2021

Laboratory Safety Management

The Center for Scientific and

Technological Equipment

Walailak University

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Preface

The Center for Scientific and Technological Equipment, Walailak University, has the responsibility of providing laboratories for practical instructions of students, in both undergraduate and graduate levels, including research rooms. To ensure the health and safety of our staff, students, and all users, we have set the guideline for safety management in laboratories for the users, at the same time as developing the safety standard in the laboratories to the international level.

This guideline shall be used along with the operations for safety management in laboratories that facilitate the students, users, and researchers to work in the laboratories safely with the Energy Environment Safety and Health Center at King Mongkut's University of Technology Thonburi as the role model.

We would like to express our gratitude to the executive of The Center for Scientific and Technological Equipment for the awareness and support in the encouragement of laboratory safety management. We will keep working to achieve the objectives in laboratory safety. Finally, we would really appreciate to hear recommendations and to rectify any noticed mistakes in order to enhance the quality of this guideline, thank you.

Editorial Staff

The Center for Scientific and Technological Equipment

Walailak University

2021

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Introduction

Chemicals including hazardous chemicals, gases, flammable substances, volatile matters, organic substances, microorganisms and lab animals are normally used in the practical sessions of scientific courses as well as toxic substances, carcinogens, or radioactive substances which are used in some needed cases. Those lab chemicals and animals are utilized along with various instruments, electronic devices, materials, tools, and scientific glassware that need to be under the strict laboratory procedures with the knowledge of safety procedures in the laboratory in order to prevent dangers and the short term/long term health problems that possibly affect the students, lecturers or the staff of the laboratory or even other unexpected situations that might impact surrounding communities and environments.

With the intention to minimize dangers and effects from the operations in the laboratory by educating the lab users' safety lab procedures, The Center for Scientific and Technological Equipment under Walailak University, therefore provides this guideline of safety management in laboratory with useful content as follow:

1. General Guidelines for Laboratory Use
2. Guidelines for Chemical Use and Management
3. Primary Procedures for Working with Chemicals
4. Guidelines for Microbiological Lab Safety
5. Guidelines for the Care and Use of Laboratory Animals
6. Guidelines for Personal Accidents Safety
7. Guidelines for Firefighting Measures
8. Personal Protective Equipment and Safety Tools

General Guidelines for Laboratory Use

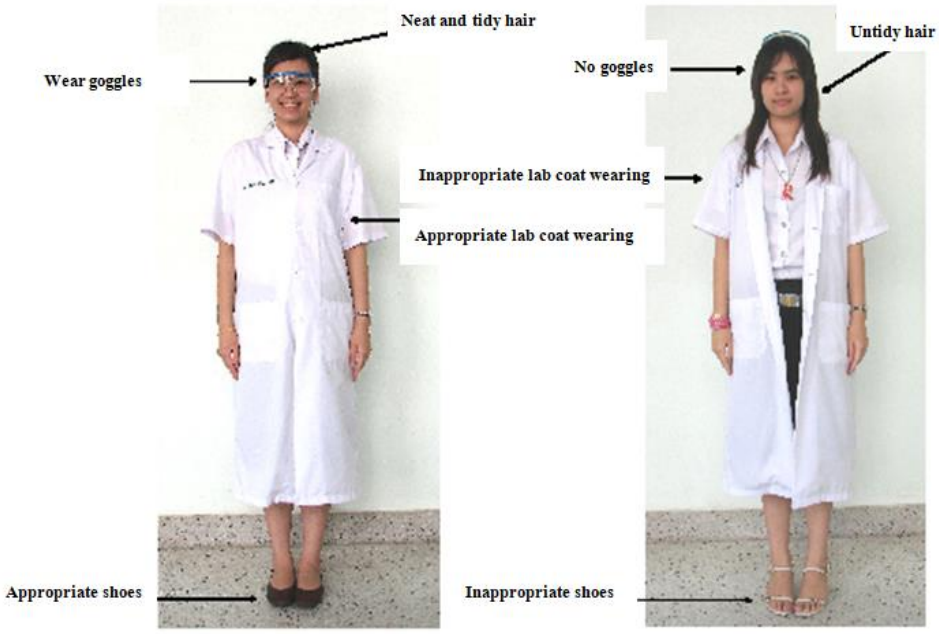
The following general guidelines for laboratory use are the basic guidelines the students should comply with, in order to prevent risk of dangers or unexpected events:

1. The students should be responsible, during all the time they use the laboratory.
2. The students should strictly comply with rules and procedures; if there are any inquiries, the students should ask the lecturers or the laboratory staff.
3. The students cannot conduct the experiments alone, without the lecturers or the laboratory staff.
4. During their first time using the laboratory, the students cannot touch any chemicals or instruments until they thoroughly understand the instructions.
5. The students cannot conduct experiments not assigned by the lecturer; all experiments must be conducted carefully.
6. Food and beverages are prohibited in the laboratory; the lab glassware is not to be used for food and drink.
7. The students are required to read and understand the experimental method thoroughly, before conducting the experiment; playing, running, or any other acts disturbing other lab users are prohibited.
8. The students are required to keep the laboratory area clean and tidy.
9. The students should always monitor if there is anything unsafe in the laboratory and inform the laboratory staff or the lecturer immediately.
10. The students are required to dispose or collect the waste and chemicals in accordance with the procedures for waste and chemicals management.
11. The students are required to read and understand the labels of chemicals or instruments before using them.
12. The students should not touch their faces, eyes, mouths, or other parts of body while using chemicals or instruments; hand cleaning is suggested after finishing experiments.
13. Every experiment must be monitored and supervised by the lecturer or the laboratory staff.
14. The students should know locations and the instructions of the safety devices e.g. the first aid kits, the fire extinguishers, the fire alarms, and fire exits.
15. The students must know the primary fire procedures in laboratory.

Attire

1. The lab attire should be polite, convenient, at the same time, comply with the regulations of the university. The necktie should be secured with the shirt or kept in the gown.
2. The students are required to wear the gowns throughout the experiments in the laboratory.
3. The students cannot wear sandals or high heel shoes in the laboratory; only boots and shoes are allowed. The students should wear safety goggles throughout the experiments to prevent injury from chemicals, heat, or lab glassware.
4. Contact lenses are not suggested when conducting experiments in the laboratory.
5. Jewelry, e.g. bracelets or rings, are not suggested when working with chemicals.

Picture 1 Prohibitions in Laboratory



A. Appropriate Attire B. Inappropriate Attire

Picture 2 Laboratory Attire

Guidelines for Chemical Use and Management

The first thing to be aware, when working with chemicals, is safety, not only in your area of responsibility, but also the whole laboratory. If you notice anything possibly leading to personal or public dangers, you should hasten to inform the lecturer or the laboratory staff. Besides, studying the correct procedures of using chemicals can also minimize chances of dangers during the experiments.

Primary Procedures for Working with Chemicals

The following are the procedures to ensure safety working with chemicals and to minimize chance of accidents:

1. The students should not work with hazardous chemicals alone.
2. The students should always be aware that every chemical is dangerous; avoid using them with bare hands, tasting, or smelling; also do not use your mouths to suck the liquid chemicals, instead using the rubber bulbs.
3. The students should check the name, label, and color stripes on the container of each chemical at least three times (before using/while using/after using); and use that chemical in the amount needed.
4. Do not return the chemical to the original container.
5. Do not take the chemicals or the lab instrument out of the laboratory without permission.
6. While carrying the chemicals, do not hold only the bottleneck or the handle of the container; use one hand to hold the container with the other hand supporting the bottom of the container.
7. Do not rinse the chemical directly from its bottle to the narrow–mouth container; use the funnel, beaker, or other appropriate container.
8. The Center for Scientific and Technology Equipment has provided the Safety Data Sheet (SDS) and Personal Protective Equipment (PPE) for the lab users; the students should notice their location in order to use them in time when needed.

Safety Data Sheet: SDS

Safety Data Sheet shows specification of each chemical including properties, hazards, ways of entering the body, first–aid, primary procedures to stop accidents, and necessary personal protective devices. This data is provided by the chemical manufacturing companies under the requirement of the law; so we can request it directly from them. The international standard SDS should give the following information:

1. Name of the chemical, product, manufacturer, or distributor.
2. Ingredients or chemicals in the products, specifying Chemical Abstract Service or CAS of every chemical in the product and their level of danger.
3. Information of hazards indicating general properties of the chemical, possible health or body hazards and symptoms, ways of entering the body, possible acute toxicity and chronic toxicity, and remediation.
4. First–aid, first–aid procedures, list of antidotes, or medical remediation.
5. Fire procedures including procedures to stop fires, flammability and explosive properties.
6. Procedures in case of chemical spills or leaking.
7. Handling and storage.
8. Chemical exposure control and personal protection.
9. Physical properties e.g. molecular weight, boiling point, freezing point, melting point, color, smell.
10. Reaction sensitivity and stability of chemicals.
11. Toxicological information, levels of toxicity of chemicals in lab animals, information identifying if the chemical is carcinogen, neurotoxin, affecting genetic system.
12. Ecological information.
13. Disposal consideration.
14. Transport information.
15. Regulatory information in each country.
16. Other information.

Sources of SDS:

1. Labels on the chemical container or the attached document.
2. Request the SDS from the distributor or the manufacturer.
3. Search from the databases e.g.
    - Chemical Product Safety Information Center, Pollution Control Department http://msds.pcd.go.th
    - Chemical Safety Database, Chulalongkorn University http://www.chemtrack.org
    - Department of Industrial Works www.diwsafety.org
    - SDS database of Merck (Thailand) www.merck.co.th

Hazardous Chemicals and Labels

All chemicals are ultimately hazardous; the users should at all times be aware that they can potentially cause hazards e.g. explosion, fire, irritation, or even long–term health problems. To prevent these hazards, the users must understand the toxicity of the chemicals they are using, potential hazards in different types of chemicals, effects on health, information and read emergency procedures.

Potential Hazards

1.1 Chemical Toxicity: Chemicals can enter our body in 4 ways, including:

1.1.1 Inhalation

1.1.2 Ingestion

1.1.3 Skin Absorption

1.1.4 Injection

The factors to consider about toxicity, when each chemical enters the body, are its dose when it enters the body by different ways and potency of its toxicity to the body. Some chemicals may cause acute toxicity right away entering the body in a small amount; whereas there may not be any symptoms noticed immediately right after a small volume of some chemicals enter the body; for example carcinogen, entering the body, however, can lead to visible chronic toxicity after entering the body regularly. Below are the general hazards of chemicals on our body:

- Hazardous to membranes e.g. Chlorine gas, Nitrogen dioxide, Sulphur dioxide
- Hazardous to blood circulation e.g. Carbon monoxide, Benzine, Nitroamines
- Hazardous to brain and metabolism e.g. Lead, Phosphorus, Benzine
- Hazardous to brain and nervous system e.g. unsaturated Hydrocarbons
- Hazardous to respiration and lung e.g. mineral dust, silica dust, asbestos

1.2 Hazards of flammable chemicals, reaction to sensitive chemicals, and explosive chemicals:

The flammable chemicals can easily and usually cause fire as these type of chemicals have low flash points, indicated by the margin between LEL and EEL of the combustible gas; as well as some reaction-sensitive chemicals which could cause fire or explosion by high temperature, improper storage, friction, reaction with moisture in the air (hydrolysis).

Important Terms

1. Flash point: the lowest point or temperature at which a liquid chemical gives off sufficient vapor to ignite in air.
2. Fire point: the lowest point or temperature when the mixture of vapor and air is ignited by a flame; this temperature is slightly higher than the flash point.
3. Ignition temperature: the least *temperature* at which the substance starts *combustion*, in a normal atmosphere without flames or sparks.
4. Flammable or explosive range: the range of which the vapor of the liquid is sufficient for combustion or explosion after reaching the ignition temperature. By the nature of ignition, all fuels must turn vaporous and when the intensity of the vapor reaches the appropriate range, the ignition or the explosion will begin. Normally, the flammable or explosive range is expressed as a percentage e.g. the range for Carbon disulfide is 1-50%.

1.3 Hazards from way of working and environment: The environment is an important factor in preventing and controlling chemical hazards, such as providing fume hoods for users when working with volatile chemicals, or basic laboratory safety devices such as fire extinguishers, eye wash, or showers.

1.4 Hazards from biological materials or radioactive agents: Some samples or culture mediums are contaminated by microorganisms, whereas some may be associated with human diseases. For the radioactive agents, proper storage suggested by the Office of Atoms for Peace should be strictly practiced as they cannot be directly touched. In addition, for the safety of lab users, the biohazard laboratory is divided into 4 levels:

Level 1: General laboratory: no special instrument or prohibition, use only the microorganisms not hazardous to the body such as Micrococcus luteus, Baceillus megaterium, Saccharomyces, and Lactobacillus

Level 2: The lab users must be aware of hazards from the pathogenic microorganisms; therefore, the users are required to wear lab gloves and coats, as well as work in the biohazard safety cabinet throughout an experiment. There is the biohazard sign indicating the level of hazard working in the lab; reserved only for the lab users working with pathogenic microorganisms at level 2 such as Stayphylococcus aureus, E.coli, Salmonella spp, Coreynebacterium diphtheriae, Cryptococcus, Blastomyces, Rabies viruses, Hepatitis A, or Hepatitis B.

Level 3: Besides the procedures as mentioned in Level 2; the hazardous level of the lab is higher, as a result, the lab users have to work in the biohazard cabinet during all the experiment. The microorganisms or the unneeded items must be kept in the specific containers; everything has to be decontaminated before being taken off the laboratory. The lab users have to wear the special lab outfits provided by the laboratory; get the anti-infection vaccine; they will be monitored and followed after working the level 3 hazardous microorganisms which can cause serious or potentially lethal disease through inhalation such as Mycobacterium tuberculosis, Francisella tularensis, Yersinia pestis, Brucella spp, Coccidioides immitis, and AIDS virus.

Level 4: Apart from the practices used in Level 3; all instruments and devices must be separated; the lab users must be extremely careful when conducting the works, change the outfits and take a shower every time before entering or after leaving the lab; all instruments and devices must be decontaminated before and after the experiment as they are used with the life–threatening microorganisms such as Lassa fever virus, Ebola or Marburg viruses.

Hazards from chemicals generally used in the laboratory:

Hazardous chemicals used in the laboratory can be divided into 7 categories as follows:

1. Flammable reagents: Most of the organic solvents used in the laboratory are flammable with different flaming sensitive levels. The lab users must be extremely careful working with ether solvents e.g. Diethyl ether or Tetrahydrofuran, as they are not only flammable, but also explosive by their peroxides. Other flammable organic solvents include Hexane, Petroleum ether, Benzine, Toluene, Ethanol, Methanol, Ethyl acetate, Acetone, and the vapors of these solvents, plus other flammable gases including Hydrogen; fine solid dust e.g. Magnesium, and catalyst which is flammable transition metals.

2. Explosive reagents: Some chemicals such as metals, Sodium, or Potassium are potentially explosive from the intense reaction with water or other substances. Some substances are self–destructive due the Redox Reaction caused by large quantity of Oxygen and Nitrogen in their molecules. This reaction releases large amounts of gas leading to high pressure in the molecule and finally explodes. Some of the explosive reagents

are vibration sensitive and can explode easily even when they are, for example, diazo compounds, and peroxide compounds.

3. Oxidizers: The oxidizers may cause fire if in contact with combustible materials such as paper. The oxidizers include Nitric acid, strong Sulfuric acid, Hydrogen peroxide, Chromium (IV) oxide, Potassium permanganate, Potassium chlorate, etc.

4. Corrosive reagents:

4.1 Acids: Sulfuric acid, Hydrochloric acid, Hydrobromic acid, Nitric acid, Phosphoric acid, organic acid e.g. carboxylic and sulphonic acids.

4.2 Phenol: Phenol causes deep burns and absorbs into the skin quickly.

4.3 Bases: Sodium hydroxide, Potassium hydroxide, Ammonia, Ammonia hydroxide, Sodium carbonate; the organic bases such as Triethylamine and pyridine.

4.4 Bromine: Bromine is a very dangerous substance which can make severe skin burns. It is restricted to use in fume hood only.

4.5 Water reactive substances: Thionyl chloride, Oxalyl chloride, Aluminum chloride. The reaction of the substance with water releases hydrogen chloride vapor which is corrosive and respiration irritating. The lab users should wear gloves every time to avoid skin contact with these substances or immediately wash the skin after the contact. The lab users are suggested to restrictively work with these substances in the fume hood.

5. **Harmful and toxic reagents:** All chemicals are harmful which possibly cause acute symptoms, immediately visible; and chronic symptoms noticeable after certain duration. The harmful chemicals include Aniline, Benzine, Bromine, Chloroform, Hexane, Hydrogen sulfide, Methanol, Nitro benzine, Phenol, and Sodium cyanite.

6. Carcinogenic or cancer suspect agents: The effects of contacting these agents are not visible immediately; the symptoms may take a long time to reveal.

This category of substance includes Iodo methane, Benzine, Hexene, Dimethyl sulphate, aromatic amine compounds e.g. Naphthylamine and Benzidine, Hydrazine, Nitrosamine, Formaldehyde, Azo compounds, Chlorinated solvents (e.g. Carbon tetrachloride and Chloroform) and Thiourea.

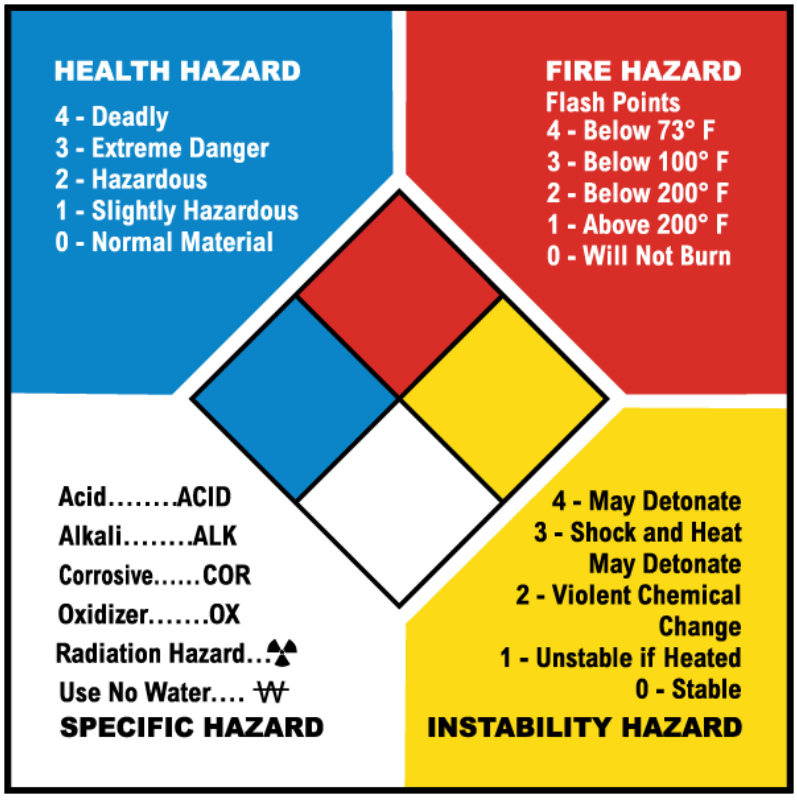
7. Irritants and lachrymators: Various organic substances are irritating to eyes, skin, or respiration, for example, Thionyl chloride, acid chloride and pyridine. The lab users should use them in the fume hood in order to avoid contacting them or their vapors.

Hazardous Data and Labels

Labels are important when working with chemicals as they identify hazards of those chemicals. The hazardous labels are normally on the container of each chemical, MSDS, or sources of reference showing samples of hazardous label in different systems:

1. The National Fire Protection Association or NFPA label the hazard with a diamond, which is further broken up into four smaller diamonds. Within the diamond are the numbers ranging from zero to four, with zero representing no hazard at all, and four representing an extreme hazard. Each number also has a specific meaning based on which diamond it belongs to.

1.1 Health hazard	Blue
1.2 Flammability	Red
1.3 Reactivity	Yellow
1.4 Special	White



Picture 3 NFPA Hazardous Material Labelling System

Source: http://www.safetysign.com

Table 1 NFPA's Rating of Hazard Levels

Types of Material	Hazard Levels	Hazard Level Indicators
Health Hazard (Blue)	**0**	No hazard.
	1	Can cause irritation if not treated.
	2	Can cause injury. Requires prompt treatment.
	3	Can cause serious injury despite medical treatment.
	4	Can cause death or major injury despite medical treatment.
Flammability (Red)	**0**	Will not burn.
	1	Ignites after considerable preheating at more than 200 °F
	2	Ignites if moderately heated at more than 100 °F but not over 200 °F
	3	Can be ignited at all normal temperatures below 100 °F
	4	Very flammable gases or very volatile flammable liquids ignite at below 73 °F.
Reactivity (Yellow)	**0**	Normally stable. Not reactive with water.
	1	Normally stable. Unstable at high temperature and pressure. Reacts with water.
	2	Normally unstable but will not detonate.
	3	Can detonate or explode but requires strong initiating force or heating under confinement.
	4	Readily detonates or explodes.
Special (White)	₩	Denotes the material is water reactive
	Corr	Denotes a corrosive hazard
	Acid	Denotes an Acid hazard
	Alk	Denotes an Alkali hazard
	OX	Denotes an oxidizing agent
	☢	Denotes an radioactive agent

* Respective hazard levels, 0 - 4

2. Globally Harmonized System of Classification and Labelling of Chemical or GHS

GHS is the global standard in chemical classification, labelling and data of chemicals shown in Safety Data Sheet (SDS) adopted from the World Summit on Sustainable Development 2002 in Johannesburg, South Africa, intending to encourage each country to understand and communicate about hazards of chemicals in the same way, in order to reduce cost and redundancy in chemical tests and evaluation as well as to ensure that each chemical will be used correctly for its purpose with no unexpected effects or harms to human health and environment.

GHS provides the classification of hazards of chemicals by the pictogram as shown in Picture 4:

Physical Hazards		☐Flammable substances ☐Self–reactive substances and mixtures ☐Self–combustible substances and mixtures ☐Self-heating substances and mixtures ☐Substances and mixtures emit flammable gases		☐Oxidizing agents ☐Organic peroxides
		☐Explosive ☐Self–reactive substances and mixtures ☐Organic peroxides		☐Compressed gases
Health Hazards		☐Life threantening hazard		☐Corrosive
		☐Irritation ☐Skin sensitization ☐Acute toxicity ☐Respiratory tract irritation ☐Narcotic effects		☐ Carcinogenecity ☐ Respiratory sensitization ☐ Genital tract hazard ☐ Special target organ toxicity ☐ Germ cell metagenicity ☐ Aspiration hazard
Environmental Hazard		☐ Hazards to the aquatic environment		

Picture 4 GHS Pictograms

Source: http://www.chemtrack.org

Classification and storage of chemicals in laboratory

Previously, the chemicals were stored alphabetically for convenient use; however, such way of storage is very risky and not applied anymore. Presently, the chemicals are classified and stored following the guideline of compatible chemical grouping; primary classifying the chemicals as liquids, solids, and gases. Based on MSDS and NFPA, we can see that the standardized classifications of hazardous chemicals include:

1. Flammable chemicals
2. Corrosive chemicals
3. Reactive agents
4. Health hazardous chemicals

The 0-4 levels of hazards will urge the users to use the chemicals carefully; level 4 signifies the highest level of hazard according to NFPA system labelling hazards levels of chemicals as shown in Table 1. For appropriate storage, The Center for Scientific and Technology Equipment, at Walailak University, uses this information to classify, color code grouping and labelling on the containers of the chemicals used in the

laboratory; for example, the flammable substances must be stored on the shelf made of fire resistant materials, the corrosive substances must be stored on the corrosive resistant cabinets, while the health hazardous chemicals, such as carcinogen and mutagen, must be kept in the locked cabinet and can only be used by the permitted users; the general chemicals are stored in the standard laboratory cabinets.

(a) Cabinet for flammable chemicals (b) Cabinet for corrosive chemicals

Picture 5 Examples of cabinets used for special chemical storage

Precautions in chemical storage

1. There should be a maximum limit for the flammable and combustible liquids to be stored in the laboratory. It is not suggested to keep liquid chemicals in the glass containers as they are breakable and risky in accidents. The liquid chemicals should be segregated from oxidizers; high flammable liquid should be kept in the secured container preventing vaporization before storing in the refrigerator.

2. The oxidizers should not be stored in the same area of flammable liquids, as they are reaction-sensitive to other chemicals and metals; dispose the oxidizers by segregating them from other trash to prevent combustion.

3. Segregate the incompatible chemicals, as example in Table 3, to prevent the reaction between them, as that is potentially hazardous to health and properties.

Table 2 Hazardous level rating of chemicals according to the chemical management in Walailak University:

Hazards	Symbols	Levels	Indicators
Health Hazard	Blue	0	No hazard.
		1	Can cause irritation if not treated.
		2	Can cause injury. Requires prompt treatment.
		3	Can cause serious injury despite medical treatment.
		4	Can cause death or major injury despite medical treatment.
Flammability	Red	0	Will not burn.
		1	Ignites after considerable preheating at more than 200 °F
		2	Ignites if moderately heated at more than 100 °F but not over 200 °F
	Red – White – Red	3	Can be ignited at all normal temperatures below 100 °F
		4	Very flammable gases or very volatile flammable liquids ignite at below 73 °F.
Reactivity	Yellow	0	Normally stable.
		1	Unstable at increasing temperature, no severe hazards
		2	Hazards from reaction with water
	Yellow – White – Yellow	3	Can detonate or explode but requires strong initiating force or heating under confinement.
		4	Readily detonates or explodes.
Corrosive	White	0	Not corrosive
	White – Black – White	1	Low corrosive
		2	Medium corrosive
		3	High corrosive
		4	High corrosive with other potential hazards

*Hazard level rated 0 – 4 respectively

Table 3 Example on storage of incompatible chemicals:

Chemicals	Segregate from	To prevent
1. Acid	Cyanide salts, cyanide solution	Highly toxic cyanide gas
2. Acid	Sulfide salts, sulfide solution	Highly toxic hydrogen sulfide gas
3. Acid	Bleach	Highly toxic chloride gas
4. Oxidizing acid e.g. nitric acid	Alcohol, solvent	Fire
5. Alkali metals e.g. Sodium, potassium	Water	Combustible hydrogen gas
6. Oxidizing agent e.g. nitric acid	Reducing agent	Fire or explosion
7. Hydrogen peroxide	Acetone	Acid or heat causing explosion
8. Hydrogen peroxide	Acetic acid	Heat causing explosion
9. Hydrogen peroxide	Sulfuric acid	Explosion

Table 4 Examples of hazards from the reactions between the incompatible chemicals

Hazards	Reactions
Exothermic reaction – boiling	Acid + water
Flammable gases	Sulfide + calcium hypochlorite, acid + metal
Vibration sensitive substances	Ammonia + iodine
Explosion	Picric acid + NaOH
High pressure in the secured container	Fire retardant
Toxic gases	Sulfuric acid + plastic, chlorine + ammonia
Toxic solubility	Hydrochloric acid + chromium
Liberate toxic dust and powder	Phosphorus trichloride + water
Violent polymerization reaction	Ammonia + acrylonitrile

Chemical storage area

1. The chemical storage area should be well ventilated;
2. The area must not be in direct sunlight and excessively hot;
3. The chemicals are segregated on the appropriate shelves based on their classifications;
4. The chemical shelves should be strongly installed on the wall;
5. The chemical storage area should have appropriate doors;
6. The fire extinguishers and protective devices should be provided near the storage area;
7. The gas tanks should be segregated from other chemicals and fastened by chains.

Procedures for chemical storage:

Below are the general procedures in chemical storage.

1. The list of all chemicals in the laboratory and their quantity must be provided.
2. All chemicals should have clear labels. Normally, the labels provided by the manufacturers identify the chemical information including name, formula, caution, risk phrase, hazard symbols, avoidances, emergency recommendations, storage recommendations, and date of expiration.
3. The chemicals must be segregated based on the groups prescribed by the laboratory.
4. The MSDS must be provided in the laboratory for emergency reference.
5. The flammable substances must be placed away from the flammable items; the switches in the storage area must not be flammable.
6. Substances breakdown-able or reactive upon contact to sunlight (or heat in the air) must be stored in the refrigerator or as recommended by the manufacturers.
7. Low boiling point solvents must be stored in the well-ventilated area, contact to direct sunlight must be avoided.
8. Special consideration must be given to the storage of substances that require special procedures.
9. The chemical containers should not be piled up vertically.
10. All chemicals in the laboratory must be labelled with date of receipt and first use.

Clean up Procedures for Chemical Spill or Contamination

Minor chemical spill means the spill of strong acids or bases, flammable liquids, carcinogens, or toxics on the specific area in the laboratory of less than 250 ml. or less than 450 g. (solid); example, 1N HCl, 100 ml.; or the spill of inflammable substances, neutral substances, and mild toxic substances for 1 – 10 liters, such as buffer solutions, on the specific area in the laboratory. Below are the procedures to follow in case of minor chemical spills:

1. Inform everyone in the area;
2. Wear the appropriate protective devices such as gloves, goggles, or safety masks;
3. Avoid inhalation by turning on the blower, fume hood, and window for ventilation;
4. Do not enter the chemical spill area to prevent the chemical spilling to other areas;
5. Minimize the spilling area by using the absorbing items, e.g. dry sand;
6. Use sodium bicarbonate or sodium sulfite to change the spilled acid or base to neutral;
7. Collect the spilled liquid into a container, label, and dispose in appropriate way;
8. Clean up the spilled area by water and dry;
9. Report the case to the laboratory lecturer.

Major chemical spill means the spill of strong acids or bases, flammable liquids, carcinogens, or toxics on the specific area in the laboratory of more than 250 ml. or less than 450 g. (solid). Below are the procedures to follow in case of major chemical spills:

1. Inform everyone in the area and immediately evacuate;
2. Close or stop every operation causing flash or heat, open the blower, fume hood, and windows for ventilation;
3. In case of flammable substance spills, move everything generating flash or heat out of the area to prevent fire;
4. Give first aid to any injured person appropriately and take to a hospital;
5. Report the case to the laboratory lecturer identifying all information including name of chemicals, spilled area, and quantity of the chemicals;
6. Close the area right after finishing evacuation;
7. Provide SDS to related officers for further appropriate disposal.

Laboratory Waste Management

The Center for Scientific and Technological Equipment, Walailak University

1. Scientists/researchers/experimenters categorize the waste from the practical subjects/experiments/ research under their responsibility and fill in the Form for Recording Chemical Information/ Hazardous Waste Generated from Experiment/ Test/ Research (CSE-HZW-01) identifying composition analysis, intensity, and hazardous waste categories.

2. Scientists/researchers/experimenters check if the intensity of each chemical, containing the waste, exceeds the Industrial Manufacturer Effluent Standards or not.

3. Scientists/researchers/experimenters identify the hazardous waste category based on the system of the center, only for the waste containing chemicals exceeding the Industrial Manufacturer Effluent Standards.

4. Scientists/researchers/experimenters provide a list of waste in the subject/research in form CSE-HZW-02.

5. Scientists/researchers/experimenters segregate each waste in appropriate size screw-capped containers by their categories (Polyethylene (PE) or Polypropylene (PP) gallons).

6. Scientists/researchers/experimenters manage the waste containers with labels based on prescribed format and waste categories.

7. Scientists/researchers/experimenters leave the waste containers in the area in laboratory for further disposal based on waste category.

8. For liquid waste, the scientists/researchers/experimenters pour the waste into a cylinder or beaker for measurement; then pour it through a funnel into a liquid waste container, label the waste category, fill the waste quantity in Form for Recording Liquid Waste Quantities or form CSE-HZW-03.

9. For the solid waste, the scientists/researchers/experimenters dispose of the waste in the waste container classified by waste categories; fill the weight of the waste in Recording Solid Waste Quantities or form CSE-HZW-04.

10. Scientists/researchers/experimenters collect all laboratory waste and record total waste quantity in the Form for Recording Laboratory Waste Quantities or form CSE-HZW-05 and submit to heads of related division.

11. Heads of related divisions or research section recheck if the waste was appropriately measured and disposed of, sign to certify form CSE-HZW-05 and forward the report to the Central Waste Storage keeper in the center.

12. Heads of related divisions or research section assign the laboratory staff to deliver the laboratory waste to the Central Waste Storage every Wednesday afternoon.

13. The central waste storage keeper collects Laboratory Waste Quantity Report from every related section for recording in the Form for Recording Waste Stock or CSE-HZW-06, responsible by the Central Waste Storage.

14. The Central Waste Storage keeper of the center collects all laboratory waste delivered to the center by all divisions, fill the information in the Form for Recoding Waste Quantites Stored in the Central Waste Storage or form CSE-HZW-07, at the end of semester or as appropriate.

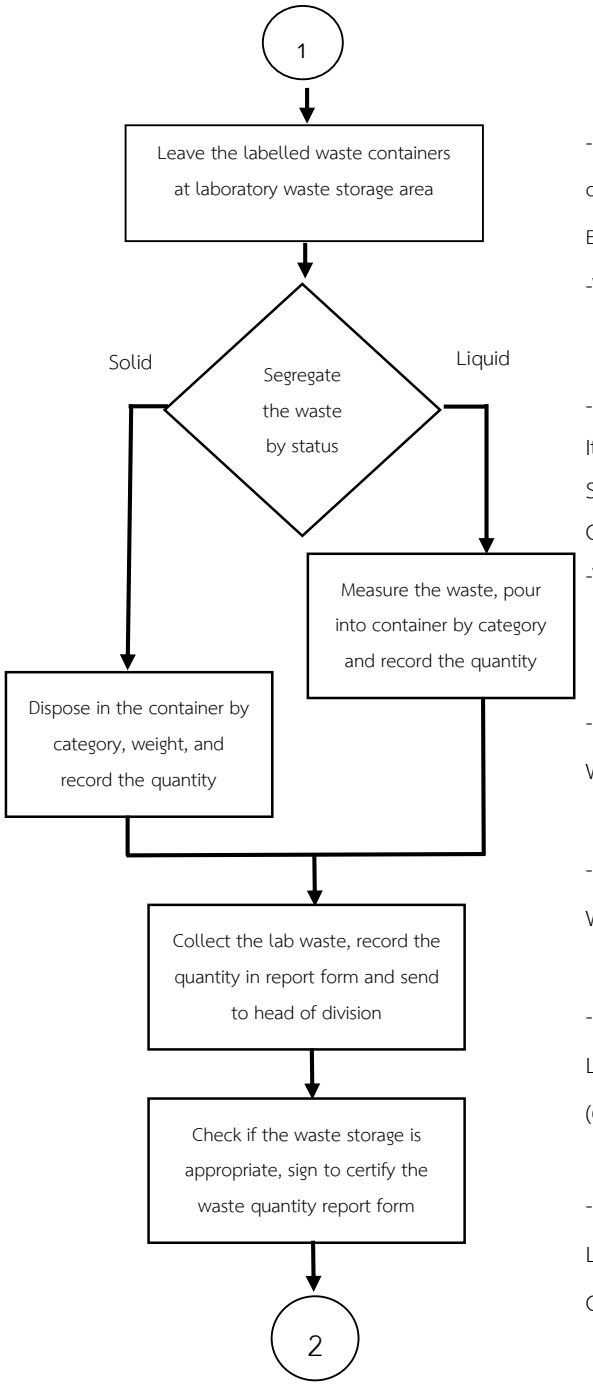
15. The Central Waste Storage keeper of the center informs the executives of the center about the quantity of the waste in the storage, and requests the approval in waste disposal pursuant to the university procurement process.

Flow Chart

of Laboratory Waste Management

The Center for Scientific and Technology Equipment, Walailak University

Actions taken by:	Activities	Related documents
1.Scientists/Researchers/Experimenters	Categorize the waste from practical subject/ experiments/ research	-Form for Recording Chemical Information/ Hazardous Waste
2.Scientists/Researchers/Experimenters	Check if the chemicals containing the waste exceeds the Industrial Manufacturer Effluent Standards or not	- Form for Recording Chemical Information/ Hazardous Waste (CSE-HZW-01) -Industrial Manufacturer Effluent Standards
3.Scientists/Researchers/Experimenters	Identify the waste category based on the center's system; only the waste with chemicals exceeding Industrial Manufacturer Effluent Standards	- Form for Recording Chemical Information/ Hazardous Waste (CSE-HZW-01)
4.Scientists/Researchers/Experimenters	Provide the List of Waste in the subject/research	- Form for Recording Waste Items of Laboratory Subject/Research Experiment (CSE-HZW-02)
5.Scientists/Researchers/Experimenters	Provide/prepare waste container based on category and value of chemicals exceeding Industrial Manufacturer Effluent Standards	- Form for Recording Waste Items of Laboratory Subject/Research Experiment (CSE-HZW-02)
6.Scientists/Researchers/Experimenters	Provide and label the waste container based on format and waste category	- Form for Recording Waste Items of Laboratory Subject/Research Experiment (CSE-HZW-02) -Waste container labels
	1	

Actions taken by:	Activities	Related documents
7.Scientists/Researchers/Experimenters		- Form for Recording Waste Items of Laboratory Subject/Research Experiment (CSE-HZW-02) -Waste container labels
8.Scientists/Researchers/Experimenters		- Form for Recording Waste Items of Laboratory Subject/Research Experiment CSE-HZW-02 -Waste container labels - Form for Recording Liquid Waste Quantities (CSE-HZW-03) - Form for Recording Solid Waste Quantities (CSE-HZW-04)
9.Scientists/Researchers/Experimenters		- Form for Reporting Laboratory Waste Quantities (CSE-HZW-05)
10. Head of division/research section		- Form for Reporting Laboratory Waste Quantities CSE-HZW-05

Actions taken by:	Activities	Related documents
	2	
11. Heads of division/research section	Send Certified Laboratory Waste Quantity Report to the keeper of the Central Waste Storage of the center	- Form for Reporting Laboratory Waste Quantities CSE-HZW-05
12. Heads of division/research section	Assign the lab staff to deliver all waste to the Central Waste Storage every Wednesday afternoon	- Form for Reporting Laboratory Waste Quantities CSE-HZW-05
13. Keeper of Central Waste Storage	Compile the waste based on all waste quantity report from every section, fill in the quantity in the waste quantity stock log	- Form for Reporting Laboratory Waste Quantities CSE-HZW-05 - Form for Recording Waste Stock Quantities of Central Waste Storage of CSE Center (CSE-HZW-06)
14. Keeper of Central Waste Storage	Compile all waste delivered to the storehouse based on Waste Quantity Stock Log at the end of the semester or as appropriate	- Form for Reporting Laboratory Waste Quantities CSE-HZW-05 - Form for Recording Waste Stock Quantities of Central Waste Storage of CSE Center CSE-HZW-06
15. Keeper of Central Waste Storage	Present the report of total quantity stored in the Central Waste Storage for disposal approve according to the university procurement process	- Form for Recording Waste Quantities Stored in Central Waste Storage of CSE Center (CSE-HZW-07)

Laboratory Waste Classification

Laboratory waste means both solid and liquid waste from the activities in the laboratory and research rooms including instructional experiments, research, and services as well as the samples for tests and experiments. Moreover, the chemicals in the waste, which are higher than the Industrial Manufacturer Effluent Standards, are hazardous to humans and environment. To prevent any impact to community and environment from the laboratory chemicals or hazardous waste and to minimize any hazards from potential reactions between chemicals in the waste, the appropriate waste management must be implemented.

According to the Laboratory Waste Management System in The Center for Scientific and Technological Equipment, Walailak University, we can classify the laboratory waste into 3 major classes based on their physical characteristics and hazards. The waste classification certainly facilitates the waste management and treatment which shall be different in each class of laboratory. Below are the 3 major classes of the laboratory waste classified by the center:

Class 1 Solid Hazardous Wastes include:

1.1 **Waste No. S01 - Empty Chemical Bottles** means the empty glass and plastic bottles used to contain chemicals, both solid and liquid.

1.2 **Waste No. S02 - Broken Glassware or Chemical Bottles** means the glassware, glass bottles, or test tubes which are broken.

1.3 **Waste No. S03 – Toxic Waste** means toxins, hazardous chemicals, carcinogens or sludge waste.

1.4 **Waste No. S04 – Organic Waste** means solid or gel culture mediums such as Agar.

1.5 **Waste No. S05 – Chemical Contaminated Waste** means the absorbers used to absorb the spilled acids or bases, chemical contaminated tissues, etc.

1.6 **Waste No. S06 – Infectious Waste** means garbage or waste suspected to be infectious or contaminated by the pathogens, remains or parts of creatures and medical materials such as parts of creatures, cottons, gauze, syringes, blood contacted items.

1.7 **Waste No. S07 – Batteries and Dry Batteries** means the used or the deteriorating batteries or dry batteries.

Class 2 Liquid Hazardous Wastes include:

2.1 **Waste No. L01 – Acidic Waste** means the waste having a pH of less than 7 and more than 5% of mineral acids contaminated in the solutions such as Sulfuric acid, Nitric acid, and Hydrochloric acid.

2.2 **Waste No. L02 – Alkaline Waste** means the waste having a pH of more than 7 and more than 5% of bases contaminated in the solutions such as Ammonia, Carbonate, and Hydroxide.

2.3 **Waste No. L03 – Salt Waste** means the waste with salt characteristic or the waste which is the product the reaction between acid and base such as Sodium chloride or Ammonium nitrate that contains salt exceeding the Industrial Manufacturer Effluent Standards.

2.4 **Waste No. L04 –Phosphorus/Fluoride Waste** means the liquid waste contains Phosphorus/Fluoride such as Hydrofluoric acid, Fluoride Compound, Silicon fluoride.

2.5 Waste No. L05 –Inorganic Cyanide Waste, classed as hazardous waste, such as Sodium Cyanide.

2.6 Waste No. L06 –Organic Cyanide Waste means the waste contains Cyanocomplex such as $[Ni(CN)_4]_2^-$, $[Cu(CN)_4)]^{2-}$

2.7 Waste No. L07 –Chromium Waste such as Cr^{6+} compound, Chromic acid, Chloride analysis.

2.8 Waste No. L08 - Inorganic Mercury Waste means the waste with inorganic mercury such as Mercury (II) Chloride which is the waste from COD analysis.

2.9 Waste No. L09 - Organic Mercury Waste means the waste with organic mercury such as Alkyl Mercury.

2.10 Waste No. L10 – Arsenic Waste means the waste contains Arsenic such as Arsenic oxide, Arsenic chloride.

2.11 Waste No. L11 – Heavy Metal Ion Waste means the waste containing the heavy metal ions other than Chromium, Arsenic, Cyanide, and Mercury; such as Barium, Cadmium, Lead, Copper, Iron, Manganese, Zinc, Nickle, Silver, Tin, Antimony, Tang stain, Vanadium. The waste from TKN analysis using $CuSO_4$ is in this class.

2.12 Waste No. L12 – Oxidizing Agent Waste means the waste producing the electrons which are explosive in the severe reaction with other substances; such as Hydro peroxide, Permanganate hypochlorite.

2.13 Waste No. L13 – Reducing Agent Waste means the waste receiving the electrons which react with other substances cause explosion, such as Sulfurous acid, Iosulfuric acid, Hydrazine, Hydroxylamine.

2.14 Waste No. L14 - Combustible Waste means the combustible organic liquid waste such as organic solvents e.g. Alcohol, Ester, Aldehyde, Ketone; organic acids e.g. Acetic acid; and organic substances or Sulphur e.g. Amine, Amide, Pyrimidine, Quinoline, and the developer used in the photo development.

2.15 Waste No. L15 – Oily Waste means the organic liquid waste from plant or animal fat such as fat acid, vegetable oil, animal oil, petroleum, and oil products e.g. Benzine oil, Kerosene, engine oil and lubricant.

2.16 Waste No. L16 – Halogenated Waste means the waste containing organic Halogen such as Carbon tetrachloride (CCl_4), Chlorobenzene (C_6H_5Cl), Chloroephedrine, and the mixture of Bromine and organic solvent.

2.17 Waste No. L17 – the Organic Liquid Waste Containing Water means the organic liquid waste mixed with water such as the mixture of oil and water, the mixture or combustible substances and water e.g. Alcohol – water, Phenol – water, organic acid – water, Amine or Aldehyde – water.

2.18 Waste No. L18 - Flammable Waste means the flammable waste which needs to be isolated from the source of flash, heat, chemical reaction, flame, electric devices, switches, etc.; such as Acetone, Benzine, Carbon disulfide, Cyclohexane, Diethyl ether, Ethanol, Methanol, Methyl acetate, Toluene, Xylene, and Petroleum spirits.

2.19 Waste No. L19 - Waste Containing Photo Stabilizers means the waste developers which contain hazardous chemicals and inorganic substances. This class of waste is the waste from the photo development in the laboratory's darkroom during the research or the instructions. The waste contains silver and organic liquid. The silver must be segregated for further reuse; the remaining and the developer

containing organic substances will be treated under the same treatment process of Combustible Organic Waste (L.14).

2.20 Waste No. L20 – Explosive Waste means the substances or compounds which are explosive by heat, friction, impact, or high pressure, such as Nitrates, Nitramines, Chlorates, Nitro perchlorates, Picrate, Promates, Azides, Diesos, Peroxides, Acetylides.

Class 3 Extremely Hazardous Wastes include:

3.1 Waste No. L21 – Radioactive Agents Collected and Delivered to Office of Atoms for Peace, means the waste containing unstable radioactive agents used in research or instruction; which are hazardous to humans and environment. The radioactive agents e.g. S35, P32, or I125, even small amount, must be segregated and kept by the appropriate containers in the radioactive storage area.

3.2 Waste No. L22 - Waste Containing Microorganisms means the waste from the cultures, identifications, or incubations of microorganisms, fungus or yeast in the laboratory and the culture conducted in the fermentation tanks. Releasing the organism contained in this class of waste will be hazardous to community and environment; therefore, they need to be retorted/heated in the Autoclave ที่ 121°C 15 psi, for 30-70 minutes, together with the culture medium; then segregated in the specific containers as organic waste.

3.3 Waste No. L23 EtBr Waste means the liquid or gel containing Ethidium bromine, such as the gel from Electrophoresis including the mixtures of Alcohol – water, Phenol – water, organic acid – water, Amine or Aldehyde – water.

Table 1: Seven Classes of Laboratory Solid Waste in The Center for Scientific and Technological Equipment

Waste Codes	Waste Classes
S01	**Empty chemical bottles**
Meaning	- Empty glass and plastic chemical bottles
Samples	- Bottles used for solid and liquid chemicals, bottles used for acids and alkaline, glass bottles used for flammable substances, plastic chemical bottles
Storage	- Clean before delivery
Treatment/Disposal	- Deliver to the outsource waste management agent
S02	**Broken glassware and chemical bottles**
Meaning	- Broken glassware, glass bottles or test tubes
Samples	- Broken glass bottles, glassware, or glass equipment
Storage	- Keep in the 50 liters PE plastic tank, cap-secured, put in old (news)paper in bottom of garbage bags at least for 2 layers before disposal.
Treatment/Disposal	- Deliver to the outsource waste management agent
S03	**Toxic Waste**
Meaning	- Toxic substances, hazardous chemicals, carcinogens
Samples	- Expired chemical substances, deteriorated chemicals, health hazardous chemicals
Storage	- Keep in the 50 liters PE plastic tank, cap-secured, put in the garbage bags at least for 2 layers, label hazardous waste before disposal.
Treatment/Disposal	- Deliver to the outsource waste management agent
S04	**Organic Waste**
Meaning	- Microorganisms or pathogens contaminated solid waste
Samples	- hard or jell culture mediums
Storage	- No storage, sterilize before disposal as community garbage
Treatment/Disposal	- Pathogens: Autoclave sterilization at 121AC, 15 psi, 70 minutes - Microorganisms: Autoclave sterilization at 121AC, 15 psi, 30 minutes
S05	**Chemical Contaminated Waste**
Meaning	- Chemical contaminated wastes or packaging
Samples	- Chemical contaminated tissues, gloves, rags, masks, or packaging
Storage	- Keep in the 50 liters PE plastic tank, cap secured, put in the garbage bags at least for 2 layers, label hazardous waste before disposal
Treatment/Disposal	- Deliver to the outsource waste management agent

Table 1 (Cont.): Seven Classes of Laboratory Solid Waste in The Center for Scientific and Technological Equipment

Waste Codes	Waste Classes
S06	**Infectious Waste**
Meaning	- Garbage or waste suspected to be infectious or contaminated by the pathogens, remains or parts of creatures and medical appliances
Samples	- Parts of creatures, cottons, gauze, syringes, blood contacted objects
Storage	- Keep in the red beg, put in the cap-secured cap and store in the storehouse
Treatment/Disposal	- Deliver to the incinerator in Walailak University for disposal
S07	**Batteries and Dry Batteries**
Meaning	- Used or deteriorated batteries or dry batteries
Samples	- Batteries and dry batteries
Storage	- Keep in the 50 liters PE plastic tank, cap-secured, put in the garbage bags at least for 2 layers, label hazardous waste before disposal
Treatment/Disposal	- Deliver to the outsource waste management agent

Table 2: Twenty-three Classes of Liquid and Special Hazardous Waste in The Center for Scientific and Technological Equipment

Waste Codes	Waste Classes
L01	**Acidic Waste**
Meaning	- the waste with a pH of less than 7 and more than 5% of mineral acids contaminated in the solutions
Samples	- Sulfuric acid, Nitric acid, and Hydrochloric acid
Storage	- Keep in good condition cap-secured PP or PE plastic containers
Treatment/Disposal	- Neutralized and Filtration before releasing to the sewer pipe, the sediment will be sent to the waste management company
L02	**Alkaline Waste**
Meaning	- the waste with a pH of more than 7 and more than 5% of basic substances contaminated in the solutions
Samples	- Ammonia, carbonates, hydroxides
Storage	- Keep in good condition cap-secured PP or PE plastic containers
Treatment/Disposal	- Neutralization and Filtration before releasing to the sewer pipe, the sediment will be sent to the waste management company
L03	**Salt Waste**
Meaning	- The waste with salt character or the waste from the reaction between acids and bases
Samples	- Sodium chloride or Ammonium nitrate containing salt more than Industrial Manufacturer Effluent Standards
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- Deliver to the outsource waste management agent
L04	**Phosphorus/ Fluoride**
Meaning	- The liquid waste containing Phosphorus or Fluoride
Samples	- Hydrofluoric acid, Fluoride compound, Silicon fluoride
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- Calcium precipitation and deliver to the waste management company
L05	**Inorganic Cyanide Waste**
Meaning	- The waste containing Sodium Cyanide, classed as hazardous waste
Samples	- Sodium Cyanide
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- Deliver to the outsourced waste management agent

Table 2 (Cont.): Twenty-three Classes of Liquid and Special Hazardous Waste in The Center for Scientific and Technological Equipment

Waste Codes	Waste Classes
L06	**Organic Cyanide Waste**
Meaning	- The waste containing complex Cyanide or Cyano complex
Samples	- $[Ni(CN)_4]^{2-}$, $[Cu(CN)_4)]^{2-}$
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- Deliver to the waste management company
L07	**Chromium Waste**
Meaning	- The waste containing Chromium
Samples	- Cr^{6+} compound, Chromic from Chloride analysis
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- Reduction and Neutralization before delivering to the waste management company
L08	**Inorganic Mercury Waste**
Meaning	- The waste containing inorganic Mercury
Samples	- Mercury (II) Chloride, the waste from COD analysis
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- Deliver to the waste management company
L09	**Organic Mercury Waste**
Meaning	- The waste containing organic Mercury
Samples	- Alkyl Mercury
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- Deliver to the waste management company
L10	**Arsenic Waste**
Meaning	- The waste containing Arsenic
Samples	- Arsenic oxide, Arsenic chloride
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- For As^{3+} , conduct Co-precipitation Fe^{3+} / deliver to the waste management company

Table 2 (Cont.): Twenty-three Classes of Liquid and Special Hazardous Waste in The Center for Scientific and Technological Equipment

Waste Codes	Waste Classes
L11	**Heavy Metal Ion Waste**
Meaning	- The waste containing heavy metal ions other than Chromium, Arsenic, Cyanide, and Mercury
Samples	- Barium, Cadmium, Lead, Copper, Manganese, Zinc, Cobol, etc. - Waste from TKN (contains $CuSO_4$) - Waste from BOD and DO experiments
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- Neutralization and precipitation, absorbed by chelating resin, deliver to the waste management company
L12	**Oxidizing Agent Waste**
Meaning	- The waste producing electrons severely react with other substances and explode
Samples	- Hydrogen peroxide, Permanganate hypochlorite
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- Oxidation/Neutralization deliver to the waste management company
L13	**Reducing Agent Waste**
Meaning	- The waste receiving electrons that severely react with other substances and explode
Samples	- Sulfurous acid, Iosulfuric acid, Hydrazine, Hydroxylamine
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- Reduction/Neutralization deliver to the waste management company
L14	**Combustible Waste**
Meaning	- Combustible organic liquid wastes
Samples	- Organic solvents such as Alcohol, Esther, Aldehyde, Ketone, organic acids - organic substances such as Nitrogen and Sulphur e.g. Amine, Amide, Pyrimidine, Quinoline, and photo developer
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- Deliver to the waste management company

Table 2 (Cont.): Twenty-three Classes of Liquid and Special Hazardous Waste in The Center for Scientific and Technological Equipment

Waste Codes	Waste Classes
L15	**Oily Waste**
Meaning	- Oily organic waste from plants and animals
Samples	- Fat acids, vegetable and animal oil, petroleum, oil products e.g. Kerosene, engine oil, lubricant oil
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- Deliver to the waste management company
L16	**Halogenated Waste**
Meaning	- The waste containing organic Halogen
Samples	- Carbon tetrachloride (CCl_4), Chlorobenzene (C_6H_5Cl), Chloroephedrine, the mixture of Bromine and organic solvents
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- Deliver to the waste management company
L17	**Organic Liquid Waste Containing Water**
Meaning	- The organic liquid waste containing more than 5% of water
Samples	- The mixtures of oil and water, flammable substances and water e.g. Alcohol and water, Phenol and water, organic acids and water, Amine or Aldehyde and water
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- Deliver to the waste management company
L18	**Flammable Waste**
Meaning	- The waste which is flammable and needs isolation from sources of flash, heat, reactions, flame, electric devices, and switches.
Samples	- Acetone, Benzine, Carbon disulfide, Cyclohexene, Diethyl ether, Ethanol, Methanol, Methyl acetate, Toluene, Xylene, and Petroleum spirits
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- Deliver to the waste management company
L19	**Waste Containing Photo Stabilizers**
Meaning	- The waste photo developers containing hazardous chemicals and organic acids
Samples	- Waste from Dark Room containing Silver and organic liquid
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- Deliver to the waste management company

Table 2 (Cont.): Twenty-three Classes of Liquid and Special Hazardous Waste in The Center for Scientific and Technological Equipment

Waste Codes	Waste Classes
L20	**Explosive Waste**
Meaning	- The waste substances or compounds explosive in heat, friction, impact, or high pressure
Samples	- Nitrates, Nitramines, Chlorates, Nitroperchlorates, Picrate, Promates, Azides, Diesos, Peroxides, Acetylides
Storage	- Keep in good condition PP or PE plastic container, cap-secured
Treatment/Disposal	- Deliver to the waste management company
L21	**Radioactive Agent Waste**
Meaning	- The waste containing unstable radioactive agents which are radiable and hazardous to humans and environment
Samples	- S^{35}, P^{32}, I^{125}
Storage	- Keep in good condition PP or PE plastic container, cap secured
Treatment/Disposal	- Deliver to Office of Atoms for Peace
L22	**Waste Containing Microorganisms**
Meaning	- The waste containing microorganisms hazardous or affecting environment and ecologies
Samples	- The waste from cultures, identifications, or incubations of microorganisms, fungus, or yeast in the laboratory and the culture in fermentation tanks.
Storage	- Sterilization before disposal, no need to keep in the storehouse
Treatment/Disposal	- Autoclave sterilization at 120°C,15 psi for 30 minutes
L23	**EtBr (Ethidium bromide) Waste**
Meaning	- The solid and liquid waste contaminating EtBr
Samples	- EtBr buffer solutions, EtBr Gel, EtBr contaminated tissues or packages,
Storage	- Keep in good condition PP or PE plastic container, cap secured -Use the green bag kit or charcoal filtration for EtBr buffer solutions
Treatment/Disposal	- Dispose EtBr Gel and EtBr Contaminated garbage in Special Waste Container and Deliver to dispose.

Table3: Containers, Quantity, Waste Storage Area in Laboratory, The Center for Scientific and Technological Equipment

Codes	Classifications	Containers	Quantities	Storage Areas
L01	Acidic Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable
L02	Alkaline Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable
L03	Salt Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable
L04	Phosphorus/Fluoride Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable
L05	Inorganic Cyanide Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable
L06	Organic Cyanide Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable
L07	Chromium Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable
L08	Inorganic Mercury Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable

Table3 (Cont.): Containers, Quantity, Waste Storage Area in Laboratory,

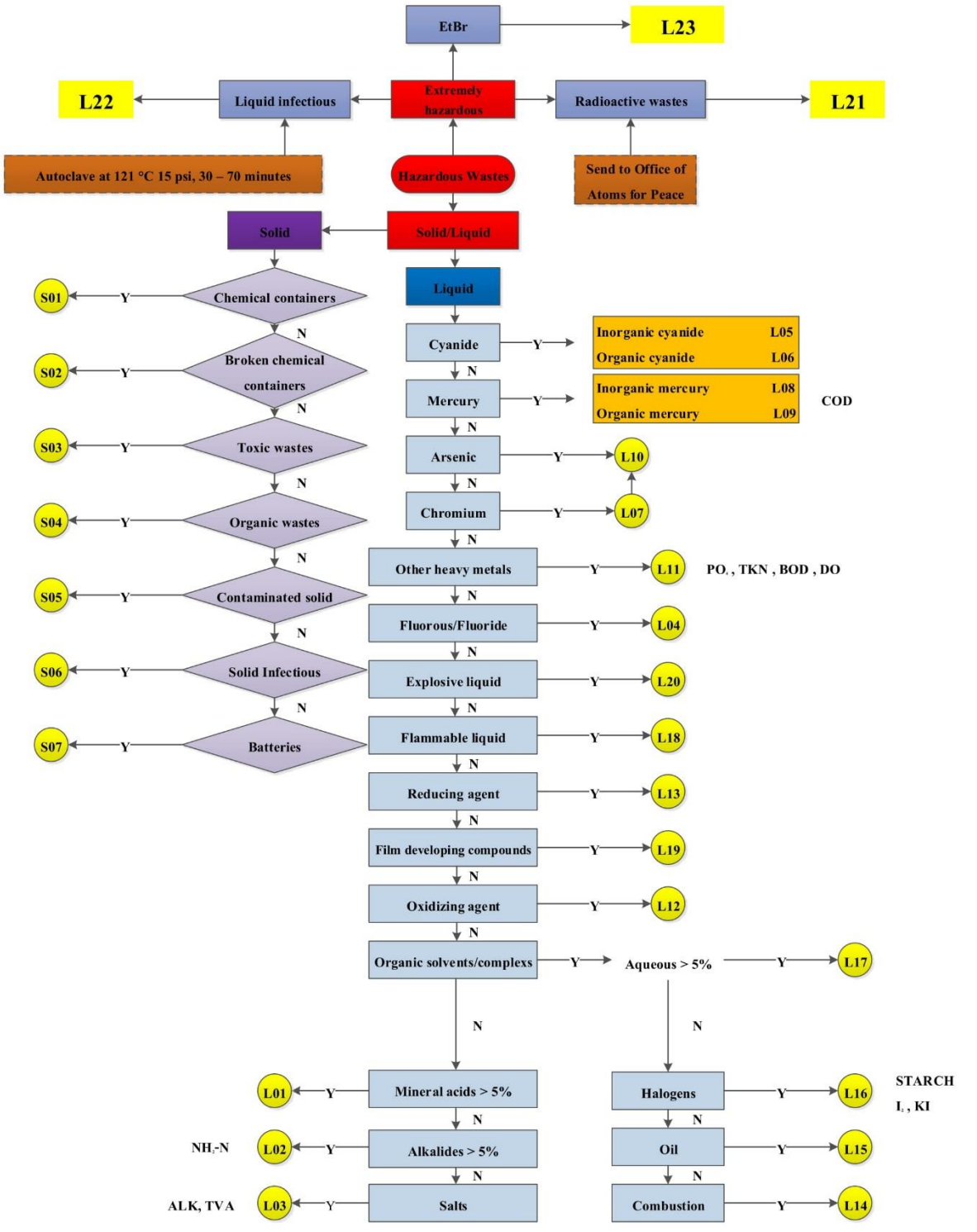
The Center for Scientific and Technological Equipment

Codes	Classifications	Containers	Quantities	Storage Areas
L09	Organic Mercury Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable
L10	Arsenic Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable
L11	Heavy Metal Ion Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable
L12	Oxidizing Agent Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	**Segregated from** Nitrogen compounds which are base, organic base; or organic solids which are neutral; flammable liquids, and organic acids
L13	Reducing Agent Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable
L14	Flammable Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	**Segregated from** Acidic, Alkaline, and Oxidizing Agent Wastes
L15	Oily Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable
L16	Halogenated Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable
L17	Organic Liquid Containing Water	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable
L18	Flammable Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable

Table3 (Cont.):Containers, Quantity, Waste Storage Area in Laboratory,

The Center for Scientific and Technological Equipment

Codes	Classifications	Containers	Quantities	Storage Areas
L19	Waste Containing Photo Stabilizers	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable
L20	Explosive Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant	70-80% of the container	- Good ventilation area - Ground floor of the building is suitable
L21	Radioactive Agents	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant **(Do not keep different radioactive agents in the same tanks)**	70-80% of the container	**Isolated storage**
L22	Waste Containing Microorganisms	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant **(Do not keep different microorganisms in the same tanks)**	70-80% of the container	**Isolated storage**
L23	EtBr Waste	PE or PP tank, 20 Liter or appropriate size; acidic, basic, and corrosive resistant **(Do not keep different EtBr in the same tanks)**	70-80% of the container	**Isolated storage**



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Picture 1 Flow Chart of Laboratory Waste Classification

Laboratory Waste Management

1 Container and Tool Preparation for Waste Management

Waste in laboratory must be separately stored in proper containers. The followings containers and tools are needed for lab waste management:

- **Containers for measuring waste volume:** glass or PE/PP plastic 250ML measuring cylinder or 1L/5L beaker (depends on waste quantity); use a glass container with acid waste and the plastic one for base waste.
- **Containers for storing waste:** 5L-20L bucket or gallon container with a proper wide compartment, tight screw cap, and handle for easy lifting or transport (select proper container material for storing each type of waste; **more details in Table 3**)

2 Waste Storage Area

Waste storage area must be separated in three places as follows:

- **Laboratory Waste Storage:** Laboratory waste should be kept in a separate area from the operating area and located in a well-ventilated area. Some lab waste must be segregated from other general waste but should not be stored in the lab room for excessive quantity and time as it can be dangerous. The lab waste should be moved quickly to the building waste storage.
- **Building Waste Storage:** Building waste storage should be in a place on the ground floor of the building. It can be a well-ventilated room or a proper space where the lab waste can be segregated from other general waste. The waste collection at the building should not be longer than 1 month and then should be moved to an on-site waste storage for further transferring to proper treatment or disposal method.
- **On-site Waste Storage:** The on-site waste storage should have good ventilation and an adequate capacity to cater for the quantity of waste produced and the frequency of waste collection. The different types of waste can be stored properly in accordance with standard waste management especially for the waste that cannot be stored with other types of waste. The on-site storage is the place for temporary waste collection before being transferred to treatment or disposal by the university or external agency that is specialized in specific waste treatment. Suitable place for lab waste storage and appropriate quantity of waste stored in container are shown in **Table 3**.

3 Labelling Waste Container

To prevent mixing of different types of incompatible waste solution which may cause severe reactions, labeling should be clearly made and affixed on the waste container.

Waste Container Label must:

- be big enough to be noticeable and put in a plastic bag to prevent danger of chemical spill;
- specify the number and type of waste written with large and legible letters using non-water erasable ink and must be firmly attached to the container to prevent its removal and falling off;
- identify types of waste generated from laboratory activities to prominently indicate the type of waste;
- identify the hazards of certain types of waste by attaching international standardized safety signs such as a sign indicating flammable waste etc.;
- have affixed two labels in separate plastic bags and the bags closed firmly. The first label must be put on the top of a waste container, and the second label on a side of the container;
- indicate waste storage duration of each waste type and notify a laboratory supervisor to plan for further transferring the waste to the central storage area of The Center for Scientific and Technological Equipment.

Samples of Waste Container Label

Label 1: Put on top of the container

Label 1: put on top of the container	Heavy Metal Ionic Waste		
	Original source of waste/experiment name/key word	Experiment name: Bilirubin blood test	
L11	Storage start date: 20 Sep 17	Lab room: Chemical lab	Building: Scientific Bldg. 7
Hazardous liquid waste type 11	Storage end date:	Name of work unit:	Tel:
Label code:			
Chemical name in waste	Volume (L)	Remark	Label written by
Cu2SO4. 0.5%	18		
			( )
			Lab officer name
Total			( )
Contact detail: The Center for Scientific and Technological Equipment (CSE), Walailak University Tel: +6675 673248-51 Fax: +6675 673247 Website: http://cse.wu.ac.th			

Label 2: Put on side of the container

Label 2: put on side of container	Heavy Metal Ionic Waste		
	Original source of waste/experiment name/key word	Experiment name: Bilirubin blood test	
L11	Storage start date: 20 Sep 17	Lab room: Chemical lab	Building: Scientific Bldg. 7
Hazardous liquid waste type 11 Label code:	Storage end date:	Name of work unit:	Tel:
Chemical name in waste	Volume (L)	Remark	Label written by
Cu2SO4. 0.5%	18		
			( )
			Lab officer name
Total			( )
Contact detail: The Center for Scientific and Technological Equipment (CSE), Walailak University Tel: +6675 673248-51 Fax: +6675 673247 Website: http://cse.wu.ac.th			

Recording Waste Volume and Quantity

To systematically record the amount of waste in each laboratory for tracking, collecting and finding appropriate ways to manage those waste, the category, type and amount of waste generated from activities must be properly recorded using the certain form named " Laboratory waste management of The Center for Scientific and Technological Equipment, Walailak University" which is attached in the appendix.

It should start with the preparation list of regular waste generated by activities in laboratory subjects, research, and experiments. Waste obtained from all laboratory activities must be measured before storing in the proper waste container. In addition, a record of waste quantity, and type of waste, must be submitted together with the lab waste to the laboratory supervisor for gathering data and transfer the waste to the waste storage of the center.

Reporting Waste Quantity

Reporting the amount of waste in every laboratory can be made by recording the waste quantity, type and volume, then submit to each laboratory supervisor. Then the supervisor collects waste in his/her laboratory and transfers to the waste storage of the center before further transporting for treatment and disposal.

All related forms can be downloaded at http://cse.wu.ac.th

1. CSE-HZW-01: Form for Recording Chemical Information/Hazardous Waste Generated from Lab Experiment/Test/Research

CSE-HZW-01 Form

Form for Recording Chemical Information/Hazardous Waste Generated from Lab Experiment/Test/Research

Part 1 General Information: Name of Lab User

Name.....Laboratory Room.....School of.....

Contact No.....E-mail address.....Building.....

Part 2 Chemical Information: Name of chemicals used and waste generated from products or experiments

Name of experiment/test.....

Reaction occurred during experimental/testing process.....

Chemical Used			Waste Generated			Classify hazadous waste	
Name	Concentration (mg/L)	Volume (ml)	Name	Concentration (mg/L)	Volume (ml)	Standard value	Type of waste
Total			Total				

Note: This form can be downloaded at http://cse.wu.ac.th

Form written by..... (Date.....)

Signed by subject coordinator/researcher/experimenter..... (Date.....)

2. CSE-HZW-02: Form for Recording Waste Items of Laboratory Subject/Research Experiment

CSE-HZW-02 Form for Recording Waste Items of Laboratory Subject/Research Experiment

Subject/Research title.....

Lab room/Research room.....Building.....

No.	Experiment name/Research Title	Waste Components	Type of Waste	Remarks

.....

Officer in charge of lab waste management

Date ...../...../.....

(.....)

Lab Supervisor/Head

Date...../...../.....

3. CSE-HZW-03: Form for Recording Liquid Waste Quantities

CSE-HZW-03 Form for Recording Liquid Waste Quantities

Name of Laboratory/Research Room.....Building.....

Date	L01		L02		L03		L04		L05-L06		L07		L08-L09		L10		L11		L12		L13		Recorded by
	Acid waste		Base waste		Salt waste		Phosphorus/Fluoride waste		Cyanide waste		Chromium waste		Mercury waste		Arsenic waste		Heavy metal ion waste		Oxidizing agent		Reducing agent		
	Component:		Component:		Component:		Component:		Component:		Component:		Component:		Component:		Component:		Component:		Component:		
	Quantity (ml)	Cumulative Quantity (ml)	Quantity (ml)	Cumulative Quantity (ml)	Quantity (ml)	Cumulative Quantity (ml)	Quantity (ml)	Cumulative Quantity (ml)	Quantity (ml)	Cumulative Quantity (ml)	Quantity (ml)	Cumulative Quantity (ml)	Quantity (ml)	Cumulative Quantity (ml)	Quantity (ml)	Cumulative Quantity (ml)	Quantity (ml)	Cumulative Quantity (ml)	Quantity (ml)	Cumulative Quantity (ml)	Quantity (ml)	Cumulative Quantity (ml)	
Total																							

Note: PE plastic container can be loaded waste at 80% of its capacity e.g. 20L bucket can contain 16L or 16,000ML of waste / Form can be downloaded at http://cse.wu.ac.th

Signed.....Information reporter (Date...../...../.....) Signed.....Head of Division/Lab (Date...../...../

4. CSE-HZW-04: Form for Recording Solid Waste Quantities

CSE-HZW-04 Form for Recording Solid Waste Quantities

Name of Laboratory/Research Room.....Building.....

Date	S01				S02		S03		S04		S05		S06		S07		Recorded by
	Used chemical bottles				Broken contaminated Glassware		Toxic waste		Organic waste		Chemical contaminated		Infectious Waste		Battery/Light Battery		
	Component: Glass bottles		Component: Plastic bottles		Component: glass shards		Component: Carcinogen		Component: Media waste		Component: **Chemical**		Component: **Infectious Waste**		Component: **Battery/Light Battery**		
	Quantity (Kg)	Cumulative	Quantity (Kg)	Cumulative	Quantity (Kg)	Cumulative	Quantity (Kg)	Cumulative	Quantity (Kg)	Cumulative	Quantity (Kg)	Cumulative	Quantity (Kg)	Cumulative Quantity (Kg)	Quantity (Kg)	Cumulative Quantity (Kg)	
Total																	

Note: Solid waste must be kept in double garbage bags with newspapers covering the bottom of the bag before disposing this type of waste into a container.

Signed.....Information reporter (Date...../...../.....)

Signed.....Head of Division/Lab (Date...../...../

5. CSE-HZW-05: Form for Reporting Laboratory Waste Quantities

CSE-HZW-05

Form for Reporting Laboratory Waste Quantities

for semester.....academic year.....

Name of Work Unit : The Center for Scientific and Technological Equipment, Walailak University

Name of Laboratory.....Program.....Department.....

Contact No.....E-mail address.....Building.....Floor.....

I, Mr./Mrs./Miss..... in charge of waste management for

laboratory room.....Program..... Department.....

would like to give a monthly report of quantity of hazadous waste generated from laborotory activities, as in the following details:

Code	Type of Waste	Quantity	Unit	Remarks
L01	Acid waste		Litre	
L02	Base waste		Litre	
L03	Salt waste		Litre	
L04	Phosphorus/Fluoride waste		Litre	
L05-06	Cyanide waste		Litre	
L07	Chromium waste		Litre	
L08-09	Mercury waste		Litre	
L10	Arsenic waste		Litre	
L11	Heavy metal ion waste		Litre	
L12	Oxidizing agent		Litre	
L13	Reducing agent		Litre	
L14	Combustible waste		Litre	
L15	Oil waste		Litre	
L16	Halogen waste		Litre	
L17	water complex solution		Litre	
L18	Flammable waste		Litre	
L19	Fixative solution waste		Litre	
L20	Explosive waste		Litre	
L21	Radioactive waste		Litre	
L22	Bio-Hazard waste		Litre	
L23	Liquid EtBr waste		Litre	

Solid Waste

Code	Type of Waste	Quantity	Unit	Remarks
S01	Used chemical bottles - glass bottle		Kilogram	
	- plastic bottle		Kilogram	
S02	Broken contaminated glassware		Kilogram	
S03	Toxic waste		Kilogram	
S04	Organic waste		Kilogram	
S05	Chemical contaminated waste		Kilogram	
S06	Infectious waste		Kilogram	
S07	Battery		Kilogram	
	Solid EtBr waste		Kilogram	

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( )

Officer in charge of lab waste management

Date...../...../.....

.....

( )

Head of Division/ Lab

Date...../...../.....

6. CSE-HZW-06: Form for Recording Waste Stock Quantities of Central Waste Storage of CSE Center

CSE-HZW-06 Form for Recording of Waste Stock Quantities of Central Waste Storage of CSE Center

Type of Waste :..

No.	Date of Waste intake	Submitted Department	Waste Components	Quantity (L)	Cumulative Quantity (L)	Remarks

7. CSE-HZW-07: Form for Recording Waste Quantities Stored in Central Waste Storage of CSE Center

CSE-HZW-07

Form for Recording Waste Quantities Stored in Central Waste Storage of CSE Center

for academic year...../..... status of waste quantity as of date...../...../.....

Code	Type of Waste	Quantity	Unit
L01	Acid waste		Litre
L02	Base waste		Litre
L03	Salt waste		Litre
L04	Phosphorus/Fluoride waste		Litre
L05-06	Cyanide waste		Litre
L07	Chromium waste		Litre
L08-09	Mercury waste		Litre
L10	Arsenic waste		Litre
L11	Heavy metal ion waste		Litre
L12	Oxidizing agent		Litre
L13	Reducing agent		Litre
L14	Combustible waste		Litre
L15	Oil waste		Litre
L16	Halogen waste		Litre
L17	Water complex solution		Litre
L18	Flammable waste		Litre
L19	Fixative solution waste		Litre
L20	Explosive waste		Litre
L21	Radioactive waste		Litre
L22	Bio-Hazard waste		Litre
L23	Liquid EtBr waste		Litre
	Total		

Solid Waste

Code	Type of Waste	Quantity	Unit
S01	Used chemical bottles - glass bottle		Kilogram
	- plastic bottle		Kilogram
S02	Broken contaminated glassware		Kilogram
S03	Toxic waste		Kilogram
S04	Organic waste		Kilogram
S05	Chemical contaminated waste		Kilogram
S06	Infectious waste		Kilogram
S07	Battery		Kilogram
	Solid EtBr waste		Kilogram
	Total		

.....

( )

Officer in charge of waste storage

Date...../...../.....

.....

( )

Director of CSE Center

Date...../...../.....

Guidelines for Microbiology Lab Safety

General Practices for Microbiology Lab Safety

1. Wear lab coats only when in the lab or work area.
2. Always wash your hands thoroughly with soap before and after handling micromicroorganisms, and apply disinfectants when working with pathogenic micromicroorganisms. In some cases, it is necessary to wear safety gloves, glasses or a mask during lab work.
3. Use a disinfectant, or 70% ethanol solution, to wipe down benches, desks and work areas both before and after lab working. The work area should have only the utensils used in the work.
4. It is rigorously prohibited to eat, drink, or smoke while working on microbes.
5. Collect waste or items that are contaminated with microbial agents in proper waste containers for further disposal.
6. Be well trained on techniques and procedures to handle microbiological agents for microbiology lab safety; for example, avoid touching your mouth when using a pipette, techniques for sterilization, preparation of culture media in the lab, maintenance and preservation of microbial cultures, and management of microbial waste and microbial-contaminated equipment.
7. In case micromicroorganisms are spilled or dropped, it is recommended to clean the affected area immediately by wiping with disinfectant to prevent microbial proliferation.
8. It is recommended to know the hazard level or bio-safety level of the laboratory in use and follow the lab rules rigorously.

Laboratory workers may possibly be exposed to microorganisms by accidentally contacting blood, feces, urine, secretions and other specimens while performing lab work in the 3 following ways:

- penetrating a stab wound from a needle, or another sharp object.
- a wound caused by sharp injuries may be exposed to blood or other specimens.
- contact through mucous membranes.

Principles of Infection Prevention in Lab Work

1. Avoiding Accidents: a guideline and process in lab work must be carefully planned and performed accordingly, especially when using sharp objects.

2. Good Sanitation and Hygiene: aseptic techniques should be taken into account such as proper hand washing, setting up a hygienic and clean workplace and environment, including disinfection, sterilization, and proper waste disposal.

3. Using Proper Protective Equipment: such as gloves, masks, coats, hoods, goggles, aprons, etc. Using protective equipment can reduce risk for a lab worker in direct contact with blood, lymph or specimens.

Practice Guidelines for Microbiology Lab Safety

- Wear a laboratory coat only when in the lab and do not wear the coat outside the working area.
- Always wear gloves in a lab test to prevent an accident caused by microorganism entering into the body, and removing gloves with utmost carefulness to prevent microbial contamination
- Always use a pipette aid and never use mouth to suck or blow any liquid from the patient's specimen.
- Eating, storing food and drinks or cosmetics in the work area are prohibited.
- Avoid experiments that can cause the diffusion of micromicroorganisms. If necessary, do this in a biological safety cabinet or Laminar flow clean bench.
- Wear safety glasses or other protective equipment when performing the lab work to prevent object rebounding or liquid splashing that can be harmful or easily get into the eyes.
- Keep the laboratory clean and tidy, only necessary tools for experiment must be stored in the lab room.
- Clean and disinfect the workbench at least once a day with 2% Lysol or 5% Sodium hypochlorite solution.
- Never leave the lab door open, do not bring children or pets into the work area.
- Lab technician working on dangerous micromicroorganisms should be vaccinated.
- Contaminated containers and materials must be disinfected before disposal or submitting in a sealed container for cleaning, sterilizing or incinerating as appropriate.
- Always wash your hands after the experiment and before leaving the lab room
- Use only a centrifuge machine with lid and a liquid container or test tube, used for liquid, must always have a lid.
- Get rid of rats, cockroaches, ants and other animals in the laboratory when appropriate.
- In case of the spill of dangerous micromicroorganisms, it is recommended to report to a supervisor immediately; then disinfect the affected area, record the accident occurred and its solution, follow up symptoms of a lab technician if any, or perform other operations to prevent a severity of the accident occurring.
- Supervisors must advise lab technicians to understand how to prevent hazards that may occur from lab operations. In this way, work instruction guidance manuals on dangerous microbes must be written, and ensure that all staff comply with the instructions especially in infectious waste management.

Specimen Handling

1. Before disposal of culture media, blood, feces, secretions and other specimens, they must be disinfected by using steam sterilization or autoclave with hot steam at 121 ℃, 15 pounds/min pressure for 15 minutes or soak in appropriate disinfectant, such as 0.5% sodium hypochlorite solution or 2% Lysol for 1 hour. Discharging sterilized liquid can be done through a water pipe with a large amount of water flushing after. For sterilized agar, let it cool down, and then put it into a sealed plastic bag and dispose of it as general waste.
2. Blood collection needles, capillary tubes, blades, any sharp objects should be disposed of in the provided containers of the lab room for further destruction.
3. For carcasses of lab animals, dog heads (for rabies test) and other organs, they must be sterilized with hot steam or autoclave before putting in a waste incinerator (temperature not less than 1,000 °C) or bury in a meter-deep hole in the ground.

Laboratory Animals refer to animals that are in captive propagation, able to breed, and used in laboratory research or teaching for the benefit of science and technology. Usage of lab animals requires strict compliance with the code of conduct for the use of animals.

Code of Conduct for the Use of Animals refers to the criteria used by animal users for research, testing, teaching, and biological production in all fields of science and technology. Users of this code of conduct must rigorously adhere to its practice on the basis of ethical, humanitarian and appropriate academic principles, as well as being a generally accepted as a standard practice.

Ethical Principles and Guidelines for the Use of Animals (National Research Council of Thailand)

1. The value of animal life must be one of awareness by lab animal users. The usage of animals must be carefully considered to be of the greatest benefit and necessity and when no any other method is appropriate.

2. The least number of animals must be used in scientific experiments, thus the accuracy of the results depends on users' awareness.

3. Usage of wildlife must not contradict wildlife conservation laws and policies.

4. Be aware that animals are living things, just like humans.

5. Lab animal users are required to keep records of how the animals are treated in a lab as evidence.

General Practices for the Use of Laboratory Animals

1. In handling lab animals, the users must strictly adhere to the Ethical Principles and Guidelines for the Use of Animals stipulated by the National Research Council of Thailand.

2. Lab workers must be proficient in lab experimental procedures as well as basic knowledge about animals used in the lab and caring.

3. Students are required to wear lab coats, including a mask and hair covering for safety protection during the work.

4. Wash your hands before and after handling animals and every time before leaving an animal lab room.

5. Workers in animal laboratory must be aware of any animal slipping out of the cage. In case that an accident occurs, such animals must be eradicated and destroyed immediately.

6. After finishing lab work, students are required to clean and disinfect any contaminated areas or the area where spills or material were dropped in the animal room with disinfectant.

7. Students must be responsible during testing, experiment, research conducted in animals throughout the experimental period. Always provide good care for laboratory animals until completion of the study.

8. Animal care takers need to change bedding materials in the cage for a good environment and hygiene, reducing bad smells in the pet room. Animal manure, waste and other unused materials must be carefully handled and collected with hygienic process.

9. Unhealthy people or workers who are more vulnerable to infectious pathogens are prohibited to work in an animal laboratory.

10. Eating, drinking, smoking, and storing people's food are forbidden in the laboratory.

11. Children or people without lab responsibility are not allowed to enter an animal lab working area.

12. Only the authorized operation and experiment can be performed in the lab.

13. Do not perform any animal cruelty actions.

14. Do not bring laboratory animals outside of the designated area.

15. Do not bring dangerous substances such as flammable chemicals and volatile substances into the lab area. Some inflammable substances prepared for animal testing should be removed immediately after finishing testing each day.

General Use of Laboratory Animals

1. Animal husbandry agencies must be continuously breeding and holding animals under Strict Hygienic Conventional or Specified Pathogen Free or Germ Free rearing system that are guaranteed free of particular pathogens.

2. The animal husbandry agency must have staff with knowledge and experience in laboratory animals.

3. Animal husbandry agencies should provide source of information for laboratory animals, equipment used for raising animals, prevention of animal infection, control and inspect the environment, and help animals to die peacefully if necessary.

4. All lab animals must be eliminated by incinerating only and waste disposal must be properly handled.

Guidelines for Personal Accident Safety

The guidelines are recommended for personal safety practices responding to the following events:

6.1 Accident

- Report an accident and injury (if any) to the lab instructor immediately.

6.2 Sharp Injury

- Remove visible glass shards from the wound area.

- Stop bleeding by using an ice pack, press tightly on the wound or wrap bandages around the veins that lead to the wound.

- Clean the wound and treat it with the medication before covering the wound.

- It is recommended to see a doctor immediately if the wound is large and injury has caused heavy bleeding.

6.3 Burn Injury

- Immerse the wound in cold water or cover the wound with a wet towel until the burning pain relieves.

- Apply a thin layer of ointment for the burn wounds.

- It is recommended to see a doctor immediately if the wound is large and injury has caused heavy bleeding.

6.4 Skin Injury from Chemical Spills

- Remove any clothing contaminated with chemicals as soon as possible.

- Quickly wipe the skin or absorb as many chemicals as possible.

- In case that the spilled chemical is an aqueous solution, but does not react with water, flush the affected area with plenty of water for at least 15 minutes or until the substance is completely washed off. If the substance is not water soluble, wash it out with soap.

- If the type of chemical spill is known, then follow the safety practice with the specific requirements for each substance provided in the MSDS. In severe cases, see a doctor immediately.

6.5 Eyes Injury from Chemical Splashing

- Wash your eyes immediately in an eye wash or apply plenty of running water for at least 20 minutes or until a chemical liquid has been washed out.

- See a doctor immediately.

6.6 Injury from Chemical Swallowing

- In this case, MSDS recommendations must be strictly followed.

- Swallowing of any chemical substances requires immediate medical attention.

The following guidelines are recommended in responding to a fire emergency:

7.1 Firefighting Measures

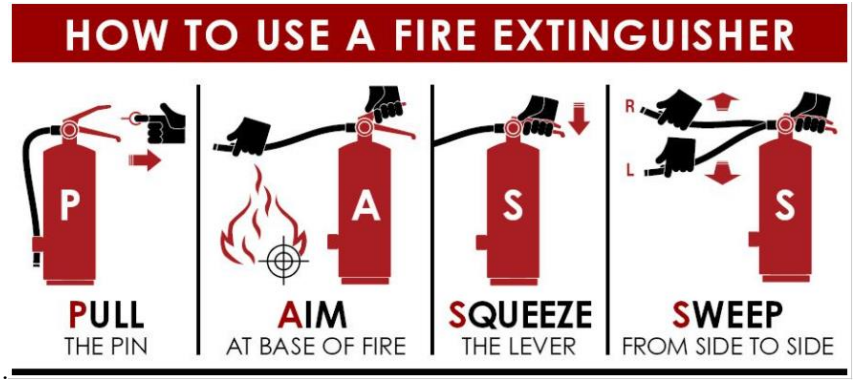
- Do not panic and assess the situation quickly.
- For lesser fires contained in a small space, using a fire extinguisher, if it is safe to do so.
- Use fire extinguishers appropriate for the different types of fire.
- If the fire cannot be extinguished manually, press the fire alarm and notify colleagues and laboratory staff.

7.2 Procedure in Case of Fire

- Report the source of the fire.
- Switch off electrical supply at main switch, switch off gas supply, move fuels away from the fire.
- Use the right type of extinguisher on the specific class of fire.
- Lie down if the fire is on your body, and roll around on the floor or cover a body with a wet cloth or heavy cloth; do not run.
- If the fire is out of control and a danger, do not attempt to put it out, evacuate the building immediately.

7.3 How to Use A Fire Extinguisher

- See the location diagram of the fire extinguisher.
- Face to the fire, stand 6-8 feet away from the fire.
- Pull the pin.
- Hold the extinguisher with the nozzle pointing away from you and release the locking mechanism.
- Aim low. Point the extinguisher at the base of the fire. Squeeze the lever slowly and evenly.
- Sweep the nozzle from side-to-side.



Picture 5 How to use a fire extinguisher

7.4 Fire Evacuation

- If the fire alarm goes off, switch off electrical supply at main switch, switch off gas supply.
- Everyone must leave the building following the fire exit signs, do not collect personal belongings.
- Do not use a lift/an elevator.
- Use wet towel to cover your eyes and nose to relieve smoke irritation.
- When evacuating, bend your body down and use a wet towel to cover your nose preventing suffering from smoke inhalation.
- Quickly move to the ground floor of the building, report your name to the instructor, to check the number of people in the building.
- Do not return to buildings until officials declare them safe.

7.5 Classes of Fires

Class A: refer to common combustibles such as wood, paper, cloth, rubber, trash and plastics.

Class B: refer to flammable liquids, solvents, oil, gasoline, paints, lacquers and other oil-based products.

Class C: refer to energized electrical equipment such as wiring, controls, motors, machinery, or appliances.

Class D: refer to combustible metals such as magnesium, lithium and titanium.

7.6 Classes of Fire Extinguishers

7.6.1. Dry Chemical Powder:

- Type ABC: These are suitable for fighting burning solids such as wood, cloth, plastics, and paper, liquids such as solvents, oil, and gases, as well as electrical equipment (Class A, B and C fires).
- TYP BC: These are suitable only for fighting burning liquids such as solvents, oil, gases, as well as electrical equipment (Class B and C fires, not for Class A).

7.6.2 Water Extinguishers: Water extinguishers are only suitable for Class A fires consisting of paper, wood, solid plastics etc.

7.6.3 Foam Extinguishers: consist of water and AFFF chemicals with high pressure. The foam smothers the fire in solids and liquids (Class A and B), but not in burning electrical equipment (Class C).

7.6.4 Halon Extinguishers: Halon 1211 is used only in portable extinguishers and is a streaming agent. They are safe and effective to use on Class A, B, and also suitable for use on electrical fires (Class C) because it leaves no residue or collateral damage.

7.6.5 Carbon Dioxide Extinguishers: These contain only pressurized carbon dioxide gas and therefore leave no residue. They are suitable for use on fires involving burning liquids (Class B), and electrical fires (Class C).

7.7 Preparation of Fire Extinguishers and Fire Fighting Equipment

- Install the fire extinguishers in easy and quick accessible location when in need.
- Must have a clearly marked location indicating the installation area and do not place any objects blocking the way to access and use. There must be a fire extinguisher plan(s) in the building.
- Quality of fire extinguishers and equipment used must meet international standards.
- There must be enough quantity of fire extinguishers to extinguish the initial fire preventing fire spreading.
- Frequent maintenance of fire extinguishers must be done to make sure that they are ready to use, not expired or deteriorated.
- There must be training for staff on fire emergency response and how to use fire extinguishers regularly.

7.8 How to Prevent Fire Incidents

- Do not place flammable materials near the fire source.
- Do not put things in the hallways and around the balcony, especially around the fire exits.
- Do not store excessive amount of flammable chemicals, solvents, and gases.
- Provide suitable fire extinguishers for the laboratory, installed in a proper location, and regularly check the conditions.
- Do not leave a machine that operates heat, without close surveillance or attendance.
- Check the condition of electrical equipment regularly; do not use damaged electrical equipment especially the power plug and devices with a rotating motor.
- Before leaving the laboratory, make sure that all unused electrical equipment is switched off and unplugged.
- If a power extension adapter is needed, select the one with a fuse to cut off the power if the current exceeds 10 Amp.
- Do not overload electrical devices that can be accepted by plugs, cords or connectors (1000 watt /1 socket outlet).
- Never use broken power cords and sockets.
- If the electrical equipment is damaged, notify the laboratory staff. Do not make any modifications or repairs by yourself.
- Place heat-radiation equipment, such as an incubator, in a well-ventilated area.
- Do not set an electric stove near flammable substances and do not bring flammable materials such as cloth and plastic near the stove.
- Special care should be taken when handling flammable materials and waste disposal.
- If performing any operations that are at risk of fire, such as the use of flammable solvents, students must consult a lab instructor.

7.9 Guidelines for Preventing Heat-Related Hazard

- If there are electric stoves used in the experiment, they must be performed with caution. Never put things near the stove and there must be a ceramic plate or a heat protective pad underneath the stove.
- When handling hot glassware, use a tweezer or heat resistant gloves to move it.
- Students must not place hot glassware or equipment directly on the workbench; always put it on a heat-proof pad such as a ceramic pad.

7.10 Fire and Electrical Hazards

Electrical fires are caused by sparking and excessive heat. Therefore, to prevent electrical fires, people must avoid the following risk factors:

- Sparks caused by a short circuit.
- The power connector or plug is loose, resulting in an uneven current flow.
- The sparking caused by unbalanced electrical load.
- The use of fuse size, or wrong amperage, or use of automatic safety cut out switch is inappropriate.
- Excessive current flow through electrical appliances.
- Motor overloading.
- Too many electrical devices are connected to the same outlet.
- The voltage at the electric motor is too low.
- The wires are damaged or being used for a long time.

The hazards of electric shock occur when the body touches or connects to an electrical circuit, then current flows through the body and affects the nervous system. The symptoms of an electric shock depend on how severe it is, as shown in Table 5.

Table 5: Electrical Shock Hazards & Effects on Human Body

Current (Milliampere: mA)	Effects
Below 0.5	Generally not perceptible
0.5 – 2	Tingling sensations
2 – 8	Muscle contraction and pain
8 – 20	Painful shock, loss of macular control
20 – 50	Muscular contraction, suffocation possible, death is possible in 2-3 minutes
50 – 100	Extreme pain, nerve damage occurs, irregular heartbeat, respiratory arrest, severe muscular contractions, death is possible in 2-3 minutes,
Over 100	Ventricular fibrillation, cardiac arrest, severe burns, paralysis, death is probable

7.11 Safety Precautions for Working with Electrical Tools and Equipment

7.11.1 Inspect electrical wiring and check connection points especially for electric node of mobile devices. If damage has been found, it must be fixed and replaced for a safe working condition.

7.11.2 An electric lamp must have a lamp cover.

7.11.3 Replacement or repair of electrical equipment must be performed by an electrician or a skilled person, do not take any action by yourself without experience.

7.11.4 Do not touch the wires while electric current is running.

7.11.5 Do not use electrical equipment with wet hands.

7.11.6 Do not step on the wires or push a heavy vehicle over the wires.

7.11.7 Do not hang electric wires on sharp objects.

7.11.8 Electrical equipment must be installed with an earth or ground wire.

7.11.9 There should be a responsible person for switching motor or transformer on and off.

7.11.10 There should be a sign obviously indicating the hazardous areas.

7.11.11 If there is any malfunction of the device, the person in charge should be informed immediately, and stop using such device.

7.11.12 Do not disconnect the protective equipment from electrical hazards, except with the permission of the experts.

7.11.13 Make sure that the switch is off when finished use of the device.

7.11.14 Regularly clean electrical equipment; kept it clean from dust and dirt.

7.11.15 Do not cover the lamp with paper, cloth, or other flammable materials.

7.11.16 Do not bring flammable substances near the electrical switch.

7.11.17 Make sure that the insulation of electrical equipment is in proper condition.

7.11.18 If someone is in danger from electrical shock, cut the switch off immediately.

7.11.19 If the switch is under maintenance, use a sign to indicate the repairing status such as a sign indicating “do not activate the device”.

7.12 Electrical Equipment Installation

7.12.1 Electrical equipment installations must comply with the requirements of electrical laws and standards.

7.12.2 The installation needs to be done by a professional or knowledgeable mechanic.

7.12.3 Be aware that the equipment installation requires specific protective equipment.

7.12.4 Do not operate or open parts of electrical equipment while the electricity is running.

7.12.5 Equipment or cables installed at high levels must be well insulated and the condition of the devices or wires must be always inspected.

7.12.6 All electrical machines/appliances should have earth grounding.

7.12.7 The machines should be switched off and there should be a system to prevent irrelevant persons to easily open the switch, such as putting a switch in a lid box.

Laboratory equipment and tools are essential for safe lab use to prevent any personal hazards for laboratory users to work under a safe environment and with confidence.

1. Ventilation: The primary functions of laboratory ventilation systems are to provide safe, comfortable, breathable environments for all lab users and to minimize exposures to hazardous air contaminants. Gernerally, it is recommended that the value of laboratory ventilation should not be lower than 6 ach (air changes per hour).

2. Fume Hood: There are many types of fume hood. A laboratory fume hood is a type of ventilation system that primarily functions to provide lab personnel protection against toxic fumes, chemicals, vapors and dust. An exhaust fan situated on the top of the laboratory building pulls air and airborne contaminants through connected ductwork and exhausts them to the outside atmosphere. Therefore, air speed inside the hood must be checked and maintained regularly as well as inspected for leakage of volatiles inside the hood.

Use a chemical fume hood anytime your work involves hazardous chemicals. The hood must perform optimum face velocity at 80-120 linear feet per minute with a sash open at 18 inches.

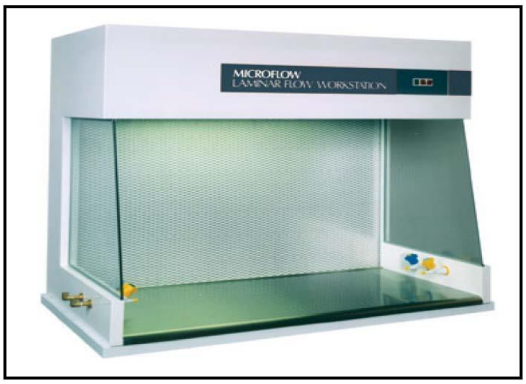
Properly Using a Fume Hood

1. Keep the sash at 18 inches (1.5 feet) or less from the working surface while using the hood.
2. Place chemicals at least six inches inside the hood.
3. Do not disturb the airflow of a fume hood.
4. Do not store chemical substances in a fume hood.

Picture 6 Fume Hood

3. Laminar Flow is installed in a biology laboratory and can be categorized into classes according to the type of use. Laminar flow is defined as airflow in which the entire body of air within a designated space is uniform in both velocity and direction. Some of these hoods protect items placed on the work surface from contamination. Others prevent exposing the user to contaminants in the work area. Laminar flow hoods are often used to work with

biological samples, semiconductors or other sensitive materials. It is equipped with a UV lamp for disinfection before and after work.



Picture 7 Laminar Flow

4. Eyewash and Emergency Shower stations are likely to be found in laboratories for washing eyes and bodies if potential harzards of chemical exposture exist during the lab work. The stations should be installed 10 seconds far from work area and do not place any obstructions along the way for convenient exposure to the stations. It is recommended to rinse the eyes or bodies for at least 15 minutes to make sure that the harzadous substances are rinsed off.

Picture 8 Eye Wash and Emergency Shower

5. Laboratory Sink: Laboratory users must always wash their hands with soap and water if there is skin contamination or after removing the gloves and finishing the lab work. Besides, the sinks are also used to wash contaminated laboratory equipment.

Picture 9 Laboratory Sink

6. Personal Protective Equipment refers to an object that is worn on an organ or parts of the body for the purpose of preventing harm to such body parts from being exposed to danger. The equipment can be classified according to the purpose of protection. The basic lab safety equipment that should be used in the laboratory are such as: lab coats, eye protection, chemical cartridge respirator, face masks, acid and alkali resistant PVC gloves, corrosive gloves, hot grip gloves, rubber gloves, medical gloves in biological lab, and chemical splash protection lab coats.

7. Laboratory Coats provides protection of skin and personal clothing from incidental contact, dust and small chemical splashes. The lab coats must be made of 100% cotton or Tyvek or Nomex; do not use lab coats made of Rayon or Polyester materials as they are flammable ones and might cause harm to the wearers. The lab coats should be cleaned regularly and are not worn outside the lab to prevent the spread of chemical contamination outside the lab.

Picture 10 Laboratory Coat

8. Gloves: There are many types of laboratory gloves. Glove selection depends on type of chemicals the users handle, such as using asbestos gloves for heat protection. Chemical resistant gloves should be made of natural rubber or Neoprene, Polyvinyl chloride, Nitrile Butyl. For use in biological lab, gloves are usually made of vinyl or latex. However, in principle, it is important to always wear gloves when handling chemical preparation or hazardous chemicals. Before wearing, check the condition of them and after finishing the work, dispose them into the specified waste container and always remove gloves when leaving the laboratory. Do not touch any devices such as doorknobs, phones, or pens, while still wearing gloves, to prevent chemical contamination to those devices.

9. Chemical goggles are utilized to protect your eyes from vapors and incidental splashes of hazardous chemicals or liquids. The glasses must be made of a material resistant to chemicals, and cover the eyes properly or can be flexible. Safety glasses need to be cleaned and disinfected after use for safety hygiene practices.

Picture 11 Chemical Goggles

10. Face and Eye Protection Use: Eye and face protection shall be required where there is a reasonable probability that injury from hazardous chemical splashes could be prevented by such protection.

Picture 12 Face and Eye Protection

11. Chemical Cartridge Respirator: The purpose of utilizing chemical cartridge respirators is to protect against toxic vapors of chemicals as they remove chemicals from the air. They are suitable for protection against organic vapors such as acetone, alcohol, benzene, carbon tetrachloride, chloroform, oil vapor. However, do not wear a chemical cartridge respirator in an area where dangerous gases can build up with low oxygen and considered immediately dangerous to life or health.

Picture 13 Chemical Cartridge Respirator

12. Ear Protection: Lab users should wear a hearing protector while working with noisy machines and their sound level is more dangerous than the exposure limits. In this case ear protection, such as ear plugs or ear muffs, reduces the amount of noise reaching the ears.

Picture 14 Ear Protection Devices

Appendix

1. First Aid Measures When Exposed to Chemicals
2. Basic First Aid Measures
3. Laboratory Attire and Safety Rules
4. Safety Signs
5. Waste Container Labelling
6. Industrial Manufacturer Effluent Standards
7. Emergency Telephone Numbers

First Aid Measures When Exposed to Chemicals

1. Exposing to Unknown Chemicals

- Move an exposed person to fresh air promptly.
- Restore respiration if breathing has stopped, be aware that if hazardous chemical is swollowed or inhaled, use Holger Niesen technique (back-pressure arm-lift) to restore breathing, instead of using mouth to mouth, or use other breathing and respiratory medical equipment.
- Use oxygen therapy if an exposed person is short of breath, take his/her contaminated clothes and shoes off.
- In case of skin or eye contact, immediately rinse off with water for 15 minutes.
- Keep a victim's body at a warm temperature and transfer to hospital.
- A victim's health effect of exposure to chemicals by swallowing, inhaling, or skin contacting may appear in the long term.
- For personal safety, properties of Chemicals or hazardous substances must be made aware to persons who give a medical treatment to an exposed person.

2. Exposing to Explosives

- Need immediate medical care by physicians.
- Remove contaminated clothes and shoes.
- In case of skin or eye contact, immediately rinse off with water for 15 minutes.
- For personal safety, properties of Chemicals or hazardous substances must be made aware to persons who give medical treatment to an exposed person.

3. Exposing to Flammable or Toxic Gases and Liquids

- Move an exposed person to fresh air promptly.
- Restore respiration if breathing has stopped, be aware that if hazardous chemical is swollowed or inhaled, use Holger Niesen technique to restore breathing instead of using mouth to mouth (back-pressure arm-lift) or use other breathing and respiratory medical equipment.
- Use oxygen therapy if an exposed person is short of breath, take his/her contaminated clothes and shoes off. If such clothes become cold, solid, or adjoin to skin, make it softer before removal.
- In case of exposing to cryogenic liquid, immediately wash out with warm water.
- Keep a victim's body at a warm temperature and transfer to hospital.
- A victim's health effect of chemical exposure by swallowing, inhaling, or skin contact, may appear in the long term and may require close physician supervision.
- For personal safety, properties of Chemicals or hazardous substances must be made aware to persons who give a medical treatment to an exposed person.

4. Exposing to Flammable Solids

- Move a victim to fresh air promptly, then assess his/her symtoms, restore respiration if breathing has stopped or use oxygen therapy in case of breathlessness.
- Remove contaminated clothes and shoes.
- In case of skin or eye contact, immediately rinse off with water for 15 minutes.
- In case of skin injured by flammable solid chemicals, removal of particulate debris from the wound must be performed by physicians.
- Keep a victim's body at a warm temperature and transfer to hospital.
- For personal safety, properties of Chemicals or hazardous substances must be made aware to persons who give a medical treatment to a victim.

5. Exposing to Oxidizing Agents

- Move a victim to fresh air promptly, then assess his/her symtoms, restore respiration if breathing has stopped or use oxygen therapy in case of breathlessness.
- Remove contaminated clothes and shoes.
- In case of skin or eye contact, immediately rinse off with water for 15 minutes.
- In case of skin injured by flammable solid chemicals, removal of particulate debris from the wound must be performed by physicians.
- Keep a victim's body at a warm temperature and transfer to hospital.
- For personal safety, properties of Chemicals or hazardous substances must be made aware to persons who give medical treatment to a victim.

6. Exposing to Infectious Substances

- Isolate a victim to a safe place; victim must be handled carefully as he/she can be a source of infection.
- Remove contaminated clothes and shoes and segregate them for disposal.
- Shower with antiseptic soap.
- Consult and notify the doctor regarding type or properties of such an infectious substance for infection prevention.
- Health effects of an inhalation of or exposure to any infectious substance may appear in the long term.

7. Exposing to Radioactive Substances

- Wrap a victim's body with a plastic sheet or blanket before transferring him/her to a safe place.
- Victim must be handled carefully as he/she can be a source of infection.
- Separate personal items used by a victim such as gloves, clothes, plastic sheet etc. and safely dispose of them as recommended in radioactive safety guidelines.
- Hospital referral is immediately needed.
- Victim care takers must understand properties of radiaoactive substances for personal safety protection.
- Health effects of an inhalation of, swallowing, or exposure to any infectious substance, may appear in the long term.

Basic First Aid Measures

First Aid Kits and Equipment in the Laboratory:

- Basic first aid medicines may contain distilled water for cleaning wounds, tincture, betadine, painkillers, cream for treatment of flame or scald burn wounds.
- Basic first aid equipment may contain sterile gauze dressings, scissors, cotton balls/pads, safety pins, eye wash/eye bath, plasters, band-aid etc.
- A guide to safe drug use.

- Safety Incident Notification Guides

1. Do not panic, remain calm.
2. Ask for assistance.

In case you are a person who provides assistance to a victim, administering first aid to injured person must be immediately done using the following caring steps:

1. Cuts and Puncture Wounds

- Remove visible dirts and debris from wound surfaces, let the bleeding clean out a wound for a second, then immediately rinse the wound with water or soap.
- Avoid rinsing the wounds with alcohol or hydrogen peroxide as they can cause irritation. 0.9 % saline is the preferred cleanser for most wounds because it is physiologic and will always be safe. The minor wounds do not need any medical care; they just need a good clean dressing.
- In case of deeper wounds, they need to be closed by physicians or heathcare providers to avoid infection. Infected wound refers to a wound with expanding redness around it, yellow or greenish-colored pus or cloudy wound drainage, increased swelling, tenderness, or pain around the wound.

2. Burn or Scald Wounds

First Aid Measures and Treatment

1. Remove clothing from the burned area, if clothing sticks to the skin, leave it there and cut away the remaining fabric.
2. Remove all jewelry including watches, rings, belt and shoes as the burned area may swell quickly causing them unremovable and some jewelry can be a heat absorber which is harmful to the skin.
3. Cool the burned area immediately (for at least 10 minutes).
4. Cool the burn wound with cool running water, do not use ice on a burn as it can further damage the tissue.
5. Use aloe vera gel or other antiseptic agent for the treatment of burn wounds, do not stab or cut the swollen skin.
6. It is recommended seeing the doctor, if the burn affects a large area of skin and requires immediate medical treatment.
7. Get vaccinated against tetanus to stimulate immunization if the last tetanus vaccine was given more than 5 years ago.

3. Electrical Burns

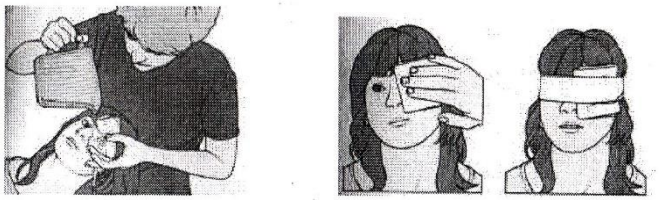
An electrical burn is a skin burn that happens when electricity comes in contact with your body and sometimes the burn can occur about 2-3days following the date of injury. Burns are usually most severe at the points of contact with the electrical source.

- Switch off or disconnect the power supply, do not touch a victim, use non-conducting objects such as wooden blooms or chairs to remove the electrical cord for a victim.
- After the victim is disconnected from the power, immediate administer the first aid care, restore respiration if breathing has stopped; if a pulse is not identified, immediately begin administering CPR, starting with chest compressions and transfer the victim to hospital.

4. Chemical Burns

4.1 Eye Burning

- Do not rub or squeeze an eye.
- To flush away the chemical, open your eye with fingers, and rinse the eye from side to side with running water, with the affected eye at the lowest point under the running water while tilting your head to the side.



- Close the eye with a clean cloth such as handkerchief and use another piece of long cloth to gently cover both eyes to prevent eye movement.

4.2 Skin Burning

- Move an exposed person to fresh air promptly and quickly take off clothing that has a chemical on it.
- In case of skin contact, immediately rinse off with water.
- Remove the chemical out of the body or reduce chemical absorbtion as recommended in a laboratory safety manual.

5. Gas Leakage

- Immediately move an exposed person to fresh air.
- Loosen any tight clothing around a victim's neck and waist, keep his/her body warm.
- If a victim is exposed to toxic gas, medical treatment under physicians care must be administered immediately.

6. Seizures and Epilepsy

- Stay calm, let the seizure take its course and always keep track of time.
- Protect the person from injuries caused by seizure, such as head injuries caused by hitting his/her head on the ground; cushion his/her head, loosen tight clothing especially around the neck.
- Do not insert any object into a person's mouth. It is not true that people having an epileptic seizure can swallow their tongue.
- Ease the person to the floor and turn the person gently onto one side. This helps him/her breathe more easily and keeps saliva from blocking their airway. Do not panic if the person stops breathing, it will return to more normal breathing.
- Seek emergency medical help immediately if the seizure continues for more than 5 minutes or a second seizure quickly follows.
- After the seizure ends, comfort the person, talk calmly and be reassuring to the person.

Laboratory Attire and Safety Rules

Appropriate and Safe

Inappropriate and Unsafe

No Drinking | No Eating | No Phone Calling | No Playing | No Running

No Putting on Make up | No Phone-Listening | No Wearing Jewelry | No Wearing Sandals | No Storing Food & Drink

Commercial & Engineer Grade

Waste Container Labelling

<table>
<tr><td>Label 1: put on side of the container</td><td colspan="3" rowspan="2">Flammable Waste</td></tr>
<tr><td rowspan="2"> 
</td></tr>
<tr><td>Original source of waste/experiment name/key word</td><td colspan="2"></td></tr>
<tr><td rowspan="2">L18</td><td>Storage start date:</td><td>Lab room:</td><td>Building:</td></tr>
<tr><td rowspan="2">Hazardous liquid waste type 18
Label code:</td><td rowspan="2">Storage end date:</td><td rowspan="2">Name of work unit:</td><td rowspan="2">Tel:</td></tr>
<tr><td>Chemical name in waste</td><td>Volume (L)</td><td>Remark</td><td>Label written by</td></tr>
<tr><td></td><td></td><td></td><td rowspan="2"></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>( )</td></tr>
<tr><td></td><td></td><td></td><td>Lab officer name</td></tr>
<tr><td></td><td></td><td></td><td rowspan="2"></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Total</td><td></td><td></td><td>( )</td></tr>
<tr><td colspan="4">Contact detail: The Center for Scientific and Technological Equipment (CSE), Walailak University
Tel: +6675 673248-51 Fax: +6675 673247 Website: http://cse.wu.ac.th</td></tr>
</table>

Industrial Manufacturer Effluent Standards

Water Quality Index	Maximum Permissible Guideline Limit (mg/L)	Analysis Methods
1. pH value	5.5-9.0	pH Meter
2. Total Dissolved Solids: TDS	● ≥ 3,000 mg/L or may be varied depening on type of waste water **reservoir** or industrial plants as deemed appropriate by the Pollution Control Committee, but not more than 5,000 mg/L ● Wastewater to be drained into brackish water with salinity value excess of 2,000 mg/L or into the sea, the TDS value of the effluent is not greater than the TDS value in brackish water or seawater, not more than 5,000 mg/L.	Dry Evaporation 103-105 ℃, 1 hour
3. Suspended Solids	≥ 50 mg/L or may be varied depending on type of waste water reservoir or industrial plants or wastewater treatment system as deemed appropriate by the Pollution Control Committee, but not more than 150 mg/L	Glass Fiber Filter Disc
4. Temperature	≥ 40°C	Thermometer
5. Colour or Odour	Not offensive	N/A
6. Sulfide as H_2S	≥ 1.0 mg/L	Titrate
7. Cyanide as HCN	≥ 0.2 mg/L	Distillation and Pyridine Barbituric Acid
8. Fat, Oil and Grease	≥ 5.0 mg/L or may be varied depening on type of waste water reservoir or industrial plants as deemed appropriate by the Pollution Control Committee, but not more than 15 mg/L	Sovent Extraction by Weight
9. Formaldehyde	**≥1.0 mg/L**	**Spectrophotometry**

Water Quality Index	Maximum Permissible Guideline Limit (mg/L)	Analysis Methods
10. Phenols	≥ 1.0 mg/L	Distillation, 4-Amino antipyrene
11. Free Chlorine	≥ 1.0 mg/L	Iodometric Method
12. Pesticide	Not found	Gas-Chromatography
13. Biochemical Oxygen Demand: BOD	≥ 20 mg/L or may be varied depending on type of waste water reservoir or industrial plants as deemed appropriate by the Pollution Control Committee, but not more than 60 mg/L	Azide Modification 20°C 5 Days
14. Total Kjeldahl Nitrogen: TKN	≥ 100 mg/L or may be varied depending on type of waste water reservoir or industrial plants as deemed appropriate by the Pollution Control Committee, but not more than 200 mg/L	Kjeldahl
15. Chemical Oxygen Demand : COD	≥ 120 mg/L or may be varied depending on type of waste water reservoir or industrial plants as deemed appropriate by the Pollution Control Committee, but not more than 400 mg/L	Potassium Dichromate Digestion
16. Heavy Metal 16.1 Zinc (Zn)	≥ 5.0 mg/L	Atomic Absorption Spectro Photometry-Direct Aspiration or Plasma Emission Spectroscopy-Inductively Coupled Plasma: ICP
16.2 Hexavalent Chromium	≥ 0.25 mg/L	
16.3 Trivalent Chromium	≥ 0.75 mg/L	
16.4 Copper (Cu)	≥ 2.0 mg/L	
16.5 Cadmium (Cd)	≥ 0.03 mg/L	

Water Quality Index	Maximum Permissible Guideline Limit (mg/L)	Analysis Methods
16.6 Barium (Ba)	≥ 1.0 mg/L	
16.7 Lead (Pb)	≥ 0.2 mg/L	
16.8 Nickel (Ni)	≥ 1.0 mg/L	
16.9 Manganese (Mn)	≥ 5.0 mg/L	
16.10 Arsenic (As)	≥ 0.25 mg/L	- Atomic Absorption Spectrophotometry--Hydride Generation or Plasma Emission Spectroscopy--Inductively Coupled Plasma: ICP
16.11 Selenium (Se)	≥ 0.02 mg/L	- Atomic Absorption Spectrophotometry--Hydride Generation or Plasma Emission Spectroscopy--Inductively Coupled Plasma: ICP
16.12 Mercury (Hg)	≥ 0.005 mg/L	- Atomic Absorption Cold Vapour Techique

Source: Notification of the Ministry of Science, Technology and Environment No. 3, B.E. 2539 (1996) dated 3 January 1996 on Standard Quality Control of Waste Water from Manufacturer, published in the Royal Government Gazette, Vol. 113, Special Part 13, dated 13 February 1996

Emergency Telephone Numbers

1. Emergency Call Center, Security Office, Walailak University	73392, 73333, 76595, 76596 (24 Hours)
2. Walaikom Gate Entrance	73393 (24 Hours)
3. Walailak University Hospital	73046, 73059
4. Security Guard, The Scientific and Technological Equipment Building 5	73669
5. Thasala Police Station	191 and 075-521-009
6. Thasala Fire Station	199 and 075-521502
7. Thasala Hospital	075-521815, 075-521133
8. Emergency Medical Service	1669

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13. Wandee Luesaiwong, Angsana Chausuwan. Getting to Know GHS, Department of Science Service. Year 60th Vol. 190 p. 24-28.

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