HAZARDOUS WASTE

GUIDELINES

A guide for a proper handling and management of hazardous waste Rev 1.0

FACULTY OF RESOUCE SCIENCE AND TECHNOLOGY

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1.0 INTRODUCTION

This document serves as a guideline for recognizing, handling and disposal of various types of hazardous laboratory wastes, primarily; chemical wastes, biological (biohazardous) waste or other dangerous substances (e.g. radioactive waste).

The users of this guide includes the waste generators in the laboratory (students and laboratory staffs), the waste handlers (postgraduate students and laboratory staffs) and waste managers (assistant science officers, science officers, academic laboratory coordinators). Everyone plays a role and has responsibilities to ensure that hazardous waste is properly dispose of. This guide assumes that readers are familiar with the typical laboratory setting and are used to the common scientific terminology.

Any new requirements from local agencies or legislation will always supersede instructions provided under these guidelines.

2.0 WHAT IS HAZARDOUS WASTE?

Hazardous waste is a waste with physical, chemical or toxicological hazards that renders it dangerous or capable of posing harmful effects on human health and the environment. (Learn the Basics of Hazardous Waste | US EPA, 2022)

In Malaysia, hazardous waste is defined as any waste falling within the categories of waste listed in the First Schedule of the Environment Quality (Scheduled Wastes) Regulations 2005. Table 1 shows the hazardous waste listed in the First Schedule (Regulation 2).

Table 1: Hazardous waste categorised in the First Schedule (Regulation 2) (Environment Quality (Scheduled Wastes) Regulations; 2005)

No.	Code	Waste Categories
	SW 1	**Metal and metal-bearing wastes**
1	SW 101	Waste containing arsenic or its compound
2	SW 102	Waste of lead acid batteries in whole or crushed form
3	SW 103	Waste of batteries containing cadmium and nickel or mercury or lithium
4	SW 104	Dust, slag, dross or ash containing aluminium, arsenic, mercury, lead, cadmium, chromium, nickel, copper, vanadium, beryllium, antimony, tellurium, thallium or selenium excluding slag from iron and steel factory.
5	SW 105	Galvanic sludges
6	SW 106	Residues from recovery of acid pickling liquor
7	SW 107	Slags from copper processing for further processing or refining containing arsenic, lead or cadmium
8	SW 108	Leaching residues from zinc processing in dust and sludges form
9	SW 109	Waste containing mercury or its compound
10	SW 110	Waste from electrical and electronic assemblies containing components such as accumulators, mercury-switches, glass from cathode-ray tubes and other activated glass or polychlorinated

		biphenylcapacitors, or contaminated with cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or polychlorinated biphenyl
	SW 2	**Wastes containing principally inorganic constituents which may contain metals and organic materials**
11	SW 201	Asbestos wastes in sludges, dust or fibre forms
12	SW 202	Waste catalysts
13	SW 203	Immobilized scheduled wastes including chemically fixed, encapsulated, solidified or stabilized sludges
14	SW 204	Sludges containing one or several metals including chromium, copper, nickel, zinc, lead, cadmium, aluminium, tin, vanadium and beryllium
15	SW 205	Waste gypsum arising from chemical industry or power plant
16	SW 206	Spent inorganic acids
17	SW 207	Sludges containing fluoride
	SW 3	**Wastes containing principally organic constituents which may contain metals and inorganic materials**
18	SW 301	Spent organic acids with pH less or equal to 2 which are corrosive or hazardous
19	SW 302	Flux waste containing mixture of organic acids, solvents or compounds of ammonium chloride
20	SW 303	Adhesive or glue waste containing organic solvents excluding solid polymeric materials
21	SW 304	Press cake from pretreatment of glycerol soap lye
22	SW 305	Spent lubricating oil
23	SW 306	Spent hydraulic oil
24	SW 307	Spent mineral oil-water emulsion
25	SW 308	Oil tanker sludges
26	SW 309	Oil-water mixture such as ballast water
27	SW 310	Sludge from mineral oil storage tank
28	SW 311	Waste of oil or oily sludge
29	SW 312	Oily residue from automotive workshop, service station oil or grease interceptor
30	SW 313	Oil contaminated earth from re-refining of used lubricating oil
31	SW 314	Oil or sludge from oil refinery plant maintenance operation
32	SW 315	Tar or tarry residues from oil refinery or petrochemical plant
33	SW 316	Acid sludge
34	SW 317	Spent organometallic compounds including tetraethyl lead, tetramethyl lead and organotin compounds
35	SW 318	Waste, substances and articles containing or contaminated with polychlorinated biphenyls (PCB) or polychlorinated triphenyls (PCT)
36	SW 319	Waste of phenols or phenol compounds including chlorophenol in the form of liquids or sludges
37	SW 320	Waste containing formaldehyde
38	SW 321	Rubber or latex wastes or sludges containing organic solvents or heavy metals
39	SW 322	Waste of non-halogenated organic solvents
40	SW 323	Waste of halogenated organic solvents
41	SW 324	Waste of halogenated or unhalogenated non-aqueous distillation residues arising from organic solvents recovery process

42	SW 325	Uncured resin waste containing organic solvents or heavy metals including epoxy resin and phenolic resin
43	SW 326	Waste of organic phosphorus compound
44	SW 327	Waste of thermal fluids (heat transfer) such as ethylene glycol
	SW 4	**Wastes which may contain either inorganic or organic constituents**
45	SW 401	Spent alkalis containing heavy metals
46	SW 402	Spent alkalis with pH more or equal to 11.5 which are corrosive or hazardous
47	SW 403	Discarded drugs containing psychotropic substances or containing substances that are toxic, harmful, carcinogenic, mutagenic or teratogenic
48	SW 404	Pathogenic wastes, clinical wastes or quarantined materials
49	SW 405	Waste arising from the preparation and production of pharmaceutical product
50	SW 406	Clinker, slag and ashes from scheduled wastes incinerator
51	SW 407	Waste containing dioxins or furans
52	SW 408	Contaminated soil, debris or matter resulting from cleaning-up of a spill of chemical, mineral oil or scheduled wastes
53	SW 409	Disposed containers, bags or equipment contaminated with chemicals, pesticides, mineral oil or scheduled wastes
54	SW 410	Rags, plastics, papers or filters contaminated with scheduled wastes
55	SW 411	Spent activated carbon excluding carbon from the treatment of potable water and processes of the food industry and vitamin production
56	SW 412	Sludges containing cyanide
57	SW 413	Spent salt containing cyanide
58	SW 414	Spent aqueous alkaline solution containing cyanide
59	SW 415	Spent quenching oils containing cyanides
60	SW 416	Sludges of inks, paints, pigments, lacquer, dye or varnish
61	SW 417	Waste of inks, paints, pigments, lacquer, dye or varnish
62	SW 418	Discarded or off-specification inks, paints, pigments, lacquer, dye or varnish products containing organic solvent
63	SW 419	Spent di-isocyanates and residues of isocyanate compounds excluding solid polymeric material from foam manufacturing process
64	SW 420	Leachate from scheduled waste landfill
65	SW 421	A mixture of scheduled wastes
66	SW 422	A mixture of scheduled and non-scheduled wastes
67	SW 423	Spent processing solution, discarded photographic chemicals or discarded photographic Wastes
68	SW 424	Spent oxidizing agent
69	SW 425	Wastes from the production, formulation, trade or use of pesticides, herbicides or biocides
70	SW 426	Off-specification products from the production, formulation, trade or use of pesticides, herbicides or biocides
71	SW 427	Mineral sludges including calcium hydroxide sludges, phosphating sludges, calcium sulphite sludges and carbonates sludges
72	SW 428	Wastes from wood preserving operation using inorganic salts containing copper, chromium or arsenic of fluoride compounds or using compound containing chlorinated phenol or creosote

73	SW 429	Chemicals that are discarded or off-specification
74	SW 430	Obsolete laboratory chemicals
75	SW 431	Waste from manufacturing or processing or use of explosives
76	SW 432	Waste containing, consisting of or contaminated with peroxides
	SW 5	**Other wastes**
77	SW 501	Any residues from treatment or recovery of scheduled wastes

3.0 STEPS TO IDENTIFY HAZARDOUS CHEMICAL WASTE

1. The first step to identify chemicals that can be considered waste is to find out whether the chemical is:
   - residues from teaching and research activities in the laboratories.
   - spilled chemicals.
   - expired or un-labelled chemicals.
   - contaminated chemicals.
   - chemical by-products that cannot be processed or re-used.
   - chemicals that have been in contact with cloth or any other materials used to clean up chemical spills.

2. After identifying the waste, the next step is to classify the waste. Chemical wastes fall into **FOUR (4)** management categories:
   i. **Hazardous Waste**
   Chemicals with properties that make it dangerous or potentially harmful to human health or the environment, including Scheduled Wastes - waste materials that are specified in the "First Schedule of Regulation 2, Environmental Quality (Scheduled Wastes) Regulations 2005 under Environmental Quality Act 1974".
   ii. **Non-Hazardous Waste**
   Chemical which does not exhibit a state or federal hazardous characteristic and is not listed as a 'hazardous waste' – for example ethidium bromide and nanoparticles.
   iii. **Universal Waste**
   A small subset of chemical wastes has been de-regulated to some extent based on the fact that they are so widespread – which include:
      - Fluorescent bulbs of all shapes and sizes
      - Many types of batteries
      - Mercury-containing devices such as switches and thermostats
   iv. **Safe for Sink or Trash disposal**
   A very small percentage of chemical wastes are un-regulated and safe to pour into sinks or place in the trash. Some examples include benign salts like sodium chloride and non-toxic, non-corrosive cleaning chemicals.

3. If the waste identified as a hazardous waste - one of the four (4) lists of hazardous waste found in the regulations, referred to as "listed waste", determine the hazardous waste characteristics. Hazardous waste characteristics are a property that, when present in a waste, indicates that the waste poses a sufficient threat to merit regulation as hazardous. The U.S. Environmental Protection Agency under Code of Federal Regulations has defined the waste as hazardous if it exhibits one of the four (4) defined hazardous waste characteristics of ignitability, corrosivity, reactivity or toxicity. Figure 1 shows the symbols of the four list of hazardous waste.

Figure 1: Hazardous waste symbols

i. Ignitable Characteristic

Chemical waste is a hazardous waste due to ignitability if:

- **Liquid Chemicals:**
  - The flash point of the liquid chemical is less than or equal to 140 °F or 60 °C.
  - Common examples include:
    - Alcohols (note: for ethanol, mixtures greater than or equal to 20% are hazardous wastes. For other alcohols the cut-off is 10%).
    - Organic solvents and mixtures containing organic solvents such as xylenes, hexane, toluene, acetone, etc.
    - Stains and mixtures containing stains (because they are solvent-based).
    - Oil-based paints and coatings
- **Solid Chemicals:** the chemical is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes, and burns vigorously when ignited.
  - Common examples include:
    - Paraformaldehyde
    - Paraffin wax with xylene
    - Rags saturated with an ignitable liquid
- **Compressed Gas:** Ignitable compressed gases must also be managed as hazardous wastes.
  - Generally, this involves partially-full, or left-over cylinders of gas.
  - Common examples include:
    - Hydrogen
    - Acetylene
    - Propane
    - Butane
- **Oxidizers:** the chemical is capable of enhancing the combustion of other materials, generally by yielding oxygen.
  - Common examples include:
    - Chlorates
    - Chlorites
    - Nitrates
    - Perchlorates
    - Perchlorites

- Permanganates
- Peroxides

ii. Corrosive Characteristic

Chemical waste is a hazardous waste due to corrosivity if:

- It is aqueous and has a pH less than or equal to 2, or greater than or equal to 12.5.
- It is a liquid and corrodes steel (Type SAE 1020) at a rate greater than 6.35 mm (approximately 0.250 inch) per year.
- Common examples include:
  - Hydrochloric Acid
  - Sulfuric Acid
  - Nitric Acid
  - Sodium Hydroxide

iii. **Reactive Characteristic**

A reactive hazardous waste is defined as a material which:

- Under normal conditions is unstable and can undergo violent changes without detonating.
- Reacts violently with water. Common examples include:
  - Sodium metal,
  - Anhydrides,
  - Sodium Borohydride
- Reacts violently with air. Common examples include:
  - *tert*-butyllithium
- Capable of detonation or violent explosion. Common examples include:
  - Dry picric acid,
  - Azide compounds,
  - Organic peroxides,
  - Old ether or tetrahydrofuran with peroxide formation
- A cyanide or sulfide which, when exposed to a pH of between 2 and 12.5, generates toxic gases, vapors or fumes. Common examples include:
  - Sodium cyanide,
  - Potassium cyanide,
  - Sodium sulfide,
  - Carbon disulfide

iv. Toxicity Characteristics

Waste that is hazardous by virtue of the toxicity characteristics if it exceeds specified concentrations of certain metals and organic compounds as listed by reference in the regulations.

4. Every waste type mentioned in First Schedule must be considered as scheduled waste regardless of its hazardous properties. The list of the waste types is divided into **FIVE (5)** groups as follows and their characteristics are summarized in Table 2.

Group 1 – SW 1 : Scheduled wastes from metal and metal-bearing wastes
Group 2 – SW 2 : Scheduled wastes from wastes containing principally inorganic constituents which may contain metals and organic materials
Group 3 – SW 3 : Scheduled wastes from wastes containing principally organic constituents which may contain metals and inorganic materials
Group 4 – SW 4 : Scheduled wastes from wastes which may contain either inorganic or organic constituents
Group 5 – SW 5 : Scheduled wastes from other wastes

Table 2: Characteristics of hazardous wastes

Characteristic	Examples of Scheduled Wastes
Ignitability	• SW 303 – Adhesive or glue containing organic solvents excluding polymeric materials. • SW 322 – Waste of non-halogenated organic solvents • SW 325 - Uncured resin waste containing organic solvents • SW 416 - Sludge of inks, paints, pigments, lacquer, dye or varnish. • SW 417 - Waste of inks, paints, pigments, lacquer, dye or varnish. • SW 432 – Waste containing, consisting of or contaminated with peroxides
Corrosivity	• SW 206 – Spent inorganic acids • SW 201 – Spent organic acids with pH less or equal to 2 which are corrosive or hazardous • SW 401 – Spent alkalis containing heavy metals • SW 402 – Spent alkalis with pH more or equal to 11.5 which are corrosive or hazardous
Reactivity	• SW 317 – Spent organometallic compounds including tetraethyl, tetra-methyl lead and organotin compounds • SW 431 – Waste from manufacturing or processing or use of explosives
Toxicity	• SW 101 – Waste containing arsenic or its compound. • SW 104 – Dust, slag, dross or ash containing aluminium, arsenic, mercury, lead, cadmium, chromium, nickel, copper, vanadium, beryllium, antimony, tellurium, thallium or selenium excluding slag from iron and steel factory. • SW 109 – Waste containing mercury or its compound • SW 204 – Sludge containing one or several metals including chromium, copper, nickel, zinc, lead, cadmium, aluminium, tin, vanadium and beryllium • SW 318 – Waste, substances and articles containing or contaminated with polychlorinated biphenyls (PCB) or polychlorinated triphenyls (PCT). • SW 320 – Waste containing formaldehyde. • SW 407 – Waste containing dioxins or furans.

4.0 MANAGING HAZARDOUS CHEMICAL WASTES

1. Environmental Quality (Scheduled Wastes) Regulations 2005 - These Regulations, under Environmental Quality Act 1974, provide for the disposal, treatment, management, storage and transport of scheduled wastes.

2. Among the objectives are to:

    - ensure proper management of scheduled wastes,
    - prevent pollution of scheduled wastes into the environment: water, land & air pollution
    - monitor the movement of scheduled wastes and to ensure that scheduled waste are handled at a licensed facility.

3. The Regulations include:

    - Identification of scheduled waste by waste generator.
    - Notification of the generation of scheduled wastes.

        - The waste generator must notify within 30 days from the date that any scheduled waste was first generated (2nd Schedule - Notification of Scheduled Wastes).

    - Waste generator shall keep an inventory of scheduled wastes.

        - Keep scheduled wastes inventory in accordance with 5th Schedule for a period of three (3) years (*refer to 5th Schedule on page 12*)

    - Scheduled waste shall be properly labelled – as per legal requirements.

        - The date when the scheduled waste is first generated, name, address and telephone number of waste generator shall be clearly labelled on the containers.
        - Containers shall be labelled clearly as specified in 3rd Schedule (Labelling Requirement for Scheduled Wastes) and marked with scheduled wastes code as specified in 1st Schedule (SW group).

    - The scheduled waste handler shall take necessary safety precautions when handling scheduled waste.
    - Scheduled waste shall be packed in a suitable container.

        - Waste can be collected using its' original container or inside other suitable containers that has been identified as the primary containers that can consists of:
            - Alloy tin
            - Plastic bottle
            - Glass bottle
            - Bottle covered with plastic
            - Plastic bag

    - Incompatible scheduled waste shall not be mixed.

- Chemical wastes should be separated based on the Scheduled Wastes of Potential Incompatibility, Fourth Schedule of the Environment Quality (Scheduled Wastes) Regulations 2005.

- Scheduled waste shall not be stored for more than 20 metric tons or 180 days.
- Scheduled waste shall be stored at a proper storage area that meets all Environment, Health and Safety (EHS) requirements.
- Scheduled waste shall be disposed of, treated or recovered at the prescribed premise only.
- Only licensed contractor is allowed to transport and treat or dispose scheduled waste.
- Transportation of scheduled waste requires consignment note and 7th Schedule (Information - prepared by waste generator).
- Spill or accidental discharge of scheduled waste shall be handled properly by the contractor (with technical support from the waste generator).

  - In the event of a spill or accidental discharge, the contractor is responsible to inform the authority immediately, to do clean-up and to study the impact due to the spill or discharge.
  - Waste generator to provide technical expertise to assist in the clean-up operation.

JADUAL KELIMA
(Peraturan 11)

AKTA KUALITI ALAM SEKELILING 1974

PERATURAN-PERATURAN KUALITI ALAM SEKELILING
(BUANGAN TERJADUAL) 2005

INVENTORI BUANGAN TERJADUAL
SEHINGGA: …….

*[a]Tarikh	*Kod Kategori Buangan	*Nama Buangan	*Kuantiti Dikeluarkan (Tan Metrik)	*Pengendalian Buangan		
				Kaedah[b]	Kuantiti Mengikut Tan Metrik	Tempat[c]

Nota:
* Inventori mengenai pengeluaran buangan terjadual semasa
a Tarikh bila buangan terjadual dikeluarkan buat kali pertama
b Distor, diproses, diperoleh kembali bahan atau hasil daripada buangan terjadual itu, dibakar, ditukarkan atau kaeadh-kaedah lain (nyatakan)
c Berikan nama dan alamat kemudahan

Saya megaku bahawa maklumat diberikan adalah benar dan betul sepanjan pengetahuan saya.

Nama Pegawai Pelapor: ……
Jawatan: ……
Tandatangan: …… Tarikh:……
No. Kad Pengenalan: ……

5.0 WASTE MINIMIZATION

1. Practise waste minimization based on waste management hierarchy (Figure 2).

Figure 2: Waste management hierarchy

2. Effective management is the key to minimising the risks associated with hazardous chemical waste. Every member of the faculty can take the following steps to minimize the volume and toxicity of chemical wastes that are generated.

i. Inventory Management

- Maintain an up-to-date inventory of the chemicals in your laboratory to avoid re-purchasing existing materials and to understand usage patterns.
- Only purchase the amount of chemical you will need in the short term. Buying chemicals in bulk is not financially sustainable when taking into consideration the risks of storage and the costs of disposal.
- Identify co-workers in your area who might have a chemical that you need.
- Dispose of outdated or unwanted chemicals immediately. Some materials, such as peroxide-forming chemicals, become more dangerous over time. It is much safer and much less expensive to get rid of ether that does not have significant peroxide formation.
- Label all chemical containers. Unknown chemical wastes are extremely expensive to dispose of.

ii. Scaling and Substitution

- Consider using microscale experiments to reduce the volume of chemical wastes generated.
- Avoid unnecessary dilutions in experimentation which might increase the volume of hazardous waste generated.
- Substitute less hazardous materials into experiments, for example:
  - Use biodegradable detergents instead of toxic, chromium-based cleaners

- Use non-mercury thermometers
- Select non-mercury preservatives, and choose products such as antibodies which have been manufactured using non-mercury preservatives
- Preserve specimens in ethanol instead of formaldehyde which is much more toxic
- Use non-halogenated solvents in place of halogenated solvents wherever possible to reduce toxicity and disposal costs
- Use sodium hypochlorite instead of dichromate
- Use 'SYBR safe' or other DNA gel stain instead of ethidium bromide

o Eliminate metal catalysts whenever practical, even if it means longer experimentation times
o Purchase chemicals pre-mixed or in the desired concentration to avoid unnecessary experimental steps and un-needed chemical stores
o Substitution of ethanol in place of methanol in experiments can often provide more waste management options.

iii. Recycling

o If your research relies on a large quantity of a specific solvent, try to contact the faculty/university's Occupational Safety and Health (OSH) unit to help you in evaluating a benchtop solvent recycling system.
o If digital image processing is not possible, work with the faculty/university's OSH unit to set up silver recovery and recycling for your darkroom.
o Consider sending chemical wastes for disposal that can be recycled at companies that provide such service (chemical recycling / recovery).

iv. Mixing Waste Streams

o Flammable liquids are the most cost-effective waste stream to dispose of. Avoid mixing halogenated solvents, metals or other hazardous materials with flammable liquid wastes.
o Wastes containing heavy metals should not be combined with any other waste streams.
o Mercury wastes should be kept separate from all other waste streams.

v. Other methods to reduce/minimize the generation of scheduled wastes:

o Commitment from the management,
o Establish a waste reduction policy,
o Usage of environmentally friendly raw materials,
o Improve quality control and process monitoring,
o Apply the concept of " waste exchange" with another plant, and
o Good laboratory housekeeping.

6.0 GENERAL LABORATORY WASTE MANAGEMENT GUIDELINES

Introduction

1. The important aspects of managing scheduled waste are packaging, labelling and storage of scheduled wastes. If it is not managed properly, it will harm the environment and will create health risks.
2. All information about the hazardous waste should be transferred onto labels by waste handlers for proper handling of scheduled wastes.
3. The waste generators should use suitable containers to ensure safety handling, storage and transportation.
4. These guidelines are prepared to fulfill the requirements of Regulation 8, Regulation 9 and Regulation 10 of the Environmental Quality (Scheduled Wastes) Regulations 2005.

Scopes

1. These guidelines provide proper guidance from when the waste is generated until final disposal. It covers the following areas:
    i. Storage of waste in the lab (Temporary)
    ii. Waste containers management
    iii. Labelling of waste
    iv. Drain disposal

Storage of waste in the lab (Temporary)

1. Store all waste in labeled containers. All chemicals waste should be stored or placed in proper containers and must be labeled properly stating the name, date and types.
2. **DO NOT** fill the waste container until full; maximum 80% of container total volume. (Figure 3)

Figure 3: Container of almost full waste.

3. Waste containers must be placed in a designated location, following the guidelines below:

    i. Near where the waste is generated.
    ii. Supervised by lab personnel or Person-in-charge (PIC).

iii. Avoid obstruction of normal lab activities.
iv. Label the area with a "DANGER – HAZARDOUS WASTE" sign.
v. The area should be easily accessible and recognizable to an authorized person.
vi. The storage area should be well ventilated to avoid further complications.

4. Use secondary containment such as trays, for spills or leakage from the primary containers.
5. Fume hoods may be used to store small quantities of waste materials temporarily but should not serve as designated waste storage areas.
6. Hazardous waste storage limits:
   i. Never store more than 208 Liters (55 gallons) of hazardous waste or one quart of acute hazardous waste at one time.
   ii. Always monitor your hazardous waste to prevent exceeding the limits.
   iii. If exceed the limits, immediately request for collection.
   iv. Store hazardous waste in quantities that can be manage properly and easily.
   v. Minimize the storage of hazardous waste in your lab.

Waste containers management

1. Store waste in sealed and compatible containers. The best container is the original chemical container. Avoid using household detergent and food containers.
2. All waste containers must be kept closed at all times except to add or remove waste.
3. Label waste containers (refer to Appendix 1) properly with all required information for each waste.
4. Stored wastes with secondary containment such as trays, for spills or leakage from the primary containers.
5. Separate wastes according to its category.
6. Avoid storing more than 208 liters (55 gallons) of waste or one quart of acute hazardous waste.
7. All waste containers must be sealed with a screw-type lid or appropriate device to prevent leakage or spillage (Never used plastic wrap, aluminum foil, and other makeshift lids).
8. If a waste container is used to collect waste from a continuous process (i.e., drainage from a process collected with tubing inserted into a bottle), the container must still be sealed using rubber stoppers with tubing inserts or other appropriate means.
9. Containers must be labeled with hazardous chemical waste tags as soon as the container is used to collect hazardous waste, regardless of whether the container is full.

Labelling of waste

1. Identification
   i. The information about scheduled waste must be displayed, which include waste name, waste code, date generated, name of waste generator, address of waste generator and their phone number.

ii. All waste containers must have a label when waste is placed into the container.
iii. All information required on the label must be completed once the waste is added to a container. Percentages and additional constituents can be added later.

iv. Write the Chemicals' full name on the label and avoid writing chemical symbols, abbreviations, or codes for waste identification.

v. Use Pencil only to write on the label inks are easily washed-off.

vi. Each containers of scheduled waste must be properly labelled for identification and warning purposes. It has been mentioned in regulation 10, of Environmental Quality (Scheduled Waste) Regulation 2005.

2. "Regulation 10. Labelling of scheduled wastes":
   - The date when the scheduled wastes are first generated, name, address and telephone number of the waste generator shall be clearly labelled on the containers that are used to store the scheduled wastes.
   - Containers of scheduled wastes shall be clearly labelled in accordance with the types applicable to them as specified in the Third Schedule and marked with the scheduled waste code as specified in the First Schedule for identification and warning purposes.
   - No person is allowed to alter the markings and labels mentioned in sub regulations (1) and (2).

3. Hazard label
   - This label is used to display the characteristic of the scheduled waste (toxic, flammable, oxidizing, irritant, corrosive, explosive etc).

Drain disposal

1. Dispose of chemical waste properly and never dispose or pour it down the drain unless without properly treating the waste first. Contact your supervisor or local waste disposal company.
2. Drain disposal is allowed in the following instance:
   - No treatment needed:
     i. Safe for Sink, type of chemical waste – refer page 6
   - Prior treatment or neutralisation required:
     i. Post treated *aqua regia* waste – refer page 27
     ii. Post treated Piranha Solution waste – refer page 27
     iii. Wastewater from solid biological waste tank – refer page 32

7.0 SPECIFIC WASTE MANGEMENT REQUIREMENTS

7.1 Waste handling - Unknown wastes

1. Unknown wastes are any materials whose chemical makeup or physical characteristics are not known at the time of disposal. Chemical bottles without labels, containers labelled merely with numbers, general process labels that do not expressly name the compounds inside, and mislabeled substances are all examples of unknown waste. Abandoned waste may also be classified as an unknown waste, and it is treated as a hazardous material until it has been identified appropriately.
2. Whenever an unfamiliar object is discovered, you must make every effort to provide a detailed description of its contents.

3. Identification
   - Generally, the contents are identifiable by those who operate in the field in which the items were employed. If this does not yield a positive identification of the item, some elementary examination of the material must be conducted**.**
   - Please use all necessary precautions prior to attempting to identify the unknown item. Protect yourself by wearing the appropriate personal protective equipment. All screening procedures should be carried out in a properly working fume hood. In the event of unexpectedly violent reactions due to flammability, it is suggested that a Class ABC fire extinguisher be ready.

Step 1: Determine radioactivity (if the facility has access to a radioactivity monitor).

Turn on the radioactivity monitor and check the battery. Check the monitor by first taking a reading far away from the material to be tested. This will be your normal background reading. The setting should be set at 1X. Hold monitor within 1 inch of the sample for a minimum of 5 seconds. Observe for any consistent readings.

Step 2: Determine physical description. Note the following:

i. color
ii. state (solid, liquid)
iii. particle size
iv. free liquids
v. layering
vi. incidental odor (**DO NOT SMELL**)

Peroxidizable compounds tend to react with oxygen over time to form potentially explosive compounds. Exposure to air and light accelerates this process. Therefore, if your unlabeled LIQUID has partially or fully evaporated and crystals are present (or the liquid has become cloudy), label the container as "POSSIBLE PEROXIDE."

Step 3: Air Reactivity

Pour a small amount (a few drops or crystals) of the material into your container in the hood. If the material is air reactive, a reaction will be apparent within 30 seconds and should be labelled "Characterized Waste—Air Reactive".

Step 4: Water Reactivity

Pour a small amount (a few drops or crystals) of the material into your container in the hood. Using a wash bottle filled with water, add a few drops of water to the compound. If the material is water-reactive, a reaction will be apparent within a few seconds. If reactive, label the container "Characterized Waste—Water Reactive".

Step 5: Corrosivity

Obtain the pH of the sample using pH paper or a pH meter. For solids which do not test positive for water reactivity, add a small amount of water to the sample. Record the pH to the nearest whole number on the container label.

Step 6: Flammability

When performing flame tests with solids, use a small spatula to minimize potential reactions. Hold the spatula a few centimetres above the flame of a bunsen burner for a few seconds. If the solid does not start burning, move the material into direct contact with the flame. If the material does not start burning after 10 seconds of direct contact with the flame, it is considered not flammable. For liquids, use cotton tipped applicators to dip into the liquid before igniting.

Step 7: Oxidizer

- For liquids, place a few drops of the sample onto a strip of potassium-iodide starch paper.
- For solids or semi-solids, slurry sample with some distilled water in a 1:1 mixture or ratio. Place the potassium-iodide starch paper onto the sample.
- Observe for any colour changes.

Observation	**Result**
Potassium-iodide starch paper turns purple	Chemical is RCRA Hazardous for an oxidizer (D001).
No color change	Chemical is not an oxidizer

4. Labelling
   - Fill up all the test results on the waste chemical tag (Appendix 2). You may also fill in any additional information.

7.2 Waste handling - Peroxide forming chemicals

1. Organic compounds that contain hydrocarbons and molecular oxygen spontaneously react with each other to generate peroxides. This is caused by a free radical interaction between the hydrocarbon and the molecular oxygen. The build-up of peroxides in a chemical container under normal storage circumstances can result in an explosion if the container is subjected to heat, friction, or mechanical trauma. When a peroxide-forming chemical is concentrated by means of distillation or evaporation, the hazard is enhanced significantly. In the laboratory, peroxides tend to burst violently, and they are capable of causing significant harm or death to researchers who are working with them.

2. Classification list of peroxide forming chemicals

Class A – Severe peroxide hazard

Spontaneously decompose and become explosive with exposure to air without concentration.

Liquid State	Solid State
Butadiene (liquid monomer)	Potassium metal
Chloroprene (liquid monomer)	Sodium amide (sodamide)
Isopropyl ether	Potassium amide
Divinyl ether	
Vinylidene chloride	
Tetrafluoroethylene (liquid monomer)	

Class B – Concentration hazard

Require external energy for spontaneous decomposition. Form explosive peroxides when distilled, evaporated or otherwise concentrated.

Acetal	Diethyl ether	2-Phenylethanol
Acetaldehyde	Dioxanes	Tetrahydrofuran (THF)
Benzyl alcohol	Ethylene glycol dimethyl ether	Tetrahydronaphthalene
Benzaldehyde	Furan	Vinyl ethers
2-Butanol	Methylacetylene	
Cumene (Isopropylbenzene)	Methylcyclopentane	
Cyclohexanol	2-Pentanol	
Cyclohexene	4-Penten-1-ol	
Diacetylene	1-Phenylethanol	

Class C – Shock and heat sensitive

Highly reactive and can auto-polymerize as a result of internal peroxide accumulation. The peroxides formed in these reactions are extremely shock and heat sensitive.

Acrylic acid	Chlorotrifluoroethylene (gas)	Vinylacetylene (gas)
Acrylonitrile	Methyl methacrylate	Vinyladiene chloride
Butadiene (gas)	Styrene	Vinyl chloride (gas)
Chlorobutadiene	Tetrafluroethylene (gas)	Vinyl pyridine
Chloroprene	Vinyl acetate	

Class D – May form peroxides but cannot be clearly categorized in class A, B or C

Crolein	p-Chlorophenetole	4,5-Hexadien-2-yn-1-ol
Allyl ether	Cyclooctene	n-Hexyl ether
Allyl ethyl ether	Cyclopropyl methyl ether	o.p-Iodophenetole
Allyl phenyl ether	Diallyl ether	Isoamyl benzyl ether
p-(n-Amyloxy)benzoyl chloride	p-Di-n-butoxybenzene	Isoamyl ether
n-Amyl ether	1,2-Dibenzyloxyethane	Isobutyl vinyl ether
Benzyl n-butyl ether	p-Dibenzyloxybenzene	Isophorone
Benzyl ether	1,2-Dichloroethyl ethyl ether	b-Isopropoxypropionitrile

1-(2-Chloroethoxy)-2-phenoxyethane	Ethyl-b-ethoxypropionate	Triethylene glycol dipropionate
Chloroethylene	Ethylene glycol monomethyl ether	1,3,3-Trimethoxypropene
Chloromethyl methyl ether	2-Ethylhexanal	1,1,2,3-Tetrachloro-1,3-butadiene
beta-Chlorophenetole	Ethyl vinyl ether	4-Vinyl cyclohexene
o-Chlorophenol	2,5-Hexadiyn-1-ol	Vinylene carbonate

3. Visual signs of peroxide formation
    - Visual inspection can help you determine if your compound has begun to form peroxides. A non-hazardous light source like a flashlight can be used to provide backlight or side light to the bottle to make indicators visible.
        i. Clear liquid containing suspended wisp-like structures
        ii. Precipitated crystal formation appears as chips, ice-like structures, solid mass (Figure 4)
        iii. Appearance of cloudiness
        iv. Gross contamination
        v. White crystal under the rim of the cap
        vi. Visible discoloration

    - For solid chemicals (potassium metal, potassium and sodium amide):
        - Discoloration and/or formation of a surface crust (for example, potassium metal forms a yellow or orange superoxide at the surface)

Evaluation of alkali metals and their amides is based on visual criteria only. These substances react violently with water and oxygen, so standard peroxide tests should not be used.

Figure 4: Sample of peroxide forming on chemical bottle.

Testing for Peroxides

1. Peroxide test strips are a simple and quick way to detect the presence of peroxides in the environment. When testing for volatile organic chemicals, the test strip is soaked in the chemical for 1 or 2 seconds, then shaken to remove any excess chemical and allow the color to stabilize before being used again. The color of the test strip is compared to a colorimetric scale printed on the bottle of the test kit (Figure 5). Testing for peroxides must be carried out in a fume hood.

Figure 5: Testing for peroxide (*Image from Health & Safety Guide, University of Minnesota*)

Peroxides concentration guide table

Peroxides concentration	Instruction
Under 20ppm	Solvent is safe for use
Between 20 and 100ppm	Solvent should not be distilled or concentrated
Between 100 and 400ppm	Solvent must be disposed of as waste
Above 400ppm	Immediate Safety & Health Officer assistance and evaluation is needed

Disposal of peroxides

1. All laboratory waste that contains peroxide-forming chemicals should be treated as hazardous waste. Items that fail the peroxide test should be disposed of as hazardous trash as soon as possible once they are discovered.
2. Always wear appropriate personal protective equipment when handling peroxide forming chemical waste. This includes lab coat, nitrile gloves and eye protection. Chemical splash goggles and safety glasses rated for impact (ANSI Z87+) should be worn.
3. Kindly read through the chemical Safety Data Sheet (SDS) before continuing with the disposal process.
4. Label potential peroxide formers with the peroxide former tag – including date received, date opened, and date tested (if applicable). See Appendix 3.
5. Do not mix the peroxide forming chemical waste with other types of waste.
6. Peroxide-forming compounds should be stored away from heat and light, and they should not be exposed to situations that could cause friction. Light can aid in the synthesis of peroxides as well as the formation of potentially hazardous peroxide breakdown products. Peroxide formers should be stored away from light and in light-resistant containers. (i.e., amber glass, aluminum cans). Do not use ground glass joint stoppers for storage containers.
7. Whenever possible, avoid storing or using peroxide-forming compounds in situations where they will be exposed to oxygen. Reduced exposure to oxygen slows the rate and quantity of peroxide generation, which is beneficial. Materials should be stored and used beneath a blanket of inert gas (e.g., sure sealed containers, solvent dispensing systems) or in an inert atmosphere (e.g., glovebox) whenever possible. Keep containers tightly closed.
8. Disposal of residual of reactive metals; peroxide forming solid chemicals (e.g. potassium and sodium)
    - Residual of sodium and potassium cannot be put together with solid waste as this can cause fire when the metals get in touch with sufficient moisture in the air.
    - To dispose the residue of sodium and potassium, place sodium or potassium in iso-propyl alcohol and stir for 4 hours in a closed container. Then followed by ethanol and lastly methanol.

7.3 Waste handling - Waste oil

1. Waste oil is one of the waste streams prescribed under the Environmental Quality (Scheduled Wastes) Regulations 2005 and is one of the few wastes that has economic value and is recovered and reuse.
2. Waste oil may contain physical and chemical impurities that can induce a variety of illnesses and diseases in human and living organisms through inhalation, ingestion or skin contact. Table 3 shows the main contaminants in waste oil.

Table 3: Principal contaminants in waste oil

Metals and Inorganics	Chlorinated hydrocarbons	Other organics
Aluminum Antimony Arsenic Barium Cadmium Calcium Chromium Cobalt Copper Lead Magnesium Manganese Mercury Nickel Phosphorus Silicon Sulphur Zinc	Dichlorodifluoromethane Trichlorodifluoromethane 1,1,1-Trichloroethane Trichloroethylene Tetrachloroethylene Total chlorine Polychlorinated biphenyls	Benzene Toluene Xylenes Benza(a)anthracene Benzo(a)pyrene Naphthalene Other PAHs

3. In Malaysia, waste oil is classified as scheduled wastes under the First Schedule of the Environmental Quality (Scheduled Wastes) Regulations 2005, with the following codes and descriptions:
    i. SW 305 – Spent lubricating oil
    ii. SW 306 – Spent hydraulic oil
    iii. SW 307 – Spent mineral oil-water emulsion
    iv. SW 308 – Oil tanker sludge's
    v. SW 309 – Oil-water mixture such as ballast water
    vi. SW 310 – Sludge from mineral oil storage tank
    vii. SW 311 – Waste oil or oily sludge's
    viii. SW 312 – Oily residue from automotive workshop, service station oil or grease interceptor
    ix. SW 314 – Oil or sludge from oil refinery or petrochemical plant

4. Waste oil is also listed as code A4060 under Annex VIII, List A of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal 1989.

Handling and management of waste oils

1. Waste oil should be managed properly according to the requirements of the Environmental Quality (Scheduled Wastes) Regulations 2005. For waste oil that still has an economic value, it can be recovered by waste oil recovery facilities that are licensed by the Department of Environment.

The list of the licensed recovery facilities can be obtained from the official website of Department of Environment at www.doe.gov.my. The recovered, recycled, or reconstituted processes of waste oil that does not meet the standard and specification set, its still categorized as scheduled waste.

2. The following guidelines must be adhered to for handling waste oils:

i. Properly storing waste oil for collection and recycling

The first step in proper oil disposal is to properly handle waste oil in the right container. The most reliable approach is to transport the oil in its original tanks. The storage container should also be tightly sealed to avoid leakage that might endanger the environment. The used oil should be properly moved into the storage container to avoid spillage. Once the storage unit has been tightly sealed, it should be clearly labeled. Examples of containers are IBC tanks (Intermedia bulk containers) and metal drums.

ii. Do not pour it into the drain, sink, or into the river nearby.

It should be properly stored and labeled as stated above to later dispose it correctly, sending it for recycling, or using the services of a professional.

Depending on where and how the waste oil was made, there are various legal criteria. Waste lubricating/hydraulic oils are classified as hazardous waste and can be subject to additional regulations criteria. In Malaysia, waste lubricating oils are mostly classified under scheduled waste code SW305.

iii. Waste oil should be packed properly and stored in a proper storage

Since you will be unable to dispose of the waste oil on the very day you replace it from your machine, do ensure that it is kept in a safe place so no one without the right information will be able to access it, particularly if children and pets are present. To avoid confusion, waste oil should not be stored in the same place as unused oil, particularly if it is stored in regular fuel storage.

iv. Call the experts to manage your waste oil properly

Not every waste generator has the right to dispose of their waste. If you do not have the consent of the Department of Environment Malaysia to dispose of waste oil, you can still contact a local waste oil collection company. The majority of waste oil disposal firms have the required equipment and facilities to ensure safe and effective waste oil disposal. When applying for such programs, the level of expertise and cost should be considered.

v. Only authorized transporters are reliable to transport the hazardous waste to the recovery facilities

Waste generators should always take note that unauthorized transporters shall put your company into trouble. Besides, oil filters, oily rags, and waste oil cans are often accepted by certain scheduled waste collectors.

7.4 Waste handling - Gas producing waste streams

1. Chemical mixtures that produce gas in the laboratory must be handled with caution to avoid pressurizing or exploding the containers. Two types of chemical mixture that result in the production of gas:

   i. Aqua regia solution (Crosland et al., 1995).

   Aqua regia (Latin for "Royal Water") is a nitric acid solution. The usual solution is a 3:1 mixture of hydrochloric and nitric acid. It is frequently used in microfabrication and microelectronics laboratories to remove noble metals such as gold, platinum, and palladium from surfaces. Additionally, glassware can be rinsed with aqua regia to eliminate trace levels of organic substances. Aqua regia solutions are extremely corrosive and should be handled with utmost caution to avoid explosions or skin burns.

   Handling aqua regia waste

   Excess or waste solutions should be neutralised with sodium bicarbonate and flushed with copious amounts of water before being disposed of down the drain. If the solution contains heavy metals (such as silver or chromium), it should be handled as hazardous waste.

Always use proper PPE when handling corrosive solutions

   ii. Piranha solution (Sun et al., 2015).

   Piranha solutions are made by mixing concentrated sulfuric acid with hydrogen peroxide in a ratio of 3:1 to 7:1. They are used to remove very small amounts of organic residues, like photoresist, from substrates, such as paper or cardboard. The mixing process is an exothermic reaction that can get hotter than 100ºC or higher. Caro's acid, or peroxymonosulfuric acid (H_2SO_5), is made when hydrogen peroxide reacts with sulfuric acid that is very concentrated.

   Handling Piranha Solution waste

   If possible, neutralize spent piranha solution as you generate it. Put five times as much ice as the amount of the solution you want to neutralize into a container large enough to hold the ice, the piranha and the neutralizing solution (e.g., use 500 g of ice for 100 ml piranha solution). Pour the spent piranha solution onto the ice and then slowly add 1M sodium or potassium hydroxide solution while stirring until a neutral pH is reached.

   Alternatively, if no ice is available, fill the bottom of a container (10 times the volume of the piranha solution) 1 inch high with dry sodium bicarbonate and cover it with water. Slowly pour the piranha solution in small portions onto the sodium bicarbonate. Carbon dioxide will form, and the solution can quickly foam over. Stir and wait for the gas to escape before adding more piranha solution. Make sure that solid sodium bicarbonate is left at the bottom of the container and add more if it is used up.

If the waste solution does not contain any regulated metals (arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, zinc), the neutralized solution can be poured down the drain.

Always use proper PPE when handling corrosive solutions

7.5 Waste handling – Mixed wastes

1. In most cases, mixed trash is made up of a combination of radioactive, biological, and chemical waste. The removal and disposal of mixed garbage is expensive and necessitates the use of specialised equipment. Because most vendors must have a permit for the sort of trash they are disposing of, a mixed waste cannot be disposed of through the typical channels of distribution. When dealing with waste, the most common technique is to destroy or remove one of the waste types. As a general rule, when dealing with waste that contains a combination of hazardous chemicals, radioactive materials, and biological agents, the biological danger should be dealt with first and foremost.
2. Steam sterilisation is generally not suggested for waste containing considerable concentrations of hazardous chemical, radioactive, or biological agents in conjunction with other hazardous agents.

7.6 Waste Handling – Empty containers

1. An empty container is defined as removing the content by pouring, pumping, or aspirating. To be considered empty, containers that hold liquids must not have one drop of material left to remove by inverting the container. Containers containing solid and semi-solid chemicals are deemed empty when no additional material can be scraped or chipped away.
2. Follow these steps to ensure empty containers are properly disposed of:

Step 1: Empty the container

i. Containers with (Acutely Hazardous) Chemicals

- Empty containers that held acutely hazardous chemicals must be triple rinsed with a material (water, solvent, etc.) capable of removing the original material. Consult with your Supervisor or Principal Investigator for a suitable rinse material.
- It may be necessary to collect the rinsate for disposal as hazardous waste depending on the original contents and the material used for rinsing.
- A liquid container is considered empty if:
  - No liquids can drain from it when tilted in any direction.
  - There is no hazardous material remaining that can feasibly be removed
  - The walls have no crusted materials on them to be considered empty
- For pesticide containers, the manufacturer's label and SDS should be read to determine if any special precautions must be taken concerning disposal. Containers that held pesticides must never

be recycled or reused. Never dispose of pesticide other than the method listed on the label.

ii. Containers with Solid or Non-Pourable

- Scrape the interior surface clean. Consult with Supervisor or Principal Investigator for proper instructions prior to scraping any chemical container.
- Triple rinse all containers with a material (water, solvent, etc.) capable of removing the original material. Consult with your Supervisor or Principal Investigator.
- It may be necessary to collect the scrapings and/or rinsate for disposal as hazardous waste depending on the original contents and the material used for rinsing.
- Allow container to air dry if necessary
- A solid or non-pourable container is considered empty if:
- The interior surface and walls of the container are scraped clean with no adhered or encrusted material, and /or residual material.

Step 2: Deface the Label

- Remove or cross-out all labels and associated hazard warning information with a large dark permanent marker. It must be obvious that the container does not hold the original material.
- Clearly write the words "EMPTY" on the container (Figure 6).

Figure 6: Labelling empty bottles

Step 3: Remove all lids and/or caps

- Remove all lids and/or caps from the container unless the container will be reused in the lab or workspace. This is to prevent the container from becoming pressurized if it is compacted.

Step 4: Reuse /Recyle

- Empty chemical containers work well to store hazardous waste. Always only reuse empty glass or plastic containers. When re-using them, make sure the chemicals or hazardous material you collect is compatible with the container or any residuals left inside the containers.

Never reuse metal containers

Step 5: Dispose of the Container

- All containers must be stored safely and securely until processed, e.g in a central collecting facility. Do not place empty containers in the hallway or any other unsecured area. Arrange for the proper removal of these containers at a central facility.

Disinfection procedure for waste containers:

3. Preparing and using a bleach solution

   Ensure the area is well ventilated when diluting or using bleach. Put on protective gear. Gloves, lab coats or plastic aprons, and goggles are recommended when handling bleach.

   For a 1L flask:

   i. Add 900 mL of water
   ii. Add 100 mL of bleach
   iii. Ensure the contents are mixed thoroughly

4. Using bleach on surfaces

   Apply the bleach solution onto a surface and allow it to sit for 10 minutes. Bleach is corrosive so if you are using bleach to disinfect a biosafety cabinet, spray bleach onto a paper towel outside of the cabinet and then wipe the surface.

5. Using bleach to decontaminate liquid biohazardous waste

   Liquid biohazardous waste may be decontaminated by adding bleach to the liquid waste until a 1-3% concentration of sodium hypochlorite (NaClO) is achieved. For example, you can add 1-part bleach (containing 10% NaClO) into 9 parts liquid biohazardous waste, or 300 mL of household bleach into 700 mL of biohazardous waste in a 1 L container. Let bleach-waste mixture stand for at least 30 minutes before disposal.

   After disinfection, the remaining waste can be disposed of as chemical or radioactive waste.

7.6 Waste Handling - Biological waste

1. Biological waste refers to discarded biological material from teaching and research laboratories and operations. This does not include household or office trash, waste from food services, physical plant, bedding and manure from normal agricultural operations or bedding and litter from non-infectious animals.
2. Biohazardous waste refers to any solid or liquid biological waste that is hazardous because of its physical and/or biological nature and is differentiated from that which contains hazardous chemicals or radioactive materials. All waste that contains infectious material or which, because of its biological nature, may be harmful to humans, animals, plants or the environment is biohazardous waste. This includes: waste from infectious animals; bulk human blood or blood products; infectious microbiological waste (including contaminated disposable culture dishes and disposable devices used to transfer, inoculate and mix cultures); pathological waste; sharps; and hazardous products of recombinant DNA biotechnology and genetic manipulation.
3. Infectious waste as biological waste can be defined into **SEVEN (7)** categories of waste:
    i. ***Cultures and stocks****:* Agents infectious to humans and associated biologicals, waste from biological production, live and attenuated vaccines and anything used to contain, mix or transfer agents. This includes but is not limited to petri dishes, pipettes, pipette tips, micro titer plates, disposable loops, Eppendorf and toothpicks.
    ii. ***Human blood, blood products and infectious body fluids****:* This category includes blood that is not contained by a disposable item or is visibly dripping, serum, plasma, and other blood products or non-glass containers filled with such discarded fluids. It further includes any substance which contains visible blood, semen, vaginal secretions, cerebrospinal fluid, synovial fluid, peritoneal fluid and pericardial fluid. Glass containers filled with such discarded fluids shall be considered sharps. Intravenous bags which did not contain blood or blood products shall not be considered a blood product. Dialysates are not considered blood or body fluids.
    iii. ***Sharps****:* needles, scalpel blades, hypodermic needles, syringes (with or without attached needles) and needles with attached tubing regardless of contact with infectious agents are considered by EPA and DEP to be regulated medical waste. Other sharps: pasteur pipettes, disposable pipettes, razor blades, blood vials, test tubes, pipette tips, broken plastic culture dishes, glass culture dishes and other types of broken and unbroken glass waste (including microscope slides and cover slips) that may have been in contact with infectious material. Items that can puncture or tear autoclave bags.
    iv. ***Animal waste****:* includes (contaminated) carcasses; body parts; whole blood and blood products, serum, plasma and other blood components; and bedding of animals.
    v. ***Isolation waste****:* biological waste and discarded material contaminated with body fluids from humans or animals which are isolated because they are known to be infected with a highly communicable disease (biosafety level 4 agent).

vi. Any material collected during or resulting from the cleanup of a spill of infectious or chemotherapy waste.
vii. Any waste mixed with infectious waste that cannot be considered as chemical hazardous waste or radioactive waste.

Segregation of biological waste in the laboratory

1. Any waste that could produce laceration or puncture injuries must be disposed of as "SHARPS". Sharps must be segregated from other waste. Metal sharps and broken glass may be commingled with each other, but not with non-sharp waste.
2. Waste that is to be incinerated should not be commingled with glass or plastics.
3. Biological waste must not be commingled with chemical waste or other laboratory trash.
4. Hazardous biological waste should be segregated from other biological waste.

Storage of biological waste

1. Biological waste must be stored in containers that is appropriate for the contents, not leak, be properly labeled, and maintain their integrity if chemical or thermal treatment is used. Containers of biohazardous material should be kept closed.
2. Biohazardous waste should be treated and disposed of promptly and not allowed to accumulate. Containers holding biohazardous material must be clearly labeled, including the Biohazard Symbol. Biological waste may be held temporarily under refrigeration, prior to disposal, in a safe manner that does not create aesthetic (visual or odor) problems. Storage enclosures must be clean and orderly with no access to unauthorized persons (warning signs must be posted).
3. Types of containers based on the type of biological waste
    i. ***Metal sharps*** Place in a rigid, puncture resistant container (heavy walled plastic is recommended). The container should be used for encapsulation and disposal. Label the container "ENCAPSULATED SHARPS". Never attempt to retrieve items from a sharps container. Do not place sharps in plastic bags or other thin-walled containers.
    ii. ***Broken glassware*** -Place in a rigid, puncture resistant container (plastic, heavy cardboard or metal), seal securely and clearly label "BROKEN GLASS".
    iii. ***Solid biohazardous waste*** - Use heavy-duty plastic BIOHAZARDBAGS" (autoclave bags) or containers for solid biohazardous waste (including contaminated disposable plastic labware, paper, bedding, etc [NOT SHARPS]).
    iv. ***Non-hazardous biological waste*** - Heavy duty plastic bags or other appropriate containers without a Biohazard label are preferred. Red or orange biohazard bags or containers should not be used for nonhazardous material.
    v. ***Liquids*** should be placed in leak-proof containers able to withstand thermal or chemical treatment.

Do not use plastic bags to contain liquids for storage of wastes at the central disposal facility

Treatment of biohazardous waste

1. Biohazardous waste must be rendered harmless by appropriate treatment prior to disposal. Waste should be treated as near the point of origination as possible. Treatment methods include: incineration; chemical disinfection, thermal disinfection and encapsulation.
    i. ***Encapsulation***- is the treatment of waste, especially sharps, using a material such as Plaster of Paris (or a commercial product such as Isolyser) which when fully reacted, will encase the waste in a solid protective matrix. The encapsulating agent must completely fill the container. The container and solidified contents must withstand an applied pressure of 40 psi without disintegration.
    ii. ***Incineration***- means burning biological waste in an incinerator permitted
    iii. ***Chemical disinfection*** - means the use of a chemical agent such as 10% hypochlorite or EPA-approved chemical disinfectant/sterilant (used according to manufacturer's direction) to significantly reduce biological activity of biohazardous material.
    iv. ***Thermal treatment*** means (a) autoclaving at a temperature of not less than 121°C, and a minimum pressure of 15 psi for at least 30 minutes (longer times may be required depending on the amount of waste, water content and the type of container used) or (b) subjecting biological material to dry heat of not less than 160°C, under atmospheric pressure for at least two hours. (Exposure begins after the material reaches the specific temperature and does not include lag time).

Labelling of biohazardous waste

1. Each container of untreated biohazardous waste must be clearly identified as such and must be labeled with the Biohazard Symbol.
2. Each container of treated biohazardous waste intended for disposal in the Landfill must be labelled to indicate the method of treatment and to cover biohazard markings.
3. Label autoclave bags with commercially available autoclave tape that produces the word "AUTOCLAVED" upon adequate thermal treatment. Apply this tape across the Biohazard Symbol on the bag before autoclaving.
4. All containers of encapsulated sharps must be labelled as "ENCAPSULATED SHARPS".

Disposal methods of biohazardous waste

1. Biological waste must be ensured non-hazardous by treating it first using one of the above methods before disposal.
    i. Encapsulate (solidify) in a properly labeled, puncture resistant container; stored together before deposition in the landfill.
    ii. Needles, such as those used for gas chromatography, should be thoroughly rinsed to remove hazardous chemicals, then disposed with non-contaminated broken glassware (refer next section).

2. Disposal methods are based on the types of biological waste:
    i. ***Animal carcasses and body parts*** - must be incinerated or sent to a commercial rendering plant for disposal.
    ii. ***Solid animal waste*** - All animal waste, including bedding, that is infectious or harmful to animals, humans or the environment, should be appropriately treated prior to disposal, regardless of the origin of contamination. The following disposal methods are acceptable:
        a. Preferred Method: incineration followed by deposition of the residual ash in the landfill.
        b. Thermal or chemical disinfection is followed by deposition in the landfill.
    iii. ***Liquid waste*** - including bulk blood and blood products, cultures and stocks of etiologic agents and viruses, cell culture material and products of recombinant DNA technology should be disinfected by thermal or chemical treatment and then discharged into the sewer system.
    iv. ***Sharp wastes*** - Discarded sharps (contaminated or not), **MUST** be contained, encapsulated and disposed of in a manner that prevents injury to laboratory, custodial and landfill workers.
    v. ***Pasteur pipets and broken glassware***
        a. Contaminated with biohazardous materials: Place in a properly labeled, leak proof and puncture resistant container; disinfect by thermal or chemical treatment; collect in central storage beforedeposition in the Landfill; OR
        b. Not contaminated: Place in a puncture resistant container, then collect in central storage before deposition in the Landfill. The container must be clearly labelled to indicate that it contains BROKEN GLASS.
        c. Do not incinerate glassware.
    vi. ***Plastic waste***
        a. Contaminated with biohazardous matereials: Place in a properly labelled, leak-proof container; disinfect by thermal or chemical treatment; collect in central storage before deposition in the landfill.
        b. Not contaminated: collect in central storage before deposition in the landfill.
        c. Do not incinerate plastics
    vii. ***Microbiological waste***
        a. Solid: Place in a properly labelled, leak-proof container; disinfect by thermal or chemical treatment; collect in central storage before deposition in the landfill.
        b. Liquid waste should be disinfected by thermal or chemical treatment and then discharged into the sewer system.
    viii. ***Genetic materials:*** Disposal of materials containing recombinant DNA or genetically altered organisms must be consistent with applicable Ministry of Natural Resources and Environment (NRE) Guidelines on Biosafety, in addition to complying with the requirements contained in this document.
    ix. ***Non-hazardous biological wastes***
        a. Biological waste (other than animal carcasses or body parts) that is not infectious or otherwise hazardous to humans, animals, plants

or the environment may be discarded as regular municipal waste (solid) or sewage (liquid).

b. There are no record keeping or labeling requirements for nonhazardous biological waste.

c. It is good laboratory practice to autoclave or disinfect all microbial products. Culture materials and biological specimens, including bacterial or "normal" cell cultures and primary tissues should be autoclaved or treated with a 10% sodium hypochlorite (or equivalent) solution. Liquid waste should be discharged into the Sewer System. Avoid conditions that may create visual or odor problems.

d. Non-hazardous waste should not be identified as hazardous. Containers should be labelled "NONHAZARDOUS LABORATORY WASTE". Do not use Biohazard bags or "red bags" for non-hazardous waste.

e. Non-hazardous bedding (laboratory animal) and agricultural waste such as bedding, manure, etc. should be used as compost or fertilizer whenever practical. Minimize deposition of recyclable material in the landfill.

x. ***Mixed waste:*** Follow the formula below to determine which waste stream.

xi. ***Radioactive waste (Biological + Radiation):*** Biological waste that contains radioactive material must be disposed of according to the procedures of the Radioactive Waste Management by Malaysian Nuclear Agency.

xii. ***Chemical waste (Biological + Hazardous chemical):*** Biohazardous waste which also contains hazardous chemicals must be treated to eliminate the biohazard, and then managed as hazardous chemical waste.

Handling and transport of Biohazardous waste

1. Properly trained laboratory personnel (not custodial) shall be responsible for transporting treated biological waste from the generation site to the central storage facility. Untreated biohazardous waste shall be handled only by properly trained technical personnel.
2. Treated waste must be properly contained and labeled before transport to the disposal site
3. Transport of untreated biohazardous materials or foul or visually offensive material through non-lab or populated areas should be avoided.
4. Trash/laundry chutes, compactors, grinders cannot be used to transfer or process untreated biohazardous waste.

Special Case Study

A. Collection & disposal of Curatorial biological waste*

**Applicable to STA and STH programmes*

For disposing of a wet biological collection specimen, the following steps are used:

Step 1: Take note of the preservation solvent that is being used and its concentration. Normally, the specimens are preserved in 70-80% Ethanol (Figure 7(a)).	 **Figure 7(a):** Specimen jars with contents
Step 2: Solvent waste to be collected and dispose of as chemical waste (Figure 7(b)).	 **Figure 7(b):** solvent waste collected in container
Step 3: The solid biological wastes are collected and weighed (Figure 7(c))	 **Figure 7(c):** weighing biological waste

Step 4: The solid wastes are placed in a tank and filled up with water on a 1 to 20 ratio (Figure 7(d))	 **Figure 7(d):** filing tank with solid waste
Step 5: Cover the tank and leave it overnight (Figure 7(e)).	 **Figure 7(e):** Tank covered with tarp
Step 6: Collect the solid biological waste in the waste bag. The water from the tank may be poured into the drain as it does not oppose any hazard. Make sure the tank is cleaned for the next use (Figure 7(f)).	 **Figure 7(f):** Collecting solid waste from tank
Step 7: The solid waste can be disposed of as normal domestic waste (Figure 7(g)).	 **Figure 7(g):** Solid waste in normal domestic waste bag.

B. Collection & disposal of Common Laboratory Biohazardous Waste*

**Applicable to STB programme*

Liquid waste

Waste	Disposal Steps
Toxic containing chemicals : - • Ethdium Bromide • Expired Chemical • Mercury containing item • Unused & surplus Reagent	1. Collect in empty bottles 2. Send to Central Waste and Storage Management Facility
Non-toxic containing chemicals: - • Liquid growth media	1. Autoclave*** (if contains live organism, if can't, proceed to next step) 2. Bleaching (Soak in disinfectant for at least 15 mins); 3. Filter and collected solid residue is dispose as solid waste, while filtered waste is dispose of down the sink with flowing water. ** Disinfectant used is: • Freshly prepared sodium hypochloride with ratio of 1:10, or • isopropyl alcohol 70%

Solid waste

Waste	Disposal Steps
• Gloves • Disposable Pipettes • Petri Dish • Tissue Paper • Culture in Flask • Agar (Gel Electrophoresis) • Petri Dish Agar • Pipette Tip	1. Collect in Biohazard Plastic bags 2. Autoclave 3. Send to Central Waste and Storage Management Facility ***Autoclave standard is: Autoclave in autoclave bag in 15psi for 121ºC for 30 minutes. Please stick with autoclave tape to confirm procedure. Leave in room to cool after.

Sharp Waste

Waste	Disposal Steps
• Scalpel • Needles • Broken Glass • Blades • Syringes with attached needles • Microscope slides • Slides cover • Pasteur Pipette	1. Collect in empty bottle or solid plastic containers, seal it and label it "SHARPS" 2. **If contaminated** with hazardous material, send to Central Waste and Storage Management Facility. Otherwise proceed to next step. 3. Collect and dispose together with domestic waste.

Human Tissue

Waste	Disposal Steps
• Tissue / cell culture	1. Mix with *Congo Red* 2. Dispose of down the sink with flowing water.

8.0 STORING WASTES AT THE CENTRAL WASTE AND STORAGE MANAGEMENT FACILITY

1. The central waste storage and management facility receives hazardous wastes for storage, and for temporary holding until they are properly disposed of.
2. Hazardous waste is commonly stored in containers that comply with local regulatory requirements, such as:
   i. Plastic open top drums with cover and clamp,
   ii. Flexible Intermediate Bulk Containers (FIBCs)/Jumbo bags, and
   iii. Carton boxes

Use of Containers:

Container	**Storage of Hazardous Wastes**
Plastic open top drums with cover and clamp	▪ Solid waste ▪ Inorganic or organic liquid waste
Flexible Intermediate Bulk Containers (FIBCs)/Jumbo bags	▪ Dry solid waste with no free-flow liquid.
Carton boxes	▪ Dry solid waste with no free-flow liquid generated in small quantities.

Incompatible hazardous wastes shall be placed/filled/packed in separate containers, as incompatible hazardous wastes when mixed will produce hazardous situations.

3. Management of containers containing hazardous wastes:
   i. Appropriate label on each hazardous wastes container shall be clear and unambiguous.
   ii. Incompatible hazardous wastes shall be stored in separate containers.
   iii. Containers containing hazardous wastes should always be closed at all-time except when it is necessary to add or remove the hazardous wastes.
   iv. Reactive wastes should be kept away from any moisture.
   v. Smoking shall be prohibited in hazardous wastes storage area.
   vi. Inventory record for each hazardous wastes should be maintained to indicate the date, type and quantity of wastes brought into or removed from the storage site.

4. Wastes are a health hazard risk to handlers by:
   i. Inhalation,
   ii. Oral intake, and/or
   iii. Dermal contact.

5. All wastes handlers shall wear suitable personal protection equipment (PPE) in carrying out their duties, such as:

   i. Gloves
   ii. Goggles
   iii. Mask
   iv. Face shield
   v. Safety shoes
   vi. Others.

6. Spill cleanup materials, first aid kit and emergency shower eye wash station shall be equipped and be available at all times.
7. In case of any waste spill or accidental discharge causing personal injury:

   i. Rush to emergency shower and eyewash station, remove contaminated clothing and shoes, and immediately flush the affected area for at least 15 minutes.
   ii. Access to first aid kit for immediate medical treatment for a minor injury.
   iii. Seek medical attention for major injury.
   iv. Observe the symptoms of intoxication while going to the nearest emergency care facility.

8. In case of a small chemical spill:

   i. Evacuate all non-essential persons from the spill area.
   ii. Confine the spill small area using sorbent pads or dry sand to absorb the spill.
   iii. Collect the residue and place it in a clear plastic bag. Double bag the waste and label the bag with the contents.
   iv. Avoid breathing in vapors from the spill. If the spill is in a non-ventilated area, do not attempt to clean it up. Call for emergency personnel to respond and clean up the spill.

9. In case of a large chemical spill:

   i. Immediately evacuate others in the area.
   ii. Close all doors.
   iii. Call for emergency personnel.
   iv. If the nature of the spill presents a situation that may be immediately dangerous to life or health of building occupants or present a significant fire risk, and you cannot safely or quickly alert others to leave the area, then activate a fire alarm, evacuate the area and wait for emergency response to arrive.

10. Waste handlers are required to transfer the laboratory generated waste to central hazardous waste management facility for temporary storage before disposal.

11. Scheduled wastes that is produced by the faculty is categorised as follows:

A. Contaminated Matters (code SW410)

- Example: gloves/glass contaminated with chemicals, chemicals contaminated with EDTA etc

Important:

Plate agar that has been inoculated with bacteria must be disinfected and dispose with domestic waste. Please refer to "B. Collection & disposal of Common Laboratory Biohazardous Waste*" section on disposal procedures.

B. Empty Chemical Bottles (code SW421)

- Example: Empty chemical bottle (either made of glass or plastic)

C. Laboratory Waste (code SW430)

- Example: Expired chemicals (either in liquid or solid form)

Important:

All liquid chemical waste (non-toxic) must ensure is pH neutral before disposal. Residual acid-base titration can be disposed as normal after making sure its pH is neutral.

12. The layout of the central hazardous waste storage and management facility is designed as below (Figure 8):

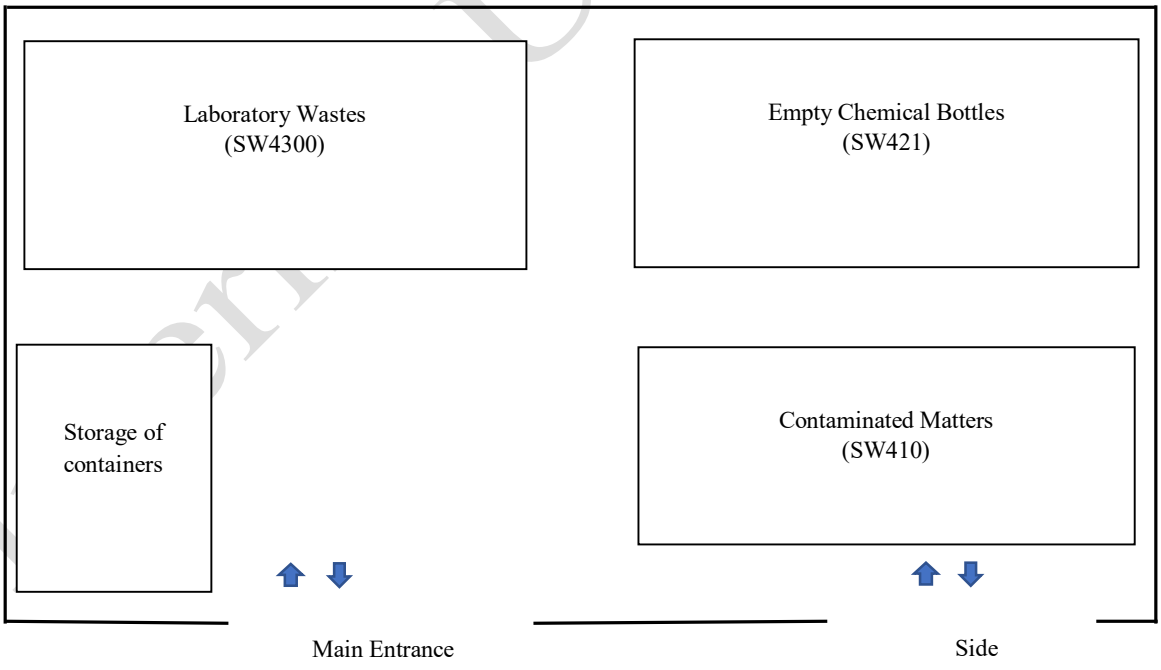

Figure 8: Layout of central hazardous waste storage and management facility. Waste classified based on First Schedule (Regulation 2) list of hazardous waste (refer Table 1, page 3).

13. The responsibilities of waste handlers:

    i. Application of transferring waste from laboratories to central hazardous waste management facility is made with store keeper through official email.
    ii. Apply for transport.
    iii. During the transfer, ensure that containers of hazardous wastes are FREE of leakage, hole, dent, bulge or corrosion.

14. Inspection of storage area shall be carried out on monthly basis to avoid any mishap and be kept in a logbook for reference. Inspection will ensure the following:

    i. Storage area is clean and tidy.
    ii. Ample aisle space maintained.
    iii. Incompatible wastes are stored separately.
    iv. Containers is dated, labelled and closed properly.
    v. Waste containers stored can only be stored there within a minimum of 180 days.
    vi. Containers observed FREE of leakage, hole, dent, bulge or corrosion.
    vii. Safety equipment in good working condition.
    viii. Containment system FREE of water or other liquids.

15. The procedure to transport waste to the Central Waste And Storage Management Facility is as follows:

    i. A representative from each program shall set a date to trasnport their waste with the facility (stor) officer, Mr. Benedict, who holds the key. No application will be approve if this step is not followed.
    ii. Reserve a transport lorry for the date that has been set.
    iii. On the day of trasnport, ensure all staff involved is wearing proper PPE.
    iv. Any waste spillage that occured during transportation must be cleaned-up immedietly.
    v. At the facility (stor), all waste must be stored according to their assigned area. Please refer to Figure 8.
    vi. Please ensure the safety of all members at all times.
    vii. Please ensure the cleaniness of the area.

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And thanks also to all our reviewers and others who help.

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APPENDICES

Appendix 1: Schedule waste label

FRST UNIMAS : SCHEDULE WASTE LABEL	
WASTE NAME:	
DATE OF GENERATION	CODE
(When it is generated)	SW
FACULTY/DEPARTMENT/PROGRAMME/SECTION/ INSTITUTE	PERSON INCHARGE
ADDRESS/ CONTACT NUMBER	

FRST UNIMAS : SCHEDULE WASTE LABEL

STEP 1	☐ HAZARDOUS	☐ NON- HAZARDOUS
REFER TO WASTE DETERMINATION FOR GUIDANCE FOR THE FIRST TIME.		
STEP 2	CHECKED ALL HAZARDS THAT APPLY	
	☐ FLAMMABLE ☐ CORROSIVE ☐ TOXIC ☐ OXIDIZER ☐ PROPHORIC ☐ WATER REACTIVE ☐ OTHER (EXPLAIN) _____	
STEP 3	☐ UNUSED ☐ USED ☐ REACTED WHEN MIXED	
STEP 4	LIST OF CHEMICAL CONSTITUENTS, WRITE FULL NAMES, NO ABBREVIATIONS, WRITE IN PENCIL ONLY.	
No.	CHEMICAL (CONCENTRATION)	% COMPOSITION
1.		
2.		
3.		
4.		
5.		
6.		
TOTAL		100%
STEP 5	PIC/MANAGER :_____ H/P No::_____ ZONE/FLOOR:_____ ROOM/LAB (NO) : _____ CONTACT PERSON: _____ DATE OF CONTAINER KEEP IN THE LAB: _____	
STEP 6	CHEMICAL WASTE COLLECTING DATE: _____	

Appendix 2: Waste Chemical Tag

UNKNOWN CHEMICAL WASTE

☐ HAZARDOUS ☐ NON HAZARDOUS ☐ TESTED ☐ NON TESTED

LOCATION :_____

_____

DATE FOUND :_____

DATE TESTED :_____ TESTED BY :_____

		☐ **POSSIBLE PEROXIDES**	
☐	**RADIOACTIVITY TEST**	☐ RADIOACTIVE	☐ NON RADIOACTIVE
☐	**AIR REACTIVITY TEST**	☐ REACT	☐ NON REACT
☐	**WATER REACTIVITY TEST**	☐ REACT	☐ NON REACT
☐	**FLAMMABILITY TEST**	☐ FLAMMABLE	☐ NON FLAMMABLE
☐	**CORROSIVITY TEST**	☐ ACID	☐ BASE pH:_____
☐	**OXIDIZER TEST**	☐ OXIDIZER	☐ NON OXIDIZER

ADDITIONAL INFO:

_____

_____

_____

Appendix 3: Peroxide former chemical

PEROXIDE FORMER CHEMICAL

CHEMICAL NAME :_____

RECEIVED :_____ (dd/mm/yy)

OPENED :_____ (dd/mm/yy)

EXPIRATION :_____ (dd/mm/yy)

Peroxide Testing:

Date:_____ Peroxide concentration:_____

Date:_____ Peroxide concentration: _____

Date:_____ Peroxide concentration: _____

NOTE: If you are unwilling or unable to test the chemical for peroxides, then it must be disposed as hazardous waste.

Check off applicable class/state and follow storage guidelines below		
PEROXIDE FORMER		KEEP NO LONGER THAN
	Unopened chemicals from manufacturer	18 months
		ONCE OPENED, KEEP NO LONGER THAN
	Class A	3 Months or manufacturer's expiration date if no peroxides detected when: ☐ Liquid tested every 3 months ☐ Solid checked visually every 3 months
	Class B or C	12 Months or manufacturer's expiration date if tested every 3 months & no peroxides detected
	Class D	Manufacturer's expiration date if no peroxides detected