drain. For a laboratory using large quantities of these solutions the silver recovered in a relatively short time will cover the installation cost.

3.2 Organic Liquids

3.2.1 Solvents

Waste organic solvents should be stored in separate labelled containers according to type (chlorinated and non-chlorinated), both to reduce risk of chemical reaction, and the likelihood of azeotrope formation, which would reduce distillation recovery quality.

3.2.2 Oils

Oils, both mineral and synthetic, also cause severe problems in sewerage plants and must be transferred to licensed waste handlers. Waste oils, if carefully segregated according to type, are recoverable either as a recycled commodity, or as fuel oil.

4. SOLID AND SLUDGE WASTES

4.1 Glass

Glass waste must be stored in a labelled robust waste bin separately from other solid waste for ease of recycling. Empty reagent bottles in good condition may be re-used within the laboratory after thorough cleaning and removal of old labels.

4.2 Sharps

Waste scalpel blades, syringes and needles are best stored for disposal in rigid containers designed for the purpose. The containers should be collected by licensed disposal companies and incinerated with their contents in approved furnaces.

4.3 Resins

As a general rule synthetic resins and resin components, whether fully cured or not, should not be mixed with general non-hazardous waste for disposal. They should be placed separately in labelled containers with appropriate labels indicating the possible hazards for disposal as special waste.

4.4 Chemical Sludges

Significant quantities of sludge can arise from activities such as:
- cleaning of pilot scale electroplating processes,
- investment casting slurry testing,
- hot oil baths.

Sludges should be stored separately in appropriately labelled containers. The labels should indicate the possible hazards for disposal as special waste.

4.5 Low Melting Point Alloys

Certain alloys used for laboratory casting activities with melting points of the order of 70 to 150^{o}C contain significant quantities of cadmium. Waste material arising from these operations should not be mixed with other metal waste but should be held separately for recovery or disposal by licensed companies.

5. OTHER SAFETY AND ENVIRONMENTAL CONSIDERATIONS

5.1 Procedures and Training

A document detailing the laboratory waste management procedures should be drawn up. It should detail relevant controls according to the types of waste generated. It should also give instructions and telephone numbers in case of emergencies. Waste compound keyholders and licensed waste contractors should be listed as separate addenda, which may be amended without the need to re-issue of the complete document.

All those employed in the laboratory should be made aware of the procedures and any other requirements. Those with specific responsibility for particular functions, such as supervision of waste compound or emergency procedures, must receive appropriate training.

5.2 Storage of Large Quantities of Waste

Laboratories, which generate large quantities of waste for disposal or reclamation, should set up a secure compound. It should be adequately protected from adverse weather conditions and identified with approved signs giving emergency telephone numbers. The compound should be bunded, i.e. it should be enclosed within low walls with an impervious surface to prevent leakage. The bund so formed should be capable of holding fifty percent more liquid than is likely to be stored in it to ensure that there will be no possibility of overflow.

Drainage of fluid or contaminated water should be directed to a chemical-resistant sump. The sump should be inspected at regular intervals, and any fluid or sludge pumped out by approved contractors. Access to the compound should be limited to approved key holders with immediate access to an emergency eyewash and shower.

5.3 Practices to Avoid

5.3.1 In general the practice of “burning off” or evaporation of small quantities of solvents and solvents in absorbent waste materials, on laboratory land, should be discouraged. There is a risk of creating a statutory nuisance by smoke or odour emissions, even if the risk to operator safety is seemingly minimised.

5.3.2 Swabs used for selective transfer of etching solutions to metallurgical or geological specimens must be well rinsed in clear water, prior to discarding to a plastic bag in a special waste bin. The etching solutions used are very corrosive, massive dilution is essential to ensure that handlers may remove the waste bag with minimum risk to personal safety.

5.4 Contractors

5.4.1 Maintenance contractors, such as plumbers, must be provided with appropriate health and safety data for the chemicals they are likely to encounter. They can then use appropriate personal protective equipment e.g. when clearing blockages and handling disconnected pipe work.

In some cases the risk assessment will identify the need for a permit to work system.

5.4.2 Contract cleaners should also be provided with relevant information on the waste generated within the laboratory, and the correct means of transferring it to the waste collection area or compound.

6. Discussion and Conclusions

There are good reasons to reduce both the volume and the hazards of laboratory waste as far as possible. Not only does this have environmental benefits it can also save money. In the past the majority of waste, including much laboratory waste, has been discharged to landfill. Increasing pressures of environmental acceptability, possible consequential land contamination and spreading urbanisation have forced not only the development of alternative waste treatment and disposal methods but, more significantly, the re-evaluation of ways in which materials once thought of as waste can be used or re-used to conserve natural resources.

The European Directives, which have been implemented in UK legislation, set objectives and targets for waste management in a manner that contributes to sustainability. This involves a hierarchy of options for dealing with waste, in order of preference:

i. Reduce waste where possible at source. In a laboratory context this could mean planning work carefully so as to minimise raw material consumption.
ii. Put objects back into use. Cleaning and re-labelling reagent bottles for re-use, or return to supplier is the best example.
iii. Recover value from waste by recycling. An example has been given above, i.e., careful segregation of waste solvents for recycling or use as low-grade fuel.
iv. Incinerate non-recyclable combustibles, [using approved methods to minimise atmospheric pollution], in order to reduce waste volume and toxicity.
v. As a last resort, render the waste less environmentally harmful by an appropriate treatment and dispose of it to landfill. The amount of waste discharged to landfill should have the lowest practicable volume and the lowest achievable environmental toxicity.

Using these principles as a guide to planning laboratory programmes and waste control measures can often lead to significant cost savings in the long term, since waste treatment and landfill costs, which are already high, are likely to continue to rise.

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