

# LABORATORY WASTE MANAGEMENT SYSTEM (Lab-WMS)

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## **GENERAL POLICIES**

- The DChE Laboratory is dedicated to providing a safe and healthy working environment for its faculty, staff, researchers, students and visitors through this Waste Management System.
- This waste management system intends to assure that minimal risk will result from the disposal of hazardous laboratory wastes.
- Being an EMB-registered hazardous waste generator, the DChE Laboratory is committed to the compliance with the rules and regulations set by government regulatory bodies.
- The HSE Officer acting as the Pollution Control Officer (PCO) serves as the focal point of the WMS and coordinates the disposal of hazardous waste resulting from laboratory operations.

## **WASTE MINIMIZATION AND MONITORING**

Waste minimization or pollution prevention is of highest priority in the hierarchy of waste management. Thus, it is an imperative for the DChE Laboratory to devise ways to minimize hazardous waste generation and control costs.

The U.S. National Institute for Occupational Safety and Health (NIOSH) lists the methods of minimizing wastes in its *School Chemistry Laboratory Safety Guide* (2006):

- Purchase chemicals in the smallest quantity needed.
- Use safer chemical substitutes/alternatives such as chemicals which have been determined to be less harmful or toxic. See list below:

**Table 1. Examples of alternative devices and chemicals (NIOSH, 2006)**

<b>Toxic chemicals/equipment</b>	<b>Possible substitution(s)</b>
Mercury thermometers	Digital and alcohol thermometers
Mercury barometer	Aneroid or digital pressure sensors
Methyl orange or methyl red	Bromophenol blue, bromothymol blue
Lead chromate	Copper carbonate
p-Dichlorobenzene	Lauric acid
Dichromate/sulfuric acid mixture	Ordinary detergents, enzymatic cleaners
Alcoholic potassium hydroxide	Ordinary detergents, enzymatic cleaners

- Use microscale experiments, particularly for instructional laboratory classes (ChE 124 and ChE 135)
- Recycle chemicals by performing cyclic experiments where one product of an experiment becomes the starting material of the succeeding ones
- Consider detoxification or waste neutralization steps
- Use interactive teaching software and demonstration videos in lieu of experiments that generate large amounts of chemical waste
- Perform classroom demonstrations
- Use pre-weighed quantities of chemicals for the students' use to prevent wastage of chemicals

### ***Instructional Laboratory Courses***

Instructors of instructional laboratory courses (ChE 124 and ChE 135) shall meet before the start of semester of the course to prepare the following:

- Experiment procedures to be implemented
- Chemical reagents to be used, including quantities
- Integration of waste minimization approaches to experimental procedures:
  - o Microscaling of experiments
  - o Substitution of hazardous chemicals to less harmful/toxic ones
  - o Prevention of unnecessary wastes
- Containers for waste storage

They shall coordinate with the HSE Officer regarding the wastes to be generated from their respective laboratory classes for anticipation of third-party disposal after the semester. They shall also ensure that students dispose wastes in the proper containers.

### ***Research Courses***

Advisers of research courses (ChE 144, MS thesis, PhD dissertation) shall require their advisees to submit a list of chemicals and other materials to be used and the corresponding waste management plan. These documents must be submitted first for the researchers to be allowed to work in the laboratory. The lists of chemicals/materials and waste management plans shall be forwarded to the HSE Officer.

A team headed by the HSE Officer and comprised of junior laboratory instructors shall monitor waste generation arising from research activities in the ChE Laboratory. Their tasks include the following:

- Receive a copy of the researcher's list of materials and chemicals to be used and waste management plan, as written in the research proposal
- Ensure that resources are available for the implementation of the waste management plans, e.g. waste containers
- Monitor the implementation of the researchers' waste management plans

- Receive notice of any changes in the material/chemical procurement and/or waste management plan, in cases of unexpected developments on the course of experimentation
- Inform adviser of any incident in which the researcher's waste management plan was not implemented properly

### **SEGREGATION**

Wastes generated in the ChE Laboratory shall be segregated to the following groups:

- Office waste
- Hazardous waste (as described in the following section)
- Non-hazardous waste, which includes
  - o Non-sharp solids
  - o Sharp solids, e.g. broken glass (that did not contain hazardous wastes)
  - o Liquids
- Used PPE's, contaminated rags and other materials (separately grouped from hazardous waste)

### **HAZARDOUS WASTE IDENTIFICATION AND CLASSIFICATION**

Wastes are considered hazardous if they are listed under the Classification of Prescribed Hazardous Wastes of DENR DAO 2004-36 (procedural manual of DAO 1992-29, the IRR of RA 6969) or they exhibit any of the four characteristics, namely: ignitability, corrosivity, reactivity and toxicity, based on Toxicity Characteristic Leaching Procedure (TCLP). The waste classification scheme under DENR DAO 2004-36 shall be adopted by the DChE laboratory, shown in the table below:

**Table 2. Waste classification (Table 1-1 of DENR DAO 2004-36)**

Class	Description	Waste Number
<b>A: Wastes with cyanide</b>		
Wastes with cyanide	Waste containing cyanide with a concentration >200 ppm in liquid waste	A101
<b>B: Acid wastes</b>		
Sulfuric acid	Sulfuric acid with pH =< 2.0	B201
Hydrochloric acid	Hydrochloric acid with pH =< 2.0	B202
Nitric acid	Nitric acid with pH =< 2.0	B203
Phosphoric acid	Phosphoric acid with pH =< 2.0	B204
Hydrofluoric acid	Hydrofluoric acid with pH =< 2.0	B205
Mixture of sulfuric and hydrochloric acid	Mixture of sulfuric and hydrochloric acid with pH =< 2.0	B206
Other inorganic acid	Other inorganic acid with pH =< 2.0	B207
Organic acid	Organic acid with pH =< 2.0	B208
Other acid wastes	Acid wastes other than B201 to B208 with pH =< 2.0	B299

C: Alkali wastes		
Caustic soda	Caustic soda with pH $\geq$ 12.5	C301
Potash	Potash with pH $\geq$ 12.5	C302
Alkaline cleaners	Alkaline cleaners with pH $\geq$ 12.5	C303
Ammonium hydroxide	Ammonium hydroxide with pH $\geq$ 12.5	C304
Lime slurries	Lime slurries with pH $\geq$ 12.5	C305
Other alkali wastes	Alkali wastes other than C301 to C306 pH $\geq$ 12.5	C399
D: Wastes with inorganic chemicals		
Selenium and its compounds	Includes all wastes with a total Se concentration $>$ 1.0 mg/L based on analysis of an extract	D401
Arsenic and its compounds	Includes all wastes with a total As concentration $>$ 5 mg/L based on analysis of an extract	D402
Barium and its compounds	Includes all wastes with a total Ba concentration $>$ 100 mg/L based on analysis of an extract	D403
Cadmium and its compounds	Includes all wastes with a total Cd concentration $>$ 5 mg/L based on analysis of an extract	D404
Chromium compounds	Includes all wastes with a total Cr concentration $>$ 5 mg/l based on analysis of an extract	D405
Lead compounds	Includes all wastes with a total Pb concentration $>$ 5 mg/l based on analysis of an extract	D406
Mercury and mercury compounds	Includes all wastes with a total Hg concentration $>$ 0.2 mg/l based on analysis of an extract. These also includes organomercury compounds. Refer to CCO.	D407
Other wastes with inorganic chemicals	Wastes containing the following chemicals: <ul style="list-style-type: none"> <li>- antimony and its compounds;</li> <li>- beryllium and its compounds;</li> <li>- metal carbonyls ;</li> <li>- copper compounds;</li> <li>- zinc compounds ;</li> <li>- tellurium and its compounds;</li> <li>- thallium and its compounds;</li> <li>- inorganic fluorine compounds excluding calcium fluoride</li> </ul>	D499
E: Reactive chemical wastes		
Oxidizing agents	Includes all wastes that are known to contain oxidizing agents in concentration that cause the waste to exhibit any of the following properties : <ol style="list-style-type: none"> <li>1. It is normally unstable and readily undergoes violent change without detonating;</li> <li>2. It reacts violently with water;</li> <li>3. It forms potentially explosive mixtures with water;</li> <li>4. When mixed with water, it generates toxic gases, vapor or fumes in a quantity sufficient to present a danger to human health;</li> </ol> <p>It is a cyanide (CN) or sulfide (S) bearing wastes, which when exposed to pH conditions between 2 and 12.5 can generate toxic gases, vapors and fumes in a quantity that poses a danger to human health</p>	E501

Reducing agents	Includes all wastes that are known to contain reducing agents in concentration that cause the waste to exhibit any of the following properties : 1. It is normally unstable and readily undergoes violent change without detonating; 2. It reacts violently with water; 3. It forms potentially explosive mixtures with water; 4. When mixed with water, it generates toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health;  It is a cyanide (CN) or sulfide (S) bearing wastes, which when exposed to pH conditions between 2 and 12.5 can generate toxic gases, vapors and fumes in a quantity that poses a danger to human health	E502
Explosive and unstable chemicals	Includes all wastes that are 1) capable of detonation or explosive reaction when subject to a strong initiating source or when heated under confinement, or 2) capable of detonation or explosive decomposition at a temperature of 20° Celsius and pressure of 1 atm.	E503
Highly reactive chemicals	Includes all other wastes that exhibit any of the properties described for D501, D502, and D503.	E599
F: Inks/Dyes/Pigments/Paint/Latex/Adhesives/Organic Sludge		
Aqueous based	Includes all aqueous based wastes that also meet one or more of the sub-categories	F601
Solvent based	Includes all solvent based wastes that also meet one or more of the sub-categories	F602
Inorganic pigments	Includes all wastewater treatment sludge from the production of inorganic pigments	F603
Ink formulation	Includes all solvent washings and sludge, caustic washings and sludge or wastewater and sludge from cleaning of tubs and equipment used in the formulation of ink from pigments, driers, soaps, and stabilizers containing Chromium and Lead.	F610
Other mixed	Includes all aqueous-based wastes that also meet one or more of the subcategories.	F699
G: Waste organic solvent		
Halogenated organic solvents	Includes the ff. spent halogenated solvents: Tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1, Trichloroethane, carbon tetrachloride, chlorobenzene, 1,2,2 Trichloroethane, chlorinated fluoro-carbons if they contain a <b>total of 10% or more (by volume)</b> of one or more of the above before use; it also includes all still bottoms from recovery of these solvents and solvent mixtures.	G703
Non-halogenated organic solvents	Includes the ff. non-halogenated solvents: Xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclo-hexanol, methanol, cresole, cresylic acid, nitro-benzene, toluene, Carbon disulfide, iso-butanol, pyridine, benzene, 2-ethoxy ethanol and 2 nitropropane and other non-halogenated organic solvents if they contain	G704

	a <b>total of 10% or more (by volume)</b> of one or more of these solvents before use; it also includes all still bottoms from recovery of these solvents and solvent mixtures.	
<b>H: Putrescible/Organic Wastes</b>		
Animal/abattoir waste	Includes all wastes from animal feed lots containing an average of 100 or more animals; All wastes from commercial slaughter houses that slaughter an average of 500 or more animals per year ; all waste from poultry farms with an average of 5,000 fowls or more; all waste from facilities that process an average of 2500 fowls or more.	H801
Grease trap wastes from industrial or commercial premises	Includes all establishments that generate an average of 50 kg per day	H802
<b>I: Oil</b>		
Waste oils	Includes all wastes from establishments that generate, transport or treat more than 200 L of waste oil per day except vegetable oil and waste tallow	I101
<b>J: Containers</b>		
Containers previously containing toxic chemical substances	Waste containers that used to hold the toxic chemical substances listed in Classes A, D, E, and L, sub-categories M504 and M505, and the chemicals listed in the Priority Chemical List. Containers that used to contain Polychlorinated biphenyl (PCB) are categorized as L406 and excluded from this sub-category.	J201
<b>K: Immobilized Wastes</b>		
Solidified wastes and polymerized wastes	Wastes whose hazardous substances are physically immobilized by consolidation to reduce the surface area of the wastes in order to meet the waste acceptance criteria	K301
Chemically fixed wastes	Wastes whose hazardous substances are chemically immobilized through chemical bonds to an immobile matrix or chemical conversion to meet the waste acceptance criteria	K302
Encapsulated wastes	Wastes whose hazardous substances are physically immobilized by enveloping the waste in a non-porous, impermeable material in order to store hazardous wastes until such time that a proper disposal facility is available.	K303
<b>L: Organic Chemicals</b>		
Wastes with specific non-halogenated toxic organic chemicals	Non-liquid waste containing the following: - Tri-butylin - 1,2-diphenylhydrazine - benzene	L401
Ozone depleting substances	Waste chlorofluoro carbons (CFCs) and halons. Recovered coolant containing chlorofluoro carbons (CFCs) or halons	L402
PCB wastes	Wastes contaminated with PCB and waste products containing PCB. Refer to CCO.	L406
<b>M: Miscellaneous Wastes</b>		
Pathogenic or infectious wastes	Includes pathological wastes (tissues,organs, fetuses, bloods and body fluids), infectious wastes and sharps	M501
Friable asbestos wastes	Wastes containing friable asbestos.	M502

	Waste blue and brown asbestos fibers. Refer to CCO.	
Pharmaceuticals and drugs	Expired pharmaceuticals and drugs stocked at producers and retailers' facilities.	M503
Pesticides	Waste pesticides other than M505. Includes all wastewater sludge from production of pesticides other than those listed in M505.	M504
POPs (Persistent Organic Pollutants) pesticides	Waste pesticides listed in the Stockholm Convention (POPs Convention) such as aldrin, chlordane, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, toxaphene, and DDT.	M505

The following are exempted from the requirements of RA 6969:

**Table 3. Wastes exempted from RA 6969 (Table 1-2 of DENR DAO 2004-36)**

<b>Description</b>
Garbage from domestic premises and households
Industrial and commercial wastewaters which are disposed of on-site through the sewerage system
Industrial and commercial solid wastes which do not contain hazardous wastes as identified in Table 1-1
Materials from building demolition except asbestos
Septic tank effluents and associated sullage wastewaters
Untreated spoils from mining, quarrying and excavation works but not materials in the nature of tailings, commercially treated materials and mine facility consumables

### **RESPONSIBILITIES AS HAZARDOUS WASTE GENERATOR**

DENR DAO 2004-36 outlines the activities that the DChE Laboratory shall comply with:

1. Notify the Department [of Environment and Natural Resources] of the type and quantity of wastes generated in accordance with the form and in a manner approved by the Department and pay the prescribed fee; and
2. Provide the Department, on a quarterly basis, with information to include the type and quantity of the hazardous waste generated, produced or transported outside.
3. Continue to own and be responsible for the hazardous waste generated or produced in the premises until the hazardous waste has been certified by the waste treater as adequately treated, recycled, reprocessed or disposed of.
4. Prepare and submit to the Department comprehensive emergency contingency plans to mitigate spills and accidents involving hazardous wastes. These plans shall conform with the guidelines issued by the Department.
5. Train/inform its personnel and staff on:
  - a. the implementation of the plan, and
  - b. the hazards posed by the improper handling, storage, transport, and use of hazardous wastes and their containers.

### **REQUIREMENTS FOR PROPER HAZARDOUS WASTE MANAGEMENT**

Per DENR DAO 2004-36, the following are requirements that the DChE shall comply with regard to the pre-transport, transport, treatment and disposal of hazardous wastes:

1. Designation of a Pollution Control Officer

2. Compliance with storage requirements

A Hazardous Waste Generator shall comply with the packaging and labeling requirements as provided for in RA 6969.

3. Compliance with pre-transport requirements

A Hazardous waste generator whose hazardous wastes are transported outside the generator's premises shall comply with the packaging and labeling requirements as provided for in the Implementing Rules and Regulations of RA 6969 and prepare a spill response plan to be handed to the designated waste transporter. The spill response plan includes the following instructions to the waste transporter in the event of an accident:

- a. immediate reporting to the EMB-DENR
- b. securing or containing the affected area
- c. cleaning up spilled or leaked hazardous waste

4. Use of authorized transporters

A waste generator is required to avail of the services of waste transporters who meet the following criteria:

- a. a waste transporter who is registered with by the DENR; and
- b. a transporter who has an approved Manifest Form to convey the hazardous waste from the waste generator's premises to the designated TSD facility.

5. Compliance with Waste Transport or Manifest System

A waste generator whose hazardous wastes are transported outside the waste generator's premises is required to comply with the Manifest system.

6. Use of recognized treaters

A waste generator is required to avail of the services of a waste treater who has a valid Facility Permit from the EMB Central Office to recycle, reprocess, treat, or dispose of the hazardous waste generated or produced at the generator's premises.

7. Confirmation of completion of treatment/disposal

A waste generator who designates a waste treater to recycle, reprocess, treat, or dispose of his hazardous wastes, shall require the said waste treater to issue a Certificate of Treatment. The certification shall be accompanied by a photocopy of the last page of the waste transport record, as provided in Chapter for 4, signed by all the parties involved.

### **EMERGENCY CONTINGENCY PLAN**

Per DENR DAO 2004-36, waste generators are required to submit a comprehensive emergency contingency plan (refer to HSE-MS) upon registration as waste generator. The plan should include at least the following items:

1. Name and responsibility of an emergency response coordinator
2. Name and responsibility of an emergency response team
3. Communication or information network among the [following]:



- a. Emergency response team
  - b. Fire brigade
  - c. Police
  - d. Ambulance and medical service
  - e. School, hospital and local population (Barangay captain)
  - f. LGU officials
  - g. National government
4. Evacuation procedure for all personnel on site
  5. Emergency response equipment
  6. Protective clothes and equipment for all emergency response team members relevant to the type of hazardous waste being handled
  7. Emergency transport procedures
  8. Temporary closure procedures
  9. Training program for all personnel on site to respond to emergency situations

### **PERSONNEL TRAINING**

Per DENR DAO 2004-36, waste generators are required to train their personnel and staff on the following:

1. Waste identification (types and characteristics)
2. Potential hazards of the wastes managed on the premises
3. Proper labeling and storage of hazardous waste including inspection procedures
4. Roles and responsibilities for implementing the emergency contingency plan including response to emergencies (fire, explosion, spill, loss of electricity, evacuation, natural catastrophes, civil disturbance, war, other cases of *force majeure*, etc.)
5. Proper use of emergency equipment (including personnel protective equipment, etc.)
6. First aid and safety procedures
7. Laws and regulations concerning hazardous waste management

### **WASTE CONTAINERS**

The types of containers used for storage of hazardous wastes are specified in DAO 2004-36:

1. Metal drum (with a lid or a cap)
2. Plastic container
3. Metal container
4. Cloth container
5. Container van
6. Tanker truck
7. Built tank
8. Containment building/warehouse (completely enclosed structure with four walls, a roof, and a floor used to store non-containerized waste, such as bulky and high volume non-liquid waste)
9. Settling ponds not used as treatment of wastewater

**WASTE LABELING AND SYMBOLS**

All containers of hazardous waste should be labeled according to DENR DAO 2004-36, as specified below:

1. The size of the label is minimum 20cm x 30cm.
2. The color of the label is yellow for background and black for letters conspicuously marked in paint or other permanent form of marking
3. The material of the label should be scratch proof and resistant to tampering and weathering.
4. The basic form is provided in Table 5-1.
5. The label is accompanied by a symbol corresponding to characteristics of the hazardous waste contained in the vessel, container, or tank as specified in 6-2 [sic 5-3] of this Chapter.

The label should be attached to the side of the container. If the container is used repeatedly, the label can be a plate and hung on the side of the container. Proper labeling should be retained until the hazardous waste reaches the TSD facility.

**Table 4. Basic form of label attached to hazardous waste containers (Table 5-1 of DENR DAO 2004-36)**

HAZARDOUS WASTE		
Waste Information	HW Class	Name of the hazardous waste class as specified in Table 1-1
	HW Description	Name of the hazardous waste description as specified in Table 1-1
	HW Number	Code of the hazardous waste description as specified in Table 1-1
	Characteristic	Toxic, Corrosive, Flammable, Explosive, Reactive, and/or Infectious
	Form	Liquid, Solid, or Sludge
	Volume	Volume of the hazardous waste contained in the vessel, container, or tank.
	Packaging date	Date on which the hazardous waste is packed in the vessel, container, or tank.
	Shipping date	Date on which the hazardous waste must be removed from the storage area and transported off site if applicable
	Waste transport record number	Manifest number if transported off site
Container Information	Capacity	Maximum capacity or volume of the container
	Material	Materials that a vessel, container, or

Generator Information		tank is made of
	ID number	ID number issued by DENR upon registration
	Name	Name of the waste generator (company name)
	Address	Address of the waste generator
	Telephone #	
	Fax #	
Name of HWMS	Name of hazardous waste management supervisor (HWMS)	

The labels should be accompanied by symbols representing the types of hazardous wastes, per DENR DAO 2004-36:

1. Explosive

Any substance or article which is designed to function by explosion, or which, by chemical reaction within itself, is able to function in a similar manner even if not designed to function by explosion.

2. Flammable (Ignitable)

Liquid: any liquid having a flash point of not more than 60.°C, closed-cup test, or 65.6°C, open-cup test.

Solid: any of the following three types of materials: wetted explosives that when dry are explosives; self-reactive materials that are liable to undergo, at normal or elevated temperatures, a strongly exothermal decomposition caused by excessively high transport temperatures or contamination; or readily combustible solids that may cause a fire through friction, show a burning rate faster than 2.2 mm per second, or be ignited and react over the whole length of a sample in 10 minutes or less.

\*Pyrophoric materials (solid or liquid) that, even in small quantities and without an external ignition source, can ignite within five minutes after coming in contact with air; or self-heating materials that, when in contact with air and without an energy supply, are liable to combustion.

3. Reactive or Oxidizing

A material that may, generally by yielding oxygen, cause or enhance the combustion of other materials.

Any organic compound containing the bivalent -O-O- structure, that is thermally unstable and can undergo exothermic self-accelerating decomposition.

4. Toxic

A substance which, if it is inhaled or ingested or if it penetrates the skin, may involve serious acute or chronic health risks including carcinogenicity, teratogenicity, and mutagenicity on human and other life forms.

5. Corrosive

A liquid or solid that causes visible destruction or irreversible alterations in human skin tissue at the site of contact, or a liquid that has a severe corrosion rate on steel or aluminum.

6. Infectious or pathogenic

Containing a viable microorganism (or its toxin) which is known or suspected to cause disease in humans or animals.

The symbols shall have specifications per DENR DAO 2004-36:

1. The minimum size of the symbol is 25 cm x 25cm for vessels, containers, and tanks and 30cm x 30cm for conveyances carrying vessels, containers, and tanks.
2. Basic shape of the symbols is a square rotated 45 degrees to form a diamond.
3. At each of the four sides, a parallel line shall be drawn to form an inner diamond 95% of the outer diamond.
4. The color should follow the colors specified in the figures below.



Figure 1. Explosive



Figure 4. Reactive



Figure 2. Flammable liquid



Figure 5. Toxic



Figure 3. Flammable solid



Figure 6. Corrosive



Figure 7. Infectious

### **WASTE PACKAGING REQUIREMENTS AND PROCEDURES**

Per DENR DAO 2004-36, storage containers of hazardous waste are required to:

1. be in good condition without leaks or damage,
2. made from materials suitable for the characteristics of the hazardous waste to be stored,
3. be equipped with a strong lid or cap to prevent spillage during the transport.

In addition, personnel packaging hazardous waste in a container are required to:

1. ensure that each vessel, container, or tank contains either only one type of waste or, when mixed, consist only of types of wastes with similar or mutually compatible characteristics (usually within a hazardous waste sub-category);
2. for self-reacting hazardous wastes, ensure that voids are not left in the vessel, container, or tank;
3. tightly seal hazardous waste in the vessel, container, or tank; and
4. ensure that the used vessel, container and tank is cleaned before being reused for storing the hazardous waste incompatible with that previously stored.

### **HAZARDOUS WASTE STORAGE FACILITY**

Per DENR DAO 2004-36, waste generators are responsible for the labeling, storage and movement of all hazardous wastes, and the PCO is responsible for the management of storage facilities:

1. The Pollution Control Officer/Environmental Officer designated by the hazardous waste generator shall be responsible for the management of the storage facility;
2. The Hazardous Waste Generator shall ensure that all movement of hazardous wastes, toxic substances and treated materials in and out of the storage facility shall be properly documented;
3. The Hazardous Waste Generator shall ensure that the requirements of classification, packaging and labeling of hazardous wastes, toxic substances and treated materials shall be complied with.

The DChE Laboratory shall be responsible for the storage of hazardous wastes prior to the transport to the TSD facility. The minimum requirements for hazardous waste storage facilities, per DENR DAO 2004-36, are the following:

1. It must be accessible in cases of emergency and for purposes of inspection and monitoring;
2. The facility should be enclosed but adequately ventilated;
3. The floors should be impermeable to liquids and resistant to attack by chemicals, not slippery and should be constructed so as to retain spillages;
4. The facility should be properly secured and not easily accessed by unauthorized persons;
5. Drums should preferably be stored upright on pallets and stacked no more than four (4) drums high;
6. Drums should be raised on pallets or similar structures to allow passage of water and circulation of air;
7. All containers should be checked regularly for leaks;
8. There should be segregation of acids from bases and other hazardous wastes; and
9. There should also be segregation of non-treated from treated hazardous wastes.

### **WASTE STORAGE, TRACKING AND INVENTORY**

#### **- Waste Tracking System**

- All wastes are to be tracked according to an online system, as mentioned in the HSE-MS. This system includes the composition and amount of wastes, as well as the person who disposed it in the waste container.
- A laboratory technician shall be assigned to monitor the transfer of wastes from individual accumulation areas in the research laboratories to a centralized waste storage area. The laboratory technician shall ensure the following:
  - Waste containers are properly labeled
  - Contents/composition of the waste are consistent with the data encoded in the online tracking system
  - Wastes are stored at appropriate locations, i.e. far from incompatible wastes

#### **- Storing Chemical Waste**

- Store all waste in containers that are in good condition and are compatible with their contents.
- Clearly and permanently label each container as to its contents and label as "Hazardous Waste"
- Store waste in a designated area away from normal laboratory operations and to prevent unauthorized access.
- Store waste bottles away from sinks and floor drains.
- Do not completely fill waste bottles; leave several inches of space at the top of each waste container.
- Cap all waste bottles

- **Incompatible wastes** should be kept as far apart from each other. They should not be stored inside the same cabinet to avoid accidents. The U.S. National Institute for Occupational Safety and Health (NIOSH) lists incompatible

chemicals through its *School Chemistry Laboratory Safety Guide, Appendix E* (2006):

**Table 5. Incompatible chemicals (NIOSH, 2006)**

<b>Chemical</b>	<b>Incompatible with</b>
Acetic acid	Chromic acid, Nitric acid, Peroxides, Permanganates
Acetic anhydride	Hydroxyl group containing compounds, Ethylene glycol, Perchloric acid
Acetone	Concentrated Nitric and Sulfuric acid mixtures, Hydrogen peroxide
Acetylene	Bromine, Chlorine, Copper, Fluorine, Mercury, Silver
Ammonium nitrate	Acids, Chlorates, Flammable liquids, Nitrates, powdered metals, Sulphur, finely divided organic or combustible materials
Aniline	Hydrogen peroxide, Nitric acid
Calcium oxide	Water
Carbon, activated	Calcium hypochlorite, other oxidants
Chlorates	Acids, Ammonium salts, Metal powders, Sulphur, finely divided organic or combustible materials
Chromic acid	Acetic acid, Camphor, Glycerol, Naphthalene, Turpentine, other flammable liquids
Chlorine	Acetylene, Ammonia, Benzene, Butadiene, Butane and other petroleum gases, Hydrogen, Sodium carbide, Turpentine, finely divided metals
Copper	Acetylene, Hydrogen peroxide
Hydrazine	Hydrogen peroxide, Nitric acid, other oxidants
Hydrocarbons	Bromine, Chlorine, Chromic acid, Fluorine, peroxides
Hydrocyanic acid	Alkalis, Nitric acid
Hydrofluoric acid, anhydrous	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Aniline, Chromium, combustible materials, Copper, Iron, most metals and their salts, Nitromethane, any flammable liquid
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Iodine	Acetylene, Ammonia (aqueous or anhydrous)
Mercury	Acetylene, Ammonia, Fulminic acid
Nitric acid, concentrated	Acetic acid, Acetone, Alcohol, Aniline, Chromic acid, flammable gases, flammable liquids, Hydrocyanic acid, Hydrogen Sulfide, Nitrateable substances
Nitroparaffins	Amines, inorganic bases
Oxalic acid	Mercury, Silver
Oxygen	Flammable liquids, solids, or gases, grease, Hydrogen, oils
Perchloric acid	Acetic anhydride, Alcohol, Bismuth and its alloys, grease, oils, paper, wood
Peroxides, organic	Acids (organic or mineral)
Phosphorus (white)	Air, Oxygen
Potassium chlorate	Acids (also refer to chlorates)
Potassium perchlorate	Acids (also refer to perchloric acid)
Potassium permanganate	Benzaldehyde, Ethylene glycol, Glycerol, Sulfuric acid
Silver	Acetylene, Ammonium compounds, Fulminic acid,

	Oxalic acid, Tartaric acid
Sodium	Carbon dioxide, Carbon tetrachloride and other chlorinated compounds, water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Any oxidizable substances (e.g., Acetic anhydride, Benzaldehyde, Carbon disulfide, Ethanol, Ethyl acetate, Ethylene glycol, Furfural, Glacial acetic acid, Methanol, Methyl acetate)
Sulphuric acid	Chlorates, Perchlorates, Permanganates

A chemical compatibility chart from the US Environmental Protection Agency may be used as basis to segregate incompatible chemicals (see Appendix A)

- **Regular waste inventories** shall be performed to monitor and arrange disposal schedule accordingly.

### **DISPOSAL: COMPLIANCE TO WASTE MANIFEST SYSTEM**

The DChE Laboratory, as a registered hazardous waste generator, shall prepare a manifest according to DENR DAO 2004-36. The manifest system requirements for waste generators are as follows:

1. Obtain a manifest form from the EMB Regional Office having jurisdiction over the location of the waste generator,
2. Complete portions referring to the waste generator in the manifest form,
3. Hand the hazardous waste to the Recognized Waste Transporter with a copy of the Spill Response Plan and 2<sup>nd</sup> through 6<sup>th</sup> copies of the manifest,
4. Retain and store the 1<sup>st</sup> copy of the manifest for twenty four (24) months from the date of receipt of the copy of the manifest by the Regional Office having jurisdiction over the location of the wastes generator.
5. Confirm the designated waste treater's acceptance of the hazardous waste by receiving the 4<sup>th</sup> copy of the manifest from the designated waste treater. If the waste generator does not receive the copy **within thirty (30) days** from the date on which the waste was received by the first waste transporter, the generator must contact the waste transporter and the designated waste treater to determine the whereabouts of the hazardous waste and make either the waste transporter convey the waste to the designated waste treater or the waste treater send the signed manifest, and
6. Confirm the designated waste treater's completion of recycling, reprocessing, treatment, or disposal of the hazardous waste by receiving a certification of completion issued by the designated waste treater with a photocopy of the 6<sup>th</sup> copy of the manifest attached.

- **Frequency of disposal**

Wastes should be removed from the laboratory to a designated area for long-term waste storage at least once a week.

Disposal by third-party treaters should be arranged on the term after the following courses are held:



- Instructional laboratory courses (ChE 124 and ChE 135)
- Undergraduate research course (ChE 144)

The HSE Officer may also arrange the disposal of wastes to a third party treater in special cases of large accumulation of wastes (e.g. from MS/PhD experiments)

### **NON-HAZARDOUS WASTE DISPOSAL**

- Non-hazardous wastes may be disposed to the sewer line (liquids) or disposed in the trash (solids), provided that certain conditions pertaining to their concentration and volume are satisfied. An extensive list of disposal methods for non-hazardous wastes is outlined by Stanford University at the following URL: <http://www.stanford.edu/dept/EHS/prod/enviro/waste/nohaz.html>
- Sharp solids such as broken glass should be segregated separately from other solid non-hazardous wastes and should be stored in a container which is not easily punctured (OSHA, 1999)

### **STORAGE AND DISPOSAL OF USED PPE'S AND OTHER CONTAMINATED MATERIAL**

- Used PPE's such as gloves and face masks, and other contaminated material such as used rags, tissue paper, mops, sand, etc. should be segregated separately from other wastes as they may contain hazardous materials.
- These materials are to be stored and disposed in the same manner as hazardous waste.

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