PROCEDURE FOR THE DISPOSAL AND MANAGEMENT OF CHEMICAL WASTE

Original approval: 14th University Meeting of Occupational Safety and Health Committee (JKKPU) on 20 February 2002

Amended at the 63rd University Meeting of Occupational Safety and Health Committee (JKKPU) on 03 July 2017

1. The USM Centres of Responsibility (PTJ) are saddled with the responsibility of managing various types of chemical wastes produced in the course of teaching, research, consulting and service activities. The chemical wastes result from:

   i. Chemicals that have been used as a result of certain reactions, mixtures or experiments.

   ii. Stock of unused chemicals

   - order or purchase of excess chemicals
   - expired chemicals
   - chemicals that react with water / air, contaminated or damaged
   - unknown, abandoned or unlabelled chemicals

   iii. Chemicals leaked on the floor or table or resulting due to leakage from damaged containers.

2. Chemical waste refers to waste of chemical which are no longer needed by the respective Department / School / Centre. Hence, they must be disposed of from the Centres of Responsibility (Pusat Tanggungjawab i.e. PTJ) buildings or work areas. However, the disposal of stocks of unused chemicals [See above Article 1 (ii)], for example, chemicals stored in the storage facilities/ stores must first obtain written approval from the University Asset and Goods Disposal Committee by PTJ accordingly. For clarification, please refer to the Management Procedure and Disposal of Unused / Applied Chemical Stocks for approval based on the 63rd JKKPU Meeting held on 03 July 2017.

3. Hazards posed by chemical waste are similar to those hazards from chemical reactions or non-waste materials. In fact, chemical wastes oftentimes carry higher hazards when compared to non-waste chemicals. Reason because the resulting chemical wastes are more complex, due to laboratory mixture and reactions performed. The following underlisted are some of the hazards chemical wastes can induce.

   - They can easily explode / be unstable
   - They can be very reactive
   - They can be highly flammable
   - Can be corrosive
   - May contain toxic substances
   - Low in temperature
   - Have high pressure
   - Carcinogenic (i.e. have the potential to induce cancer)

4. Adequate planning, management and disposal must be ensured by the Centres of Responsibility i.e. PTJ in the management of the chemical waste. Reason because improper management or handling of the chemical waste affect not just the occupants of the building but it equally poses threat to public health and the environment.

5. Numerous methods exist for the disposal of laboratory chemical waste among which are evaporation, neutralization, dilution, incineration, landfill, recycling, reuse etc. Whichever method(s) chosen for the disposal and management of chemical waste must be safe, not pose any harm or risk to human health (workers and the general public inclusive), ensure it must not pollute the environment over time and must comply with the requirements of national and local legislation, especially the Environmental Quality Act. 1974 and the Environmental Quality (Scheduled Waste) Regulations 2005.

6. Pursuant to the Environmental Quality (Scheduled Waste) Regulations 2005, scheduled waste shall be disposed of at the prescribed premises, treated at on-site treatment facilities or recovered at the on-site recovery facility [Rules 4, 5 and 6]. For the disposal of chemical waste based on method other than the identified methods as above, written permission must be obtained from the Department of Environment [Regulation 7]. A list of the scheduled chemical wastes is given in **APPENDIX 1**.

7. Further, subject to the approval of the Department of Environment and the Environmental Quality (Scheduled Waste) Regulations 2005, the following methods can be adopted by Centres of Responsibility (PTJ) for the management and disposal of chemical waste produced in the responsibility centres:

   I. Recovery

      Chemical waste can be reused after purification with certain methods.

   II. Treatment

      Chemical waste produced must be treated in the corresponding PTJ laboratories to an acceptable level and thereafter dispose of through normal disposal methods or sent to prescribed premises for further disposal.

   III. Temporary Storage

      Chemical waste generated from time to time must be collected and stored while being treated or sent to the prescribed premises for further disposal.

   IV. Disposal at Prescribed Premises

      Chemical waste that cannot be recovered, or disposed into the environment after treated must be sent to the prescribed premises for further disposal.

8. **Recovery**

Most chemical wastes from the laboratory can be reused after they have been purified using certain methods. However, precious metals like mercury, argentums (silver) and gold recovered either through extraction or precipitation and distillation method can be used to recover the solvents used in the laboratory. Note: Recovering can help reduce the negative impacts of chemical waste disposal.

9. **Treatment**

9.1 It is difficult to give detailed and comprehensive outline of the processing methods adopted by PTJ USM because USM as an institution of higher learning uses various types of chemicals for its teaching purposes, research and service activities. Besides, most of chemicals available in the market are used in USM with each of the chemical generating its unique waste, has unique properties and often requires unique method of processing and disposal.

Therefore, it is the responsibility of every chemical waste producer/ generator at USM to refer to the relevant documents and the Environmental Quality Act 1974 (especially the Environmental Quality (Scheduled Waste) Regulations 2005) for the disposal of their chemical waste in accordance to the methods permitted or allowed. Suggested references can be made from the **BIBLIOGRAPHY** section.

9.2 Below are the general guidelines that must be adhered to in the disposal of chemical waste produced in the responsibility centres (PTJ).

(i) <u>Disposal Through Sewerage Treatment System (Sanitary Sewer System)</u>

(a) Most chemical wastes that are soluble in water and does not pose hazards can be disposed of into sinks that are connected to the sewerage treatment systems or through toilets in the designated PTJ buildings.

(b) For responsibility centres (PTJ), especially in the main campus, if the outflow of laboratory sinks are not connected to the sanitary sewer system or where outlet of the laboratory sink are not connected to the normal drainage system (storm sewer system) directly, it is prohibited to dispose of chemical waste through such laboratory sinks. Instead, chemical waste must be disposed through the toilets in the responsibility centres under strict control and supervision.

(c) Generally, disposal of chemical wastes through the sanitary sewer system is limited and shall comply with the following regulations;

- The quantity of chemical waste to be disposed of should not exceed several hundred grams or millilitres at each disposal and

adequate care must be taken to ensure chemicals are disposed with a water flow of at least 1000 times to obtain very high dilution.

Organic Chemical Wastes

- Only organic waste soluble in water at a certain rate is allowed to be disposed of through the sewer treatment system, which must be soluble at a rate of at least 3% (i.e. 0.1 ml or 0.1 g of chemical waste soluble in 3 ml of water tested in a test tube)

- A mixture of chemical wastes can only be disposed of through the sewer treatment system provided no chemical waste is in the mixture and does not dissolve less than 2% of the mixture.

- List of organic chemical waste that can be disposed of through the sewerage treatment system are indicated in **APPENDIX 2.**

  However, compounds not listed in the appendix are deemed not suitable for disposal through the sewerage treatment system.

Inorganic Chemical Wastes

- Inorganic chemical wastes whose anions and cations have low hazards can be disposed of through the sewerage treatment system. The chemical residues of which are listed in **APPENDIX 3.**

- Mineral acids and strong alkali/base must be neutralized (pH 6-9) before disposal.

(ii) Convert Hazardous Waste to Non-Hazardous Waste or Acceptable Level.

(a) Some hazardous chemical waste can be treated or processed with certain methods to reduce the level of hazard to an acceptable level before disposal or stored for further disposal management. For example;

- sodium reacts with iso-butanol
- Mercury is treated with sulfur powder
- cyanide reacts with sodium hypochlorite solution.
  Please refer to the Cyanide Use Safety Rules (update of the 59th JKKPU Meeting, 19 April 2016)

(b) Meanwhile, the methods of conversion shall be carried out by or under the supervision of a trained chemist who understands the concept of chemical reactions involved or to be carried out by other experienced persons. Hence, reference materials noted above should be referred to

from time to time and must be understood before executing the disposal of chemical wastes by either method, especially for highly hazardous or toxic chemicals.

10. Disposal at Prescribed Premises

10.1 Any chemical wastes whether scheduled or non-scheduled, that can neither be recovered, treated or disposed of directly after processing, or which pose risk to human health and could pollute the environment must be collected, segregated and packaged in their responsibility centres (PTJ). Subsequently, an application must be submitted to the University Occupational Safety and Health Unit (UKKP) to coordinate the delivery of the waste to the scheduled waste treatment and disposal facility at the Syarikat Kualiti Alam Sdn. Bhd. in Bukit Nenas. Syarikat Kualiti Alam is a prescribed premises to dispose of the country's chemical waste.

10.2 UKKP is responsible for coordinating and managing the collection of chemical waste stored at the PTJ with Syarikat Kualiti Alam and to bear all related costs. All matters related to chemical waste handling work such as mixing, packaging, labelling, segregation etc. are entrusted to the PTJ.

10.3 Each centre/PTJ is responsible for the reporting of chemical waste produced at their respective centres to UKKP every month using the application form attached to **APPENDIX 4.**

11. Temporary Collection and Storage of Laboratory Chemical Waste

11.1 Chemical waste produced at the responsibility centre’s laboratories must be collected in the specified containers appropriate for their disposal in accordance to the type and quantity of waste produced from time to time before further disposal (packaged for collection by the Syarikat Kualiti Alam or On-site treatment)

11.2 Routine collection must be made for chemical waste from on-site processing and should not be collected on a large extent.

11.3 Containers used for the collection of chemical wastes must be resistant to any corrosion and reaction from chemical wastes stored. Adequate measure must be taken to prevent leakage or easy damage.

11.4 Ensure compatibility in the mixing and segregation of the chemical wastes at all time. Never mix or combine incompatible chemical wastes in one container because combining/reactions between incompatible chemicals can result in exposure to dangerous and harmful reactions.

See **APPENDIX 5.1** and **APPENDIX 5.2**. in the later section of this document for a list of incompatible chemicals.

11.5 Wastes containing chloroform should not be mixed with wastes containing acetone because reaction between both chemical (especially for chloroform combined with contaminated / dirty acetone) wastes can result in serious explosion.

11.6 Chemical wastes containers especially the volatile organic wastes must never be filled to the brim. Allow an air space of about 15% of the container.

11.7 Using the chemical waste groups classified by Syarikat Kualiti Alam, chemical wastes produced at the Centre of Responsibility (PTJ) should be separated and segregated into appropriate containers as far as possible based on the following groupings;

GROUP	**WASTE TYPE**
A	MINERAL OIL WASTE Waste containing lubricating oil, hydraulic oil, soil contaminated with oil etc.
B	ORGANIC CHEMICAL WASTE CONTAINING HALOGEN AND/ OR SULFUR ≥ 1% Freons, PVC wastes, chloroforms, solvents, capacitors and transformers containing PCBs etc.
C	WASTE SOLVENTS CONTAINING HALOGENS AND / OR SULFUR <1% Acetone, alcohol (Eg. Ethanol, methanol), benzene, turpentine, xylene etc. Waste should be pumpable, containing < 50% water 18MJ / kg calorific value

H	ORGANIC CHEMICAL WASTE CONTAINING HALOGENS AND / OR SULPHUR < 1% Glue, latex, paint, phenol, printing ink, synthetic oils, soaps, epoxy etc.
K	Waste Containing Mercury Mercury, Vapour lamps, COD-fluids, Mercury batteries etc.
I	PESTICIDE WASTE Insecticides, fungus and weed killers, rat poison, etc
X	IN-ORGANIC WASTE Acid, alkaline, sodium hypochlorite, inorganic salts, sludge metal hydroxide, chromium waste and cyanide etc.
Z	OTHERS Medical waste, lab-packs, asbestos waste, mineral sludge, isocyanates (MDI, TDI), batteries etc.

11.8 Liquid wastes especially the organic solvents should be collected and stored by using Winchester bottles or Carboy plastic containers depending on the quantity and forms or types of waste which can be combined or mixed on the basis of the compatibility group of the waste produced. Subsequently, the Centre of Responsibility (PTJ) should combine or mix the liquid waste according to their compatibility and their respective groups. For example, compatible or similar type organic solvent wastes (GROUP C) that have been collected in Winchester bottles should be poured into plastic containers or drum (please refer to item 11 above) for packaging and collection by the Syarikat Kualiti Alam.

11.9 Ensure all chemical waste containers are properly and clearly labelled. Faded or damaged label must be re-labeled. State the name of each chemical waste mixture. Sufficient information must be supplied in the labels based on the following underlisted to ensure their safety during transportation, storage and final disposal.

- Scientific name (trade name, if any)
- If mixture, stated name of each mixture and its percentage
- Date of waste collection
- Hazard symbols of the Department of Environment (See Table III)

- Lab/room name & number
- Name of the generating officer in-charge of the waste
- Waste group code & type (Item 11.7)

Please refer to the distribution of Occupational Safety and Health Unit (UKKP USM) dated 25 March 2010 with USM reference (UKKPU) viii / a Vol. 1).

11.10 Chemical waste containers already filled to about approximately 85% level should not be stored in laboratories or work areas. Instead they should be stored in a special temporary storage room/storage place before the waste is processed or collected by Syarikat Kualiti Alam.

11.11 Designated rooms/temporary storage spaces for chemical waste shall meet the requirements of the Uniform Building By Law and Fire Rescue Services Department. Such storage areas should be as close as possible.

- Must not be exposed to direct sunlight or placed near heat / ignition sources
- Must have sufficient and satisfactory air circulation paired with an 'extractor fan' i.e. must be placed in a well-ventilated area
- Must be placed in tightly closed containers to prevent spills, leakages and explosions
- Hazard symbols must be clearly placed on room doors
- Areas for storage of the waste containers should be located away from working areas and public routes
- Adequate installation of fire and emergency prevention equipment
- Designated areas for the chemical waste should be locked at all times and only concerned officers should be allowed access.
- Incompatible waste should be stored separately and if possible, in separate rooms

11.12 The inventory of waste produced by each laboratory and those stored in the respective School / Center must be prepared and constantly updated.

11.13 The safety regulations on chemical handling must always be adhered when handling chemical wastes. For instance, wearing appropriate Personal Protective Equipment (PPE), avoid carrying / eating food at workspace, wash hands regularly with water after handling chemical waste etc.

12. **Packaging of Chemical Waste to be Collected by Syarikat Kualiti Alam**

Subsequent packaging work will be coordinated by the Occupational Safety and Health Unit (UKKP) based on the waste disposal application form received from the respective responsibility centres (PTJ) as a whole.

12.1 Containers

For the transportation of USM chemical waste to Syarikat Kualiti Alam plant, the following containers will be used based on the type, quantity and compatibility of the chemicals.

WASTE TYPE	**USAGE**	**NOTES**
Liquids, especially organic solvents	'Carboy' plastic containers with 25 litres capacity OR 'Bunghole drum' plastic or metal container, with a maximum capacity of 200 litres or less depending on the quantity of waste	Chemicals of the same type or compatible mixtures to be put together in these containers.
Solid	'Open top drum', plastic or 'metal' container with a maximum size of 200 litres or less depending on the quantity of waste	Small containers or bottles of chemical waste are to be inserted directly into the drum depending on compatibility
Unlabelled Chemicals	Open top drum', plastic or 'metal' container with a maximum size of 200 litres or less depending on the quantity of waste	Small containers or bottles of chemical waste are to be inserted directly into the drum depending on compatibility. Solids and liquids will be placed directly in separate containers
Other types of waste	Open top drum', plastic or 'metal' container with a maximum size of 200 litres or less depending on the quantity of waste OR similar containers allowed by the Syarikat Kualiti Alam Sdn. Bhd.	Small containers or bottles of chemical waste are inserted directly into the drum according to compatibility. Solids and liquids will be placed directly in separate containers

12.2 Pallet

All the containers must be placed on a wooden pallet with a measurement of 120cm x 120cm. Ensure containers are neatly and tightly closed to prevent spillage or been scattered in the course of transporting to the facility.

12.3 Marking and labelling

All containers must be properly labelled and marked as follows;

- consignment number
- Department of Environmental hazard codes and labels (Table III)

12.4 Forklift

Forklifts should be used to lift waste onto the truck to be taken to the Syarikat Kualiti Alam Sdn. Bhd.

13 **Closing**

It is hoped that the procedure issued will provide guidelines to Centre of Responsibility i.e. PTJ to handle and manage the chemical waste produced safely and effectively. The University Occupational Safety and Health Committee can only provide policy guidelines regarding the disposal of chemical waste; however, the full implementation are the responsibilities of the respective centres.

[(a)] Prescribed premises - means the premises designated by the Environmental Quality (Scheduled Waste Processing and Disposal Facilities) Order 1989, i.e. off-site storage facilities, off-site processing/ off-site treatment facilities, off-site recovery facilities, scheduled waste incinerators, land treatment facilities and secure landfills.

[(b)] On-site treatment facilities – refers to facility located at a waste disposal site, other than scheduled wastes incinerators or land treatment facilities and used solely to manage scheduled wastes incurred at the site

This procedure is translated by Jawatankuasa Kecil (SDG-12) for Times Higher Education - Global Impact Ranking (THE-GIR) under Centre for Global Sustainability Studies (CGSS) on 22 November 2020.

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6. Environmental Quality Act 1974 (Act 127) & Regulations and Orders, MDC Publishers Sdn Bhd, Kuala Lumpur, January 2008

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ATTACHMENT 1

ENVIRONMENTAL QUALITY (SCHEDULED WASTE) REGULATIONS 2005

FIRST SCHEDULE
(Rule 2)

SW 1	**Metal and metal-bearing wastes**
SW 101	Wastes containing arsenic or its compounds
SW 102	Waste of lead Acid batteries in whole or crushed form
SW 103	Waste of batteries containing cadmium and nickel or mercury or lithium
SW 104	Dust, slag, dross or ash containing aluminium, arsenic, mercury, lead, cadmium, chromium, nickel, copper, vanadium, beryllium, antimony, tellurium, thallium or selenium exclude slag from iron and steel factory
SW 105	Galvanic sludges
SW 106	Residue from recovery of acid pickling liquor
SW 107	Slags from copper processing for further processing or refining containing arsenic, lead or cadmium
SW 108	Waste leachate from zinc processing in the form of dust and sludges
SW 109	Wastes containing mercury or its compounds
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 biphenyl-capacitors, 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**
SW 201	Asbestos waste in the form of sludge, dust or fiber
SW 202	Waste catalysts
SW 203	Immobilized scheduled wastes including chemically defined encapsulated, solidified or stabilized sludges
SW 204	Sludges containing one or more metals including chromium, copper, nickel, zinc, lead, cadmium, aluminium, tin, vanadium and beryllium
SW 205	Gypsum waste resulting from chemical industry processes or power plants
SW 206	Spent inorganic acids
SW 207	Sludge containing fluoride

SW 3	**Wastes containing mainly organic constituents that may contain metals and inorganic materials**
SW 301	Applicable organic acids with pH less than or equal to 2 which are corrosive or hazardous
SW 302	Flux waste containing mixture of organic acids, solvents or ammonium chloride compounds
SW 303	Adhesives or glue waste containing organic solvents excluding solid polymeric materials
SW 304	Press cake from pre-processed/pre-treatment of glycerol soap lye
SW 305	Used lubricating oil
SW 306	Used hydraulic oil
SW 307	Used mineral oil -water emulsion
SW 308	Oil tanker sludges
SW 309	Oil-water mixture such as ballast water
SW 310	Sludge from mineral oil storage tank
SW 311	Oil waste or greasy sludge
SW 312	Oily residue from automotive workshops, oil service stations or grease interceptor
SW 313	Oil-contaminated earth from re-refining of used lubricants
SW 314	Oil or sludge from oil refinery plant maintenance operations
SW 315	Tar or tarred residue from oil refineries or petrochemical plants
SW 316	Acid sludge
SW 317	Applied organometallic compounds including tetraethyl lead, tetramethyl lead and organotin compounds
SW 318	Wastes, substances and articles containing or contaminated with polychlorinated biphenyls (PCB) or polychlorinated triphenyls (PCT)
SW 319	Phenol wastes or phenolic compounds include chlorophenol in liquid or sludge form
SW 320	Waste containing formaldehyde
SW 321	Rubber or latex wastes or sludges containing organic solvents or heavy metals
SW 322	Non-halogenated organic solvent wastes
SW 323	Halogenated organic solvents wastes
SW 324	Halogen or non-halogenated aqueous distillation residue resulting from organic solvent recovery process
SW 325	Uncured resins waste containing organic solvents or heavy metals including epoxy resins and phenolic resins
SW 326	Waste of organic phosphorus compounds
SW 327	Waste of thermal fluids (heat transfer) such as ethylene glycol
SW 4	**Waste which may contain either inorganic or organic constituents**
SW 401	Applied alkali containing heavy metals
SW 402	Applied alkali with pH greater than or equal to 11.5 which is corrosive or hazardous
SW 403	Discarded drugs that contain psychotropic substances or contain toxic substances, harmful, carcinogenic, mutagenic or teratogenic
SW 404	Pathogenic wastes, clinical wastes or quarantined materials
SW 405	Waste resulting from the preparation and production of pharmaceutical

	products
SW 406	Clinker, slag and ashes from a scheduled waste incinerator
SW 407	Waste containing dioxin or furans
SW 408	Contaminated soil, debris or matter resulting from the cleaning of spills of chemicals, mineral oils or scheduled wastes
SW 409	Disposed containers, bags or equipment contaminated with chemicals, pesticides, mineral oils or scheduled waste
SW 410	Rags, plastic, paper or filters contaminated with scheduled waste
SW 411	Applied activated carbon excluding carbon from the treatment of potable water and processes of food industry and vitamin production
SW 412	Sludge containing cyanide
SW 413	Used salt containing cyanide
SW 414	Aqueous alkaline solution containing cyanide
SW 415	Applied quenching oils containing cyanide
SW 416	Sludges of inks, paints, pigments, lacquer, dye or varnish
SW 417	Waste of inks, paints, pigments, lacquer, dye or varnish
SW 418	Inks, paints, pigments, lacquer, dyes or varnish products containing organic solvents which are discarded or do not conform to specifications
SW 419	Applicable di-isocyanates and residual isocyanate compounds excluding solid polymeric materials from foam manufacturing process
SW 420	Leachate from scheduled waste landfills
SW 421	Scheduled waste mixture
SW 422	Mixture of scheduled waste and unscheduled waste
SW 423	Used processing solutions, discarded photographic chemicals or discarded photographic wastes
SW 424	Applied oxidizing agents
SW 425	Waste from the production, formulation, trade or use of pesticides, herbicides or biocides
SW 426	Products that do not conform to specifications from the production, formulation, trade or use of pesticides, herbicides or biocides
SW 427	Mineral sludges including calcium hydroxide sludge, phosphate sludge, calcium sulphate sludge and carbonate sludges
SW 428	Waste from wood preserving operations using inorganic salts containing copper, chromium or arsenic of fluoride compounds or using compounds containing chlorine phenol or creosote
SW 429	Chemicals discarded or off-specifications
SW 430	obsolete laboratory chemicals
SW 431	Waste from manufacturing or processing or use of explosives
SW 432	Waste containing, consisting of, or contaminated with peroxides

SW 5	**Other waste**
SW 501	Any residue from the treatment or recovery of scheduled wastes

APPENDIX 2

List of Organic Chemical Waste Compounds Fit for Disposal Through Sewerage Treatment System

Alcohols	Alkanols with fewer than 5 carbon atoms
	t-Amyl alcohol
	Alkanediols with fewer than 8 carbon atoms
	Glycerol
	Sugars and sugar alcohols
	Alkoxyalkanols with fewer than 7 carbon atoms
	$n\text{-}C_4H_9OCH_2CH_2OCH_2CH_2OH$
	2-Chloroethanol
Aldehydes	Aliphatic aldehydes with fewer than 5 carbon atoms
Amides	$RCONH_2$ and RCONHR with fewer than 5 carbon atoms
	$RCONR_2$ with fewer than 11 carbon atoms
Amines[a]	Aliphatic amines with fewer than 7 carbon atoms
	Aliphatic diamines with fewer than 7 carbon atoms
	Benzylamine
	Pyridine
Carboxylic acids[a]	Alkanoic acids with fewer than 6 carbon atoms
	Alkanedioic acids with fewer than 6 carbon atoms
	Hydroxyalkanoic acids with fewer than 6 carbon atoms
	Aminoalkanoic acids with fewer than 7 carbon atoms
	Ammonium, sodium and potassium salts of the above acid classes with fewer than 21 carbon atoms
	Chloroalkanedioic acids with fewer than 4 carbon atoms
Esters	Esters with fewer than 5 carbon atoms
	Isopropyl acetate
Ethers	Tetrahydrofuran
	Dioxolane
	Dioxane
Ketones	Ketones with fewer than 6 carbon atoms
Nitriles	Acetonitrile
	Propionitrile
Sulphonic acids	
Sodium or potassium salts of most are acceptable	

[a]Those amines and acids with offensive odor such as 1,4-butanediamine, dimethylamine, butyric acids, and valeric acids, should be neutralized, and resulting salt solutions flushed down the drain, diluted with at least 1000 volumes of water.

APPENDIX 3

List of Inorganic Chemicals that can be disposed of through the Sewerage Treatment System

Cations	Anions
Al(III)	BO_3^{3-}
Ca(II)	Br^-
Cu(II)	CO_3^{2}
Fe(II),(III)	Cl^-
H	HSO_3^-
Li	OH^-
Mg	I^-
Na	NO_3^-
NH(IV)	PO_4^{3-}
Sn(II)	SO_4^{2-}
Sr	SCN^-
Ti(III),(IV)	
Zn(II)	
Zr(II)	

[b]This list comprises water-soluble salts in which both the cation and anion have a low toxic hazard. Any of these salts that are strongly acidic or basic should be neutralized before being flushed down the drain.

APPENDIX 4

UNIVERSITI SAINS MALAYSIA

APPLICATION FORM FOR CHEMICAL WASTE DISPOSAL

MONTH OF_____ YEAR _____

(Completed forms must be submitted to the Occupational Safety and Health Unit of each Campus respectively)

WASTE NAME	**CAUSE OF WASTE**		**QUANTITY, FORM & TYPE OF CONTAINER USE AS PACKAGE**	**NOTES / REVIEWS**
Please specify the botanical name of the chemical waste with full details. Also state the name of the waste and whether it has been mixed during experiment.	Please specify in detail room number and name. E.g. Room 333, Laboratory Analysis	Please state in detail how the waste was generated. For instance: Waste generated from practical analysis classes, plant extraction, NMR tools	Please state (i) Quantity – E.g:1Liter, 500g etc. (ii) Form – E.g: solid, semi-solid, liquid etc. (iii) Container type E.g: Winchester bottles, plastic sacks, canned containers etc.	Please leave space blank (for office use only)

Page _____

(Please copy this page and number if space is insufficient)

Name of Waste Manager: _____

_____

School / Center / Campus:_____

Contact Phone:_____

Official Signature & Stamp: _____Date: _____

APPENDIX 5.1

List of Incompatible Chemicals

The term “incompatible chemicals” refers to chemicals that can react with each other violently; with evolution of heat; or to produce flammable products or toxic products. Incompatible chemicals must not be placed in the same lab pack for transport or landfill disposal and must always be handled, stored and packed so that they cannot accidentally come into contact with each other. Guidelines for the segregation of common laboratory chemicals that are incompatible are presented in Tables E.1 and E.2. Table E.1 contains general classes of compounds that should be kept separated; Table E.2 lists specific compounds that can pose reactivity hazards. Chemicals in each grouping in columns A and B of each table should be kept separate. Further information on specific chemical reaction hazards can be found in Bretherick, (1986 & 1990).

Table E.1. General Classes of Incompatible Chemicals

Column A **Acids and oxidizing agents[a]**	**Column B** **Bases, metals and reducing agents[a]**
Chlorates(VI)	Ammonia, anhydrous and aqueous
Chromates(VI)	Carbon
Chromium(VI) oxide	Metals
Halogens/Halogenating agents	Metal Hydrides
Hydrogen Peroxide	Nitrates(III)
Manganates(VII)	Organic compounds in general
Nitric(V) acid/Nitrates(V)	Phosphorus
Peroxides	Silicon
Sulfates(VII)	Sulfur

[a]The examples of oxidizing and reducing agents are illustrative of common laboratory chemicals. The listings are not intended to be exhaustive.

Table E.2. Specific Chemicals Incompatibilities	
Column A	**Column B**
Acetylene, monosubstituted acetylenes	Group IB and IIB metals and their salts
	Halogens/Halogenating agents
Ammonia, anhydrous and aqueous	Halogens/Halogenating agents
	Mercury
	Silver
Alkali and alkaline earth carbides hydrides	Water
	Acids
	Halogenated organic compounds
hydroxides metals oxides/peroxides	Halogenating agents
	Oxidizing agents[a]
Azides, inorganic	Acids
	Heavy metals and their salts
	Oxidizing agents[a]
Cyanides, inorganic	Acids/Strong bases
Mercury and its amalgams	Acetylene
	Ammonia, anhydrous and aqueous
	Nitric(V) acid
	Sodium azide
Nitrates(V), inorganic	Acids
	Reducing agents[a]
Nitric(V) acid	Bases
	Chromic(VI) acid
	Chromates(VI)
	Metals
	Manganates(VII)
	Reducing agents[a]
	Sulfides
	Sulfuric acid
Nitrates(III), inorganic	Acids
	Oxidizing agents[a]
Organic compounds	Oxidizing agents[a]
Organic acyl halides	Bases
	Organic hydroxy and amino compounds
Organic anhydrides	Bases
	Organic hydroxy and amino compounds
Organic halogen compounds	Group IA and IIA metals
	Aluminium
Organic nitro compounds	Strong bases
Oxalic acid	Mercury and its salts

	Silver and its salts
Phosphorus	Oxidizing agents[a]
	Oxygen
	Strong bases
Phosphorus(V) pentoxide	Alcohols
	Strong bases
	Water
Sulfides, inorganic	Acids
Sulfuric acid (concentrated)	Bases
	Potassium manganate (VII)
	Water

[a]See list of the examples in Table E.1.

APPENDIX 5.2

ENVIRONMENTAL QUALITY (SCHEDULED WASTE) REGULATIONS 2005

FOURTH SCHEDULE

(Rule 2)

SCHEDULED DISPOSAL WITH POTENTIAL INTEGRITY

Mixing a waste in Group A with a waste in Group B may potentially result in the following:

Group 1-A	Group 1-B
Alkaline caustic liquid Alkaline cleaners Alkaline corrosive liquid Caustic wastewater Limestone sludge and alkaline sludge other corrosives	Acid sludge Chemical cleaners Electrolytes, acids Acids, liquids or solvents Pickled liquid and other corrosive acids Acid used mixed acids Used

Potentially resulting in: Heat generation, strong reaction.

Group 2-A	Group 2-B
Asbestos Beryllium Unwashed pesticides Pesticides	Solvent Explosives Petroleum Oils and other flammable wastes

Potentially resulting in: Release of toxic substances in the event of a fire or an explosion.

Group 3-A	Group 3-B
Aluminium Beryllium Calcium Lithium Magnesium Potassium Zinc powder and other reactive metals as well as metal hydride	Same as in Group 1-A or 1-B

Potentially causing: Fire or explosion; the generation of hydrogen gas flammable.

Group 4-A	Group 4-B
Alcohol	Any concentrated waste in Group 1-A or 1-B Calcium Lithium Metal hydride

	Potassium Sodium Reactive waste-water

Potentially resulting in: Fire, explosion or heat generation; generation flammable toxic gases.

Group 5-A	Group 5-B
Alcohol Aldehyde Hydrocarbons are halogenated Nitrate hydrocarbons and compounds organic reactive other as well as solvents Hydrocarbons are not saturated	Concentrated waste in Group 1-A or 1-B Waste in Group 3-A

Potentially resulting in: Fire, explosion or strong reaction.

Group 6-A	Group 6-B
Applicable cyanide and sulfide solutions	Waste in Group 1-B

Potentially resulting in: Generation of hydrogen cyanide gas or hydrogen sulfide which is toxic.

Group 7-A	Group 7-B
Chlorates and other powerful oxidants Chloride Chromic Acid Hypochlorite Nitrate Nitric acid Perchlorate Permanganate Peroxide	Organic Acid Waste in Group 2-B Waste in Group 3-B Waste in Group 5-A and simple waste

Potentially resulting in: Fire, explosion or strong reaction.