University of Glasgow

SEPS Guidance Note

(GN-CHEM08/2018)

Chemical Waste Handling and Disposal

1 Introduction

It is inevitable during normal laboratory operations some chemical waste will be generated. This waste may take a number of forms including chemicals, solvents, stock solutions and items contaminated with chemicals such as paper, filters and contaminated laboratory equipment. The improper disposal of chemical waste can pose a number of potential hazards both to the environment and to the safety of staff and students, for example:

- Pesticides and biocides can damage both the aquatic environment and associated facilities, for example water or sewerage treatment works rely on bacteria which can be harmed by biocidal substances.
- Strong smelling substances such as mercaptans can give off strong-smelling, unpleasant vapours that can linger in drains and pipework moving throughout the building and escaping in other areas.
- Flammable / reactive substances can give rise to a build-up of flammable vapours in drainage systems which could lead to a risk of fire or explosion in extreme cases.
- Corrosive substances including acids and alkalis can damage pipework and fittings as well as reacting with other chemicals released into the drainage system potentially leading to the release of harmful vapours.
- Radioactive substances can be released to drains under controlled circumstances but in the event that the licensing of this is very strictly controlled to reduce the risk of radioactive contamination.
- Unexpected reactions may occur when chemicals are released to drain, for example bleach can mix with some common drain cleaning compounds to release the toxic gas chlorine.
- Poisonous substances may enter the environment if released to drain and can either have a toxic effect on watercourses or other discharge sites, they may also introduce toxic residues into drinking water that can persist even after water treatment.

As a result discharging chemicals to foul water drains should be avoided wherever practical and only considered where there is no viable alternative or for relatively innocuous substances.

2 Duty of Care

The Environmental Protection Act 1990includes a “duty of care” that requires all persons involved in the handling of waste (including production of waste) to take reasonable and appropriate measures to ensure that:

- Waste is only kept, treated, deposited or disposed of in accordance with a waste management license or other authorisation
- Waste does not escape from the control of the holder
- Waste is only transferred to authorised persons such as registered waste carriers or licensed disposal operators who are permitted to accept that type of waste.
- All transfers / movements of waste are accompanied by an adequate written description of the waste allowing it to be identified and subsequently handled correctly.

The duty of care begins with the person who generates the waste and it cannot be delegated to others. This duty is legally enforceable and breaches of it can lead to criminal prosecutions of both the individual and the University. Consequently, the University (and its staff and students) must make every effort to categorise, segregate and contain waste according to current legislation and best practice. The duty of care for pollution control imposes strict management and documentation procedures which must be adhered to. In simple terms waste must be properly described and appropriate handling precautions recorded. The description must be sufficiently detailed to ensure that anyone who subsequently handles or takes possession of the waste can do so safely and avoid mishandling it.

The description of the waste should include the source of the waste, what it is made up of, how it is produced and details of any special hazards or considerations to be taken into account during handling or storage.

Note: The University of Glasgow operates a "Zero to Drain" policy so far as is reasonably practicable. This means that unless there is no other alternative all chemical waste (including stock solutions, unused detergents and biocides along with any unused chemicals) should be disposed of via the University's approved chemical waste contractor.

Note: It is recommended that the disposal of waste be considered at the start of any process where hazardous substances are used as part of the usual CoSHH assessment procedure.

3 Hazardous Chemical Waste

It is inevitable that most laboratories produce waste in the course of normal research or teaching activities. Most general laboratory waste which is uncontaminated or has only been exposed to very small quantities of chemicals can be considered non-hazardous for example:

- Paper towels, cloths and tissues
- Packaging
- Disposable gloves
- Plastic items and glassware (including chemical bottles) that have been emptied and rinsed thoroughly*

Note: Prior to disposal any bottles or containers that originally contained chemicals must be thoroughly rinsed out three times with water or a suitable solvent, any solvent residue should be allowed to evaporate in a fume cupboard and labels should be defaced or clearly and unambiguously marked as empty.

To qualify as uncontaminated (non-hazardous) waste the following thresholds should be considered as a hard and fast rule to be applied to all containers and contaminated materials:

Substances with a total concentration of zero

- Flammable gases, solvents or solids (flash point of 60C or less)
- Self, air or water reactive substances
- Prescription only medicines
- Oils, heavy metals or any substances listed in appendix 2
- Persistent organic pollutants
- Substances listed as producing a stench

Substances with an absolute maximum concentration of 0.1%

- Very toxic substances
- Carcinogenic substances (category 1 or 2)
- Mutagenic substances (category 1 or 2)
- Reproductive toxins (category 1 or 2)
- Corrosive substances listed as causing severe burns
- Other ecotoxins
- Unknown substances or novel compounds (not confirmed as falling into another category)

Substances with an absolute maximum concentration of 1%

- Toxic substances
- Corrosive substances listed as causing burns
- Eye, skin and respiratory irritants
- Harmful substances

Only waste that falls below these thresholds may be treated as non-contaminated and be disposed of via the normal general waste streams. In the event that any of these thresholds are exceeded then the waste (including contaminated solid waste) should be treated as contaminated and treated or disposed of accordingly.

Hazardous chemical waste may include oils, solvent waste, reaction by-products, washings, chemicals that are obsolete / out of date chemicals, water treatment chemicals, biocides, unknown substances and novel compounds.

It may also include any chemically contaminated equipment, containers or sharps which cannot be safely decontaminated including filters, contaminated spill absorption media and needles (whether contaminated or not).

4 Segregation of Hazardous Waste

Hazardous chemical waste should be segregated with due regard to chemical compatibility / properties in order to reduce the risk of adverse chemical reactions occurring during either storage or transport which could pose a risk to persons, property or the environment. In general the following incompatible chemicals should be separated:

- Mineral acid waste (in particular oxidising acids such as nitric acid) should be separated from organic acids, such as acetic acid.
- Acids (including acidic compounds such as Virkon and calcium bisulphate) should be kept separate from cyanide salts, sulphide compounds and alkalis.
- Halogenated solvents (e.g. dichloromethane should be kept separately from non-halogenates solvents such as pentane, ethanol etc.
- Pyrophoric substances (i.e. substances that react violently with air or moisture) including lithium aluminium hydride, alkali metals, white phosphorus, butyl lithium should be separated from other substances.
- Any mixture containing (or suspected of containing) iodine must be clearly segregated and clearly identified due to restrictions on incineration / disposal of iodine.
- Oxidising agents must be separated from other substances in particular organic materials, mineral acids and reducing agents e.g. sodium borohydride.
- Waste (including aqueous waste) which contains heavy metals such as mercury, cadmium etc. which cannot be incinerated should be segregated to ensure it is disposed of appropriately.

5 Chemical Waste Containers

Chemical waste should only be stored in appropriate containers which must be clearly labelled and suitable for the type of waste contained. Consider the following:

- Glass bottles (such as Winchester bottles) can be used for most chemicals with the exception of hydrofluoric acid waste (or other related substances such as ammonium bifluoride).
- Plastic bottles can generally be used for acids and alkalis as long as they have been properly cleaned out and rinsed. Aggressive solvents such as diethylether and dichloromethane (or mixtures containing aggressive solvents) may attack some common plastics. High density polyethylene (HDPE) containers may be used for some aggressive solvents as long as it has been confirmed that they will not damage the plastic.
- Steel drums may be used for large quantities of non-acidic organic solvents, neutral aqueous solutions and oils but should never be used for corrosive substances such as acids or alkalis.
- Containers that have been designed for holding solid substances **must not** be used to store liquid waste, such containers are unlikely to be liquid-tight leading to the possibility of leaks.
- Needles that have been used solely for chemicals should be segregated from other hazardous waste and disposed of in sharps bins. Sharps bins containing needles that have only been exposed to chemicals should have any reference to biological waste removed from the label. Only if it is safe and practical to do so should needles be subject to rinsing or cleaning prior to disposal.
- Where possible, malodorous chemicals such as mercaptans should generally be disposed of in a glass bottle, the top of which should be sealed with laboratory film or tape. Secondary containment is also highly recommended.

Before any container is used for waste it should be checked prior to use or disposal to ensure that it is clean and does not contain any residue that could react with the waste (i.e. residual acids may react with organic solvents). The integrity of the container must also be checked before it is used, it must be:

- Physically sound i.e. it must not exhibit cracks (including star cracks), chips or punctures. Remember that old plastic containers and lids may have degraded and become fragile especially if exposed to sunlight for long periods of time (this can often manifest as fading / changing colours).
- The container must be capable of being securely fastened / sealed. Containers without secure lids such as stoppered flasks or containers with damaged lids should not be used for disposal of waste.
- Containers should also be liquid tight, any container that shows evidence of leaking should not be used to store hazardous waste.

Containers used for waste should not be overfilled, as a rule of thumb waste containers should not be filled to more than ¾ of their capacity. This air space (also known as ullage) allows for pressure changes above the liquid in response to changes in the rate of evaporation with ambient temperature. The cap of the container should not be overtightened to allow some pressure relief which could prevent a container from failing catastrophically.

Waste containers should be clearly labelled with the full details of the contents, date and the name of the person (or laboratory manager for communal waste containers) responsible for accumulating and transferring the waste. Major components of the waste (including solvents, water or other media) must be clearly listed and where possible the original container used to help provide hazard information. If the original container is being used then it should be clearly marked as waste but the rest of the information on the label should be retained.

Where a container is being recycled for use as a waste container then the original label should be defaced or removed to ensure obsolete chemical information is illegible. The container should be clearly labelled with both contents and relevant hazard symbols, this information should also be clearly visible on any secondary containment used.

6 Storage Areas for Chemical Waste

Chemical Waste in the Laboratory

Waste containers may be stored in laboratory areas as a temporary measure while they are being filled until they can be transferred to a dedicated waste storage area. Containers of chemical waste (including historical and other obsolete chemicals) should not be allowed to accumulate in laboratories and working areas. When waste containers are full or substances are identified as no longer being required they should be disposed of appropriately as soon as possible. Consider the following:

- Flammable solvent waste should be stored in suitable flammable storage cabinet or fire resistant container. It is worth remembering that waste solvents should be counted towards the 50l guideline limit for storage of flammable liquids in laboratories.
- Waste solvent containers should be clearly marked and all users given clear instruction in local colour coding schemes used to help ensure waste is properly segregated.
- Where possible containers used to store waste chemicals in the liquid form should be stored with secondary containment, this may simply take the form of a small tray to act as a bund in the event of a spillage.
- Incompatible chemical wastes should be stored separately, the ideal situation is to ensure physical separation between incompatible waste materials.
- Care should be taken to avoid ambiguous labelling of waste containers and ensure that they are properly labelled with appropriate hazard symbols added to the outside f the container.
- Fume cupboards should not be used for the long term storage of waste or for unwanted chemicals to prevent them from being cluttered which may make them dangerous to work in.

Note: When vacating (or taking possession of) a laboratory, any chemicals that are no longer required should be treated as waste and disposed of appropriately.

Hazardous Chemical Waste Stores should be separate from laboratory facilities and may be rooms located within buildings, stand-alone buildings or proprietary containers. All types of chemical waste store should:

- Be constructed of suitable fire resisting or non-combustible materials
- Have fire extinguishing apparatus close by, identified by appropriate signage

- Have an emergency eye wash station close by, identified by appropriate signage, ideally this should be located within the storage area to allow ease of access.
- Where possible be located away from rain/surface water drains or unsealed man-hole covers;
- where not possible a means of preventing spillages entering these drains must be available.
- Where applicable have unobstructed corridors at least 1.1 metres wide
- Be inaccessible to the public. External stores and the outside doors of internal stores should be robust and kept locked
- Have a sign indicating 'Hazardous Chemical Waste Store, No Unauthorised Access', or similar and additional signs indicating which hazards may be encountered e.g. Flammable Liquids
- Incorporate fire protection appropriate to the hazards posed by the substances stored inside. Note that it may be necessary to have intrinsically safe lighting or even fire suppression systems etc (further information on fire protection is available from the University's Fire Safety team)
- Have adequate passive or intrinsically safe mechanical ventilation, to prevent the build-up of hazardous vapours and flammable vapours where flammable liquids or gases are stored
- Be designed to contain leaks from containers by either sloping the floor away from the door and/or by providing a liquid proof sill across the door opening. Liquid spillages should be prevented from running into areas where incompatible materials are stored. This may be achieved by utilising in-rack bunds or drip trays
- Be bunded to prevent leakages or hazardous spills escaping to drains
- Be equipped with an appropriate emergency response kit / spill kit that reflects the intrinsic hazards of the substances stored within the store.
- Outdoor storage areas should be bunded to prevent leakages or spills escaping to drains. The bund should enclose a volume which is at least 110% of the capacity of the largest container stored there, or 25% of the total volume stored, whichever is the greater.

7 Accidents and Emergencies

In the event that a hazardous substance is discharged into an unprotected drainage system or watercourse it is vital that the University Environmental Adviser (or the Radiation protection Adviser in the event that the substance is radioactive) is informed as soon as possible so that the necessary authority can be informed. The following information should be provided:

- The full name of the substance(s) entering the drain
- The amount of material that has entered the drain (an estimate is fine)
- The concentration of the substance
- The nature of any solvents or other additives that might be present
- The location where the substance entered the drain

8 Further Information and Guidance

For the most part it is possible to accurately identify which chemicals are likely to pose an environmental or safety risk during disposal from the information available from the supplier along with the guidance provided by SEPS. The disposal of chemical waste should form a part of the CoSHH assessment carried out prior to use. In the event that you are unsure then the default position should be to aim for compliance with our target of "zero to drain".

If you require further information on disposal of specific chemicals this can be obtained by contacting Safety and Environmental Protection Services using the details below:

General Office: 0141 3305532
Biological Safety Adviser: 0141 3305854
Chemical Safety Adviser: 0141 3302799
Environmental Adviser: 0141 3307105

Appendix 1: Substances that must not be released to drain*

Certain substances used in research and teaching are likely to cause serious environmental damage or other harmful effects if released into the drainage system. The substances listed below **must not** be released to foul sewers in any quantity under any circumstances.

- Calcium carbide
- Oils, petroleum spirit or any other volatile / flammable organic solvent
- Substances classified as being **priority substances** for control due to their potential to cause serious environmental damage, these substances formerly appeared on the UK Red List of the most dangerous substances for the environment (see appendix 2)
- Any substance listed in the schedule of the Poisons List Order 1982 (Part I)
    - Aluminium phosphide
    - Arsenic and its compounds
    - Barium salts
    - Bromomethane
    - Chloropicrin
    - Fluoroacetic acid and its salts, fluoroacetamide
    - Hydrogen cyanide, metal cyanides (other than ferrocyanides and ferricyanides)
    - Lead acetates
    - Mercury salts and compounds
    - Oxalic acid
    - Phenol and phenols
    - Phosphorus (yellow)
    - Strychnine, salts and quaternary compounds
    - Thallium salts
- Waste likely to cause viscous or solid deposits in any part of the sewerage system (e.g. wax, agar, fats)
- Ethidium bromide solutions (as DNA stain or for other purposes)
- Other DNA stains (without specific approval)
- Mineral , silicon and synthetic oils
- Substances likely to give rise to fumes or strong odours (e.g. mercaptans)
- Halogenated hydrocarbons
- Halogen substituted phenolic compounds
- Thiourea and its derivatives
- Solutions containing any concentration of the following elements:
    - Antimony
    - Arsenic
    - Chromium
    - Selenium
    - Tellurium
- Organohalogen, organophosporus or organonitrogen pesticides, triazine herbicides and any other biocidal compound.
- Metal phosphide compounds (e.g. aluminium phosphide)
- Elemental phosphorus
- Poisonous organosilicon compounds
- Spent photographic solutions
- Picric acid and picrate compounds

Note: This list is not exhaustive, any highly toxic, ecotoxic, flammable / explosive or highly reactive substance should be prevented from entering the drainage system.

Appendix 2: List of Priority Substances (including the former UK Red List)

These substances are extremely damaging to the environment and should always be prevented from entering drains, watercourses and other sensitive areas no matter how small the quantity or how high the dilution. It is generally illegal to discharge any of these substances into the environment.

- 1,2-dichloroethane
- Alachlor
- Aldrin, Dieldrin, Endrin
- Anthracene
- Atrazine
- Benzene
- Brominated diphenylether
- Cadmium (and its compounds)
- Carbon tetrachloride
- Chlorfenvinphos
- Chloroalkanes (C10 –C13)
- Chloroform
- DDT (all isomers)
- Dichloromethane
- Dichlorvos
- Dieldrin
- Di(2-ethylhexyl)phthalate
- Diuoron
- Endosulfan
- Fenitrothion
- Gamma-Hexachlorocyclohexane (Lindane)
- Hexachlorobenzene
- Hexachlorobutadiene
- Isoproturon
- Lead (and its compounds)
- Malathion
- Mercury (and its compounds)
- Naphthalene
- Nickel (and its compounds)
- Nonylphenols
- Octylphenols
- Pentachlorobenzene
- Pentachlorophenol (and its compounds)
- Polychlorinated biphenyls
- Simazine
- Tributyltin compounds
- Trichlorobenzene (all isomers)
- Trifluralin
- Triphenyltin compounds

Appendix 3: Substances that may be disposed of via drains

While the University of Glasgow is working towards a **"zero to drain"** policy it is recognised that for small quantities (typically 500ml or less) of low-hazard, water soluble substances it may be acceptable to wash waste to drain as long as copious quantities of running water accompany the waste to ensure adequate dilution.

The judgement of what constitutes a low hazard substance or an appropriate amount relies on the professional judgement of the individual bearing in mind that different thresholds may apply to different substances that even some seemingly innocuous chemicals can have adverse effects on the environment. Large quantities or highly concentrated substances should always be disposed of properly via an approved contractor.

The list below gives some guidance as to the classes of chemical which may be disposed of via the drainage system in small quantities with dilution. This list is not intended to be exhaustive but in the event that a substance is not listed then further advice should be sought.

- Dilute acid solutions (not including HF)
- Dilute alkaline solutions (not including ammonia)
- Non-toxic, water soluble alcohols
- Non-toxic, water soluble inorganic salts (e.g. sodium chloride , sodium citrate)
- Small quantities of detergent used for cleaning
- Disinfectant solutions at the working concentration only (i.e. 2% Virkon)
- Hypochlorite (bleach) solutions at the working concentration only
- Dilute, aqueous chemical solutions (below the relevant threshold levels)
- TAE / TBE buffer at the working concentration only (not including stock / concentrated solutions)

Note: Although it may be acceptable to wash small quantities of the above substances to drain with copious quantities of water it is not acceptable to deliberately dilute bulk waste chemicals for the purposes of disposal. Any large quantity of waste should be retained safely for disposal via an approved contractor.

Note: Remember that even dilute solutions of incompatible substances may react violently if they come into contact within the drainage system potentially producing flammable or toxic products (e.g. Virkon will react with bleach to produce toxic chlorine gas). Care should be taken to ensure that the risks are properly assessed before disposing of any substance via the drainage system.