King Abdullah University of Science and Technology

Laboratory Hazardous Waste Management Manual

August 2022

Health, Safety and Environment

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DEFINITIONS

Flashpoint: The lowest temperature (corrected to a standard pressure of 101.3 kPa) at which the application of an ignition source causes the vapors of a liquid to ignite under specified test conditions.

Globally Harmonized System for the Classification and Labeling of Chemicals (GHS): An international agreement to classify chemicals into certain categories that have specific hazards and warnings, and to use a consistent label format and a consistent "Safety Data Sheet (SDS)" to provide information to those who use the chemical. The classification scheme is at: http://www.unece.org/trans/danger/publi/ghs/ghs_rev01/01files_e.html

International Fire Code (IFC). Model international consensus code establishing minimum fire safety requirements for new and existing buildings, facilities, storage and processes. The IFC addresses fire prevention, fire protection, life safety, and safe storage and use of hazardous materials in new and existing buildings and sites, regardless of the hazards stored being stored indoors or outdoors.

Lethal Dose 50 (LD_{50}): The dose amount of a toxic solid or liquid substance, administered orally (ingestion) or dermally (contact), required to kill 50% of the tested population.

Lethal Concentration 50 (LC_{50}): The dose amount of a toxic gas, administered through inhalation, required to kill 50% of the tested population.

Hazardous Waste: Exhibits characteristics related to the potential to cause harm to life safety, property, and the environment. In general, regulated characteristics are ignitable, corrosive, reactive, and/ or toxic to living organisms or the environment.

Oxidizers: Chemicals, other than blasting agents or explosives, that initiate or promote combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases (e.g. chlorate, permanganate, and nitrate compounds).

pH: The value that represents the acidity or alkalinity of an aqueous solution. The number is the logarithm, to the base 10, of the reciprocal of the hydrogen-ion concentration of a solution. Pure water has a pH of 7. The substance in an aqueous solution will ionize to various extents giving different concentrations of H+ and OH- ions.

Teratogen: An agent or substance that causes physical defects in the developing embryo.

1.0 INTRODUCTION

The Department of Health, Safety and Environment (HSE) has been charged to develop robust systems to ensure the safe and legal disposal of hazardous waste generated on campus, and provide guidance for hazardous waste management and disposal services for all King Abdullah University of Science and Technology (KAUST) operations. This manual utilizes international best practices and guidance from national and local waste requirements. These requirements apply to all hazardous waste generated by KAUST laboratories and impose specific requirements on all waste generators.

The objectives of this Hazardous Waste Management Manual are to:

- Provide guidance for the KAUST community to both work safely with and appropriately dispose hazardous substances - both chemical and biological.
- Minimize the risk of exposure to health hazards to all members of the KAUST community, its contractors, and visitors.
- Reduce the potential for the contamination of natural resources by hazardous substances generated within the University.
- Protect the reputation of KAUST through systems that ensure safe and legal disposal of hazardous substances.

In order for all campus personnel to properly dispose of hazardous wastes generated in their respective work areas, they must make accurate waste characterizations and disposal determinations. This document seeks to assist with waste determination and required waste management activities. Though this document focuses primarily on the campus research operation, where applicable, many topics are applicable to the community at large (e.g., used oil, fluorescent lamps, batteries, etc.).

1.1 TRAINING

For chemical laboratory workers, Hazardous Waste training and Lab Safety training are required. This training is provided by HSE. Beyond the Hazardous Waste training provided by HSE, personnel must be thoroughly familiar with waste handling and emergency procedures relevant to site-specific responsibilities.

1.2 REGULATIONS AND STANDARDS FOR THE MANAGEMENT OF HAZARDOUS WASTE

- UN Recommendations on the Transport of Dangerous Goods - Model Regulations
- IATA's Dangerous Goods Regulations
- International Fire Code, 2009 Edition
- International Agency for Research on Cancer
- United Nations Globally Harmonized System of Classification and Labeling of Chemicals
- KAUST Laboratory Safety Manual

2.0 RESPONSIBILITIES

All chemical users have a legal and moral responsibility to ensure the proper disposal of any hazardous waste that is generated. The KAUST management 's HSE policy is available at King Abdullah University of Science and Technology, HSE [Health Safety & Environment] Policy.

2.1 LIABILITY

Individuals or units that fail to comply with the regulated hazardous waste disposal requirements will be held be responsible for their non-compliance. *Individuals who knowingly choose to ignore established protocols may face institutional disciplinary action, up to and including termination of their employment.*

2.2 WASTE GENERATOR RESPONSIBILITIES

The principal investigator (PI), Lab Manager (Core Lab), or Center Director have ultimate responsibility to ensure the personnel working under their direction follow all policies and procedures established in this manual. Individuals who generate waste (e.g., lab technicians), or are responsible for the generation of waste (e.g., principle investigators), are considered the generators of these regulated materials. Therefore, it is the responsibility of each generator to verify waste materials are handled in a manner consistent with HSE requirements.

General responsibilities include:

- Attending Hazardous Waste Management Training.
- Cleaning up minor spills (with the proper training and spill equipment).
- Identifying all spent or surplus materials using the technical knowledge within the department (Section 4.0).
- Packaging, labeling, and storing all chemical wastes in accordance with established guidelines (Section 5.1).
- Maintaining good housekeeping in waste generation areas (Section 5.2).
- Consulting with supervisors and/or HSE regarding the safe handling and proper disposal of hazardous waste chemicals (when they are unsure or have questions).

While many of these tasks can be delegated to others, it is imperative that PIs or supervisors closely monitor and understand work undertaken by those under their responsibility. It is equally critical that workers inform PIs or supervisors of any unexpected changes in waste management practices or any intended deviations from established plans. Work and research should not proceed until PI or supervisor concurrence is established.

2.3 HSE RESPONSIBILITIES

KAUST's HSE Policy delegates the primary responsibility for administering KAUST's chemical waste management program and establishing policies and procedures for the proper chemical waste management to HSE.

Elements of the chemical waste management program include:

- Developing a written Hazardous Waste Management Manual and an online program detailing university policies related to hazardous waste and material management.
- Developing and maintaining a Contingency Plan for all KAUST central hazardous waste storage processes.
- Organizing & offering waste management training to all required campus personnel. Training will be tailored to meet both regulatory requirements and campus needs. The level of training required for trainees is a direct function of the work related to waste management.
- Acting as an information resource for campus personnel with hazardous waste related questions.
- Monitoring pickup and transport of chemical hazardous waste from campus Satellite Accumulation Areas to the campus central hazardous waste storage area.
- Providing periodic inspections of the campus central hazardous waste storage area.
- Acting as a point of contact with all regulatory agencies related to waste management issues.
- Preparing and maintaining records, reports, and manifests as required by regulations.
- Initiating policies and programs to minimize the generation of hazardous wastes.
- Keeping up-to-date with current regulations and best practices.

HSE personnel are available to assist campus personnel in the identification and handling of chemical wastes. These staff members manage the collection and proper disposal of the chemical waste generated at KAUST.

3.0 MINIMIZING HAZARDOUS WASTE GENERATION

Disposal of hazardous waste requires the facility's operating processes have no adverse effects on man's health, safety and welfare or on the environment and natural resources making it illegal to mismanage hazardous waste.

Placing the emphasis on waste reduction and recycling helps reduce research costs by decreasing the portion of research funds associated with waste disposal and material procurement.

3.1 MAINTAIN A CURRENT CHEMICAL INVENTORY

Maintaining a current inventory of all chemicals being used helps to minimize the generation of hazardous waste by avoiding over-ordering of chemicals. Over-ordering often results in excessive chemicals that expire due to non-use. This can be done with an effective inventory system, such as the Salute chemical management system used by KAUST. An inventory system allows labs to better check chemical inventories before ordering any new chemicals.

Instances requiring a small amount of material, such as the development of a new procedure or method, are encouraged to borrow from other labs where possible to avoid the procurement of excessive materials associated with unsuccessful processes. Please take the time to check with your colleagues. Additional information on the campus chemical inventory system can be found at Salute Chemical Inventory.

3.2 PURCHASING CHEMICALS

When ordering new chemicals, only order the quantity of chemicals anticipated for the experiment being conducted *or* that would be consumed within a year. Do not order a larger

size container of chemicals for an experiment that will only last a semester or for an experiment that *may* occur in the future. Although chemicals usually cost less per unit when purchased in larger containers; the actual usage, storage, and disposal costs quickly diminish the savings and may result in higher costs overall. Additionally, infrequently used containers can be rendered useless over time by contamination or degradation.

3.3 NONHAZARDOUS SUBSTITUTES

There are many nonhazardous substitutes for hazardous chemicals used in laboratories. When possible, labs are encouraged to use less hazardous chemicals. Chemicals with any of the following characteristics require special consideration and may result in more stringent requirements for use: highly toxic, reactive, contain heavy metals, and/ or are known or possess suspected carcinogens, mutagens, or teratogens .

Examples of nonhazardous chemical substitutes can be found in reference materials such as Prudent Practices in the Laboratory. The electronic version of this book can be obtained via the KAUST online library system.

3.4 APPROPRIATE STORAGE PRACTICES

Storing chemicals properly promotes safer and healthier working conditions and extends the usefulness of chemicals. Improperly stored chemicals can result in any of the following:

- Degraded containers that allow chemicals to become contaminated, release hazardous vapors that are detrimental to the health of lab workers or surrounding materials;
- Degraded labels that can result in the generation of unknowns;
- Chemicals becoming unstable and/or potentially explosive;
- Purchasing a chemical that is already present in the lab or work area.

More information on chemical storage classes and chemical storage guidelines can be found in the KAUST Laboratory Safety Manual.

3.5 CYLINDER AND LECTURE BOTTLES

Disposal of cylinders and lecture bottles is expensive, especially if the contents are unknown. Make sure that all cylinders and lecture bottles are labeled and included in chemical inventories. Before placing an order for a cylinder or lecture bottle, determine if the manufacturer will take back the cylinder or lecture bottle when it becomes empty. If possible, only order from manufacturers who will accept cylinders and lecture bottles for return.

3.6 MICRO-SCALE ACTIVITIES

If possible, consider switching to micro-scale experiments. Benefits might include:

- Reduced costs in chemical purchases and hazardous waste disposal;
- Shortened analysis times;
- Lowered rate of glassware breakage;
- Less exposure of employees and students to hazardous chemicals;
- Minimized potential for fires and explosions.
- Less space required for chemical and hazardous waste storage.

4.0 IS YOUR WASTE "HAZARDOUS"?

Waste is any garbage, refuse, sludge and other discarded material . Different countries have their own definitions to determine if waste material is "hazardous". KAUST requires special disposal processes for any waste materials (in any form (solids, liquids, sludges, gases, etc.)) that are ignitable, corrosive, reactive, toxic, biohazardous, carcinogenic, and/ or radioactive as defined in the below subsections (This document does not address radioactive waste disposal. For further information on this issue, please see the Radiation Safety Manual).

The appropriate hazards can be identified through analytical testing, but often the most beneficial and economical source of information comes from the user's knowledge of the respective materials and processes. These decisions are informed by the chemical's original

label, other relevant resources (i.e., Safety Data Sheet (SDS), Merck Index, etc.), and an understanding of their use in the respective processes.

Materials are classified as a hazardous waste based on the manner in which they are disposed and the hazards their disposal will present to human health & safety and as potential environmental damage. The intentional dilution of a hazardous waste, for the purpose of avoiding hazardous waste requirements, is not permitted.

4.1 IGNITABLE

Ignitable waste materials are defined as materials that present a characteristic hazard capable of starting a fire (i.e., oxidizers, water reactive materials, etc.), or as a dangerous and rapid source of fuel for fires that increase the ferocity of a fire (i.e., organic liquids, flammable gases, etc.). When reviewing the Safety Data Sheet (SDS), ignitable materials will have one or more of the following attributes:

- A liquid having a flashpoint of less than 60°C (140°F).
- A non-liquid capable under standard temperature and pressure of causing fire through friction, spontaneous combustion, **and** when ignited, burns so vigorously and persistently that it creates a hazard.
- Ignitable compressed gas,
- Oxidizing materials that readily yield oxygen, or other oxidizing gas, or that readily react to promote or initiate combustion. (IFC 2009)

4.2 CORROSIVE

KAUST considers corrosive materials hazardous because of their ability to attack and chemically destroy exposed body tissues -- especially the eyes and respiratory system. Corrosive materials can also have a degrading effect on infrastructure and the environment. Many corrosive materials present subsidiary hazards (i.e., being toxic, ignitable, etc.) that may also need to be addressed. Characteristics of corrosive material are:

- Aqueous solutions having a pH of less than 5 or greater than 12;
- Corrodes steel at a rate greater than 6.35 mm (0.250 inch) per year;
- Destroys or causes permanent tissue damage when placed on the intact skin of an albino rabbit for 4 hours in accordance with the United States Department of Transportation 49 CFR 173.137 procedures

4.3 REACTIVE

Highly reactive chemicals are defined as those chemicals that are inherently unstable and/ or susceptible to rapid decomposition. Also, other features of highly reactive chemicals are those that, under specific conditions, can react alone, or with other substances in a violent uncontrolled manner, liberating heat, toxic gases, or lead to an explosion. Reaction rates almost always increase dramatically as the temperature increases. A waste chemical is reactive when it meets any of the following conditions:

- Normally unstable and readily undergoes violent change (e.g., acrylonitrile, t-butyl lithium).
- Violently reacts with water and/or generates toxic gases (i.e., cyanide compounds, sulfide compounds, etc.), vapors or fumes that present a danger to human health or the environment.
- Detonate or explode if subjected to a strong initiating source or if heated under confinement.
- Easily detonates, results in explosive decomposition, or reacts at standard temperature and pressure.

- Forbidden explosives as defined in [UN Recommendations on the Transport of Dangerous Goods - Model Regulations].

4.4 TOXIC

Table 4-1 identifies the features of toxic substances (according to the *United Nations Globally Harmonized System of Classification and Labeling of Chemicals* (GHS)). Users of "acutely toxic" materials will likely have special requirements and expectations for materials use and waste collection. Toxicity for liquids and solids are generally based on the ingestion LD_{50} for rats or the LD_{50} for dermal contact with LC_{50} (i.e., concentration of a substance in a given media) for inhalation exposures or aquatic assessments. If data is available for more than one toxicity test, use the data showing the severest toxicity.

Table 4-1 Waste Toxicity Categories

Toxicity Category	Rat- Oral LD50 (mg/kg)	Rat- Inhalation LC50 (mg/L)	Dermal (rabbit) LD50 (mg/Kg)	Fish- LC50 (ppm)
1 - Acutely Toxic	<5	<0.5	<50	<0.01
2- Highly Toxic	>5 - <50	>0.5 - <2	>50 - <200	<0.1
3- Toxic	>50 - <300	>2 - <10	>200 - <1000	>0.1 - <1.0
4- Warning	>300 - <2000	>10 - <20	>1000 - <2000	>1.0 - <10.0
5- Disposal Eligible	>2000	>20	>2000	>10
Carcinogenic	International Agency for Research on Cancer Monographs (IARC) carcinogens			

Waste that fits in any of these categories is hazardous waste. "Highly toxic" and "Acutely Toxic" chemicals are subject to additional requirements, such as Standard Operating Procedures, emergency preparedness measures, and HSE approvals. "Disposal Eligible" materials are not regulated as toxic, but may still be managed as hazardous waste if carcinogenic.

4.4.1 CARCINOGENIC MATERIAL

Human carcinogens are defined as those materials that, when humans are exposed to them, may contribute to the development of cancer. Such determination requires evidence from epidemiologic (demographic and statistical), clinical, and/or tissue/cell studies involving exposed populations to the substance in question. Due to the ethics of deliberately testing potential carcinogens on human populations, "proving" causality in the rigorous scientific sense is often not possible. Therefore materials that are known (Group I) or "probable" (Group IIA) human cancer causing agents as identified by the International Agency for Research on Cancer are to be treated as hazardous waste.

4.5 BIOHAZARDOUS MATERIALS

The unique research enterprises at KAUST cover a wide range of activities including marine, environmental, and a vast array of medically-oriented research.

Applying a universal precautions approach in conducting these varied research activities is a prudent standard. A universal precautions approach means managing all biological research materials as if they were an infectious disease or environmental release risk. For this reason, it is recommended that all research lab biological wastes be managed as biohazardous waste. This action will ensure that *all* biological research materials are inactivated or managed in a manner that isolates the exposure risk for the general public and the environment.

In the research lab or field environment, any non-sharp item that is contaminated with biological material is assumed to present an infectious disease transmission risk or an environmental release risk is to be treated as biohazardous waste. These items include recombinant DNA, human or animal diagnostic specimen material, any microbiological culture material, etc.

Examples include but are not limited to:

- Gloves and other disposable PPE that has been contaminated with specimen or culture material;

- Plastic ware such as pipettes or pipette tips, culture plates, specimen vials, etc. that are contaminated with biological specimens, bacterial and cell culture material, or nucleic acids;
- Cultures and stocks of infectious agents (including specimen cultures from medical and pathological labs) cultures and stocks of infectious agents from research and industrial labs, wastes from the production of biological, discarded live and attenuated vaccines, and culture dishes and devices used to transfer, inoculate and mix cultures;
- Towels and bench paper that are biologically contaminated (Note: Bench paper that is used in areas where samples or cultures are opened and manipulated must be regarded as biologically-contaminated and therefore removed and managed as solid biohazardous waste);
- All culture or sample containers that are contaminated with biological materials;
- Human and non-human primate blood, tissue, body fluids, and cell lines;
- Pathogenic agents (bacteria, rickettsia, fungi, viruses, protozoa, parasites and prions).
- Recombinant DNA, cultures, stocks and cell lines containing recombinant DNA;
- Carcasses, tissues and bedding from animals exposed to biohazardous agents;
- Human pathological waste;
- Lab waste that has come in contact with the above listed biohazardous agents; and
- Sharps waste.

4.6 SHARPS

Discard all needles, needle and syringe units, scalpels, and razor blades, **whether contaminated or not,** directly into rigid, red, labeled sharps containers. *Do not recap, bend, remove or clip needles*. Sharps containers should not be overfilled. Full containers should be placed in the Hazardous Waste Satellite Accumulation Area. These are no longer collected into the large yellow biohazard waste collection bins.

Uncontaminated Pasteur pipettes and broken glassware may be discarded into containers specifically designed for broken glass disposal, or into heavy-duty cardboard boxes that are closeable.

5.0 HAZARDOUS WASTE STORAGE REQUIREMENTS

Once it is determined that your waste materials are deemed “hazardous”, it is the responsibility of “generators” of waste products to follow appropriate collection, storage, and disposal requirements.

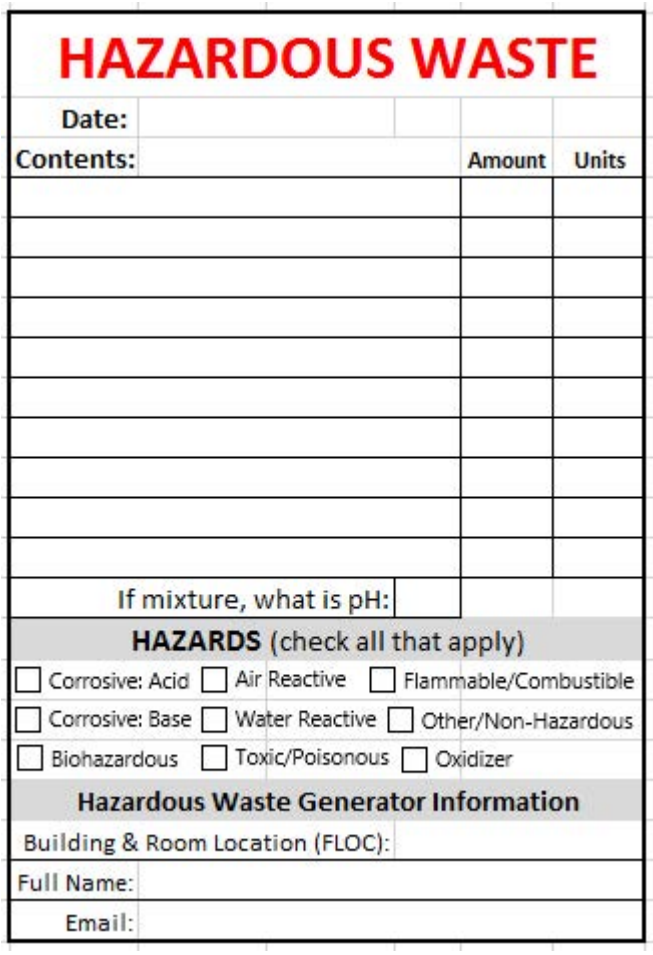
5.1 CONTAINER MANAGEMENT

Containers of hazardous waste generated at KAUST must comply with the following requirements:

- Contents must be compatible with the container, lid and with other chemicals accumulated in the container;
- Preferably when a waste container is started, but at a minimum when it is filled, a KAUST hazardous waste tag must be attached to each container for disposal. When properly filled out, a KAUST Hazardous Waste label (Figure 1) attached to a hazardous waste container meets all regulatory labeling expectations
- Smaller containers (e.g. eppendorf tubes, GC vials, etc.) can be collected into a single labeled container such as a box or resealable plastic container;
- If not initially using the KAUST Hazardous Waste label, containers must be marked with the words "hazardous waste" and the contents identified;
- Contents must be legibly described in English and free from any abbreviations, formulas, lab short hand (i.e. CHCl3, MeOH, etc.). When more than one chemical waste is stored in a container, the *approximate percentage of each of the major constituents* must be identified on the label;
- Containers must be securely closed when not actively being filled;

- Containers must not be leaking, bulging, rusting, damaged, or dented.
- Containers must be free from external contamination.

The intentional evaporation of Hazardous Waste in lieu of appropriate waste disposal is prohibited.



HAZARDOUS WASTE

Date:		
Contents:	Amount	Units
If mixture, what is pH:		

HAZARDS (check all that apply)

☐ Corrosive: Acid ☐ Air Reactive ☐ Flammable/Combustible
☐ Corrosive: Base ☐ Water Reactive ☐ Other/Non-Hazardous
☐ Biohazardous ☐ Toxic/Poisonous ☐ Oxidizer

Hazardous Waste Generator Information

Building & Room Location (FLOC):	
Full Name:	
Email:	

Figure 5-1 KAUST Hazardous Waste Label

The use of original chemical containers for the storage of hazardous waste is a good management practice with cost savings realized from not having to purchase new waste containers. Although this practice is encouraged, it is conditional. When reusing these containers, the following guidelines should be adhered to:

- The KAUST barcodes must be updated within the Salute inventory system to show that the bottle has been disposed of. Failure to do so will result in the apparent buildup of materials in the Salute inventory system, possibly triggering a HSE review of storage practices.
- Meet all other conditions stated above (KAUST waste label, lids, compatibility, etc.),
- The original label must be sufficiently obliterated to avoid confusion as to contents (except when the waste matches the label).
- When the waste contents are similar to those of the original bottle, the words "Hazardous Waste" need to be included on the bottle so that it may be distinguished from original containers.

The storage of hazardous waste in containers for household products (e.g., bleach, detergents, or any food products) is prohibited.

5.2 SATELLITE ACCUMULATION AREA (SAA)

Once the container is sufficiently labeled and ready for disposal, the materials should be placed in the temporary storage location for waste pickup. This location is known as the Satellite Accumulation Area (SAA). The SAA is where hazardous waste containers are inventoried and collected prior to campus services removing them to a central collection point. Each facility that generates hazardous waste should have its own SAA (e.g., laboratories, shops, photographic studios.)

Requirements for the Satellite Accumulation of Hazardous Waste:

- Hazardous waste must be stored near the point of generation.
- A "Hazardous Waste Satellite Accumulation Area" sign should be posted where the waste is stored.
- To avoid the inadvertent mixing of waste materials, users must be able to control the collection of generated waste.
- Containers must be closed except when adding or removing waste, including removal of funnels when not actively filling.

- Store hazardous waste chemicals in secondary containment whenever possible (i.e., trays). Materials stored on the floor are required to have secondary containment to protect the containers and contain spills.
- Ensure the outside of the waste containers are free of any obvious contamination, leaks, or spilled materials.
- Segregate the waste from other incompatible waste types (where necessary).

It is prudent for people to clean up small spills of hazardous waste if they (1) have the proper training, (2) have the proper personal protective equipment (PPE), and (3) feel comfortable doing so. Spill cleanup material of certain kinds of hazardous waste, particularly "Highly Toxic" materials, must also be disposed of as hazardous waste. If the person cleaning up is unsure, they should contact HSE at hse@kaust.edu.sa. They can find more information on cleaning up small spills in the KAUST Laboratory Safety Manual.

5.3 UNKNOWN MATERIAL

Appropriate laboratory management practices prevent the generation of containers where the contents are unknown. Containers with unknown contents will not be collected by the Site Services Waste Pickup team. In the event that such containers are discovered, please contact HSE for assistance (hse@kaust.edu.sa).

6.0 WASTE DISPOSAL PROCEDURES

Once the waste is ready for disposal, it is important to select the appropriate disposal method. The following waste disposal procedures are listed in order of preference with "Hazardous Waste" as the final procedure. This final disposal method "Hazardous Waste" is ultimately the least desirable option for disposal. Waste generators should try to choose another waste disposal option to help reduce the need to dispose of hazardous waste.

6.1 Material Return/ Redistribution

Wherever possible, generators are encouraged to return unwanted materials to the warehouse so that they can be issued to others. Another alternative is to distribute a message through the Lab Safety Representatives (LSRs), or HSE, to find an outlet where the materials can be used for their intended function.

6.2 Direct Drain Disposal

The following chemicals can be disposed of down the drain, providing the solution does not contain materials otherwise prohibited.

- Aqueous solutions such as salts and buffer solutions within the 5 to 12 pH range.
- Chemicals that are water soluble and are non-hazardous by way of definition
    - *Naturally-occurring Amino Acids and Salts*
    - *Enzymes*
    - *Sugars*
    - *Proteins*
    - *Citric Acid* and its Na, K, Mg, Ca, and Ammonium Salts
    - Lactic Acid and its Na, K, Mg, Ca and Ammonium Salts
- Acids and bases that have been neutralized and fall within the 5 to 12 pH range.
- Biological liquids that have been treated with disinfectant or autoclaved.
- Chemicals within the defined limits established in Section 4.
- Mop water

Do not dispose of any chemicals into a storm sewer or similar untreated disposal options. For additional information on drain disposal review the Appendix A- Drain Disposal Guidance. Contact HSE for any needed guidance.

6.3 ACID-BASE NEUTRALIZATION

When a material identified as corrosive presents no other hazards (i.e. flammable, toxic metals, etc.), the material can be neutralized and disposed directly to a campus sink using the appropriate neutralization procedure from APPENDIX C. After neutralization, materials may be drain disposed if the requirements listed above in the drain disposal section are met.

Due to their toxicity, Chromic Acid and Hydrofluoric Acid solutions are not eligible for drain disposal.

6.4 UNIVERSAL / RECYCLABLE WASTE

Unlike hazardous waste generated from research and campus operations, "universal waste" materials are ubiquitous throughout many laboratory and non-laboratory areas of the organization and community. Items such as fluorescent light bulbs, consumer electronics, and rechargeable batteries are examples of universal waste. These items often contain Mercury, Lead, Cadmium and other substances that would be considered hazardous to human health and the environment. These hazardous items are handled differently than regular hazardous waste.

While their volume does not make them any less hazardous, it is advantageous to collect these materials for component recovery and metal recycling. These items should not be discarded in the general trash. Materials that can be disposed through the Universal Waste program are:

- Fluorescent Light Bulbs
- Rechargeable Batteries (NiCd, Lead-Acid, etc.)
- Consumer Electronics (i.e. cell phones, computers, etc.)
- Used Oil
- Mercury containing devices

Waste batteries are collected at various battery collection locations throughout campus. Batteries can be placed into these containers with no further action required. For all other

materials meeting the waste conditions described above, contact Campus Recycling recycle@kaust.edu.sa to arrange for collection.

6.5 LIQUID BIOHAZARDOUS WASTE

Solutions that do not contain any other hazards (i.e., corrosive, ignitable, etc.) are to be disinfected/ sterilized using chlorine bleach solutions or other disinfectants with similar or greater demonstrated efficacy. If liquid disinfectants are used, they must be shown to be effective against the organism(s) present (see Appendix B).

6.6 SOLID BIOHAZARDOUS WASTE

In the research lab or field environment, any non-sharp item that is contaminated with human or animal diagnostic specimen material (i.e., body fluids, tissue debris), any microbiological culture material (including recombinant DNA), or any disposable materials used in handling such items are to be treated as biohazardous waste.

Labeling and accumulation requirements are similar for all other waste types. The differences in disposal of biohazardous waste are as follows:

- Solid biohazardous waste is collected in a biohazard bag (red or transparent) in a rigid biohazard container with a lid.
- Once the container is full, the biohazard bag is removed from the bin and sealed.
- A completed hazardous waste tag is attached to the bag.
- Sealed and labeled bags are then delivered to the large yellow biohazardous collection containers located in the lab service corridor. These materials are collected and disposed on a daily basis.

Sharps containers, whether biologically contaminated or not, are NOT to be disposed as solid biohazardous waste. They are to be disposed following the Hazardous Waste disposal procedures.

6.7 Disposal of Sharps

Whether contaminated with chemical, biological, or no contaminants at all, sharps materials are destined for incineration. Therefore, there is no need to maintain separate containers for each sharp material. Once full, the containers are to be closed securely and placed in the SAA for collection with the hazardous waste.

Sharps containers are also an acceptable receptacle for the disposal of chemically contaminated pipette tips.

6.8 Chemically Contaminated Items

If any Chemically Contaminated Items (CCIs) are generated, or other materials you do not feel are appropriate for normal trash, then they are to be packaged in a leak-proof container or directly into the yellow hazardous waste bags located in the red bins found in labs.

When bags are ready to be picked up for disposal ensure:

- A completed KAUST hazardous waste tag is attached (label "Chemically Contaminated Items").
- The bag is securely sealed with tape or other positive closing means.
- The bag is placed in the SAA or other location in the service corridor area for hazardous waste pick up.

Pipette tips are not to be collected as CCI unless contained in a rigid container. Review Appendix C-12 for additional information on pipette tips disposal considerations and options.

If you have any questions concerning the management of chemically contaminated items or containers, please contact HSE at hse@kaust.edu.sa.

6.9 EMPTY CHEMICAL CONTAINERS WITH KAUST BAR CODES

As discussed previously, waste generators are encouraged to use empty chemical containers for the collection of hazardous waste once the container has been updated to show the original container has been disposed within the Salute inventory system.

In the event empty containers are not needed, they can be left at the chemical waste collection site where they will be collected. The containers must be free from excess chemical residue inside and out. The Chemical Waste Pickup team will then collect these containers during the regular waste collection appointment. Containers should NOT be placed in any other containers such as the yellow bags that are designated to be used for "Chemically Contaminated Items".

6.10 EMPTY CHEMICAL CONTAINERS WITHOUT KAUST BAR CODES

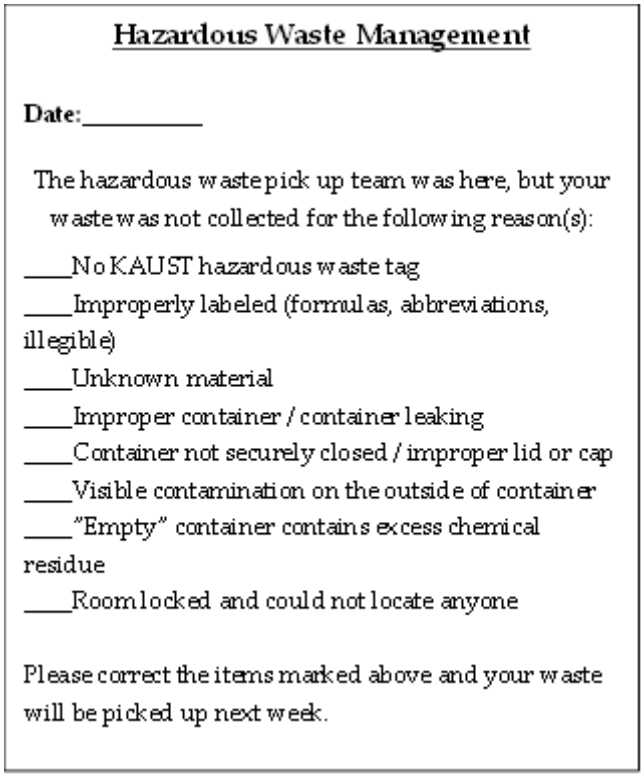
Containers that do not have a KAUST bar code (e.g., empty lab stock containers) can be used without any action in the Salute inventory system. Under no circumstances are chemical waste bottles to be placed in the regular trash. At this time the custodial personnel are unable to discern if the contents are innocuous or hazardous. Therefore they assume that all containers present possess sufficient hazards to draw concerns.

6.11 HAZARDOUS WASTE

If a generator's waste has one or more of the characteristics listed in Section 4 and none of the previous disposal options have presented an alternative disposal outlet, hazardous waste disposal is the remaining option. All containers are to be prepared as discussed in Section 5.1 and pending pick up, the waste should be stored in the SAA as described in Section 5.2.

Prior to waste pickup, the Waste Collection team will visit the various SAAs to inventory waste. If properly labeled, stored, and delivered to the SAA, Site Services will collect these waste containers on a weekly basis. Only inventoried waste will be picked up on the collection day.

Items that are not appropriately prepared will be left behind with a “Waste Not Picked Up” (Figure 2) tag describing the reasons for refusal.



Hazardous Waste Management

Date:_____

The hazardous waste pick up team was here, but your waste was not collected for the following reason(s):

____No KAUST hazardous waste tag
____Improperly labeled (formulas, abbreviations, illegible)
____Unknown material
____Improper container / container leaking
____Container not securely closed / improper lid or cap
____Visible contamination on the outside of container
____“Empty” container contains excess chemical residue
____Room locked and could not locate anyone

Please correct the items marked above and your waste will be picked up next week.

Figure 6-1 Waste Not Picked Up Tag

Liquid materials awaiting pickup in the service corridor must be stored in secondary containment.

If you are unsure of any items, please contact HSE at hse@kaust.edu.sa for more information and assistance.

APPENDIX A- DIRECT DRAIN DISPOSAL

RESPONSIBILITIES

Within individual work areas and laboratories, authorization for specific operations, delineation of appropriate safety procedures and instruction about these procedures is the responsibility of the Principal Investigators and/or supervisors. This includes appropriate chemical waste disposal practices and accidental discharges.

It is the responsibility of **each** KAUST employee to ensure that generated chemical waste is disposed of properly. Some materials may be safely disposed into the sanitary sewer while many cannot due to potential damage to human health, the environment or the functioning of the KAUST wastewater system.

Certain classes of chemicals **cannot** be poured down the drain - they must be collected and disposed of as hazardous waste using KAUST HSE's waste procedures. If you have questions regarding the proper collection and disposal of aqueous solutions, low concentrations or small volumes of chemicals within the categories below, contact HSE at hse@kaust.edu.sa.

(a) **PROHIBITED FROM DRAIN DISPOSAL**

The following list identifies chemicals that **cannot** be disposed of down the drain.

- Any flammable liquids with a flashpoint less than 60°C (140°F) – including (but not limited to) any quantity of gasoline, kerosene, naphtha, benzene, toluene, xylene, fuel oil, ethers, ketones, aldehydes, chlorates, perchlorates, bromates, carbides, hydrides and sulfides. This does not include aqueous solutions of these compounds that have a flashpoint greater than 60°C (140°F).
- Explosive chemicals.
- Any liquids, solids or gases that pose a fire hazard alone or can potentially interact with other chemicals in the sewer and become a fire or explosion hazard.

- Solutions outside 5-12pH range. Labs may neutralize acids and bases to a pH within this range and then drain dispose, provided there are no prohibited items in the solution.
- Halogenated hydrocarbons and aqueous mixtures containing halogenated hydrocarbons (including but not limited to: bromodichloromethane, chloroform, chloromethane, dibromochloromethane, methylene chloride, tetrachloroethene).
- Insoluble materials.
- Mercury metal (any discharge down the drain must be reported per the below Accidental Discharge procedure).
- Water reactive materials (including but not limited to aluminum alkyls, barium, lithium, potassium, sodium, sodium borohydride, zinc powder or zinc dust).
- Infectious substances.
- Photographic chemicals
    - Developer solutions containing Hydroquinone or heavy metals (e.g., Barium or Selenium)
    - Used fixer solutions.
- Any solids or viscous substances capable of causing obstruction to the flow of sewers, including but not limited to:
    - Grease
    - Particulates greater than 12.7 mm (0.50 inch) in any direction
    - Animal products (gut or tissue, paunch manure, bones, hair, hides or fleshing, entrails, whole blood, feathers)
    - Ashes, cinders, sand, spent lime, stone or marble dust, metal, glass or residues from glass grinding or polishing, straw, shavings, grass clippings, spent grains
    - Rags, waste paper, wood, plastics, rubber, tar, asphalt residues, mud
    - Residues from refining or processing of fuel or lubricating oil, petroleum oil, non-biodegradable cutting oil, or products of mineral oil origin
    - Water soluble polymers that could form gels in the sewer system
- Any solution alone or by interaction with waste that can cause a noxious or malodorous gas (e.g., Hydrogen Sulfide, Sulfur Dioxide, Nitrous Oxide) that can be hazardous individually or by reaction with other components in the sewer.

- Any chemical that either alone, or if mixed with other wastes, results in the presence of toxic gases, vapors and/or fumes that could be harmful to utilities workers, workers of the wastewater treatment facility or create a public nuisance.
- Malodorous chemicals such as Mercaptans.
- International Agency for Research on Cancer (IARC) Group I and Group IIA carcinogenic materials
- Mutagens or teratogens, such as Ethidium Bromide.

Note: If you are generating or planning to generate large volumes of waste that you think may exceed these limits please contact HSE at hse@kaust.edu.sa for further information.

b) ACCEPTABLE CHEMICALS FOR DRAIN DISPOSAL

The following list identifies chemicals that can be disposed of down the drain, providing the solution does not contain materials otherwise prohibited.

- Aqueous solutions such as salts and buffer solutions within the 5 to 12 pH range.
- Chemicals that are water soluble and are non-hazardous by way of definition
    - *Naturally-occurring amino acids and salts*
    - *Enzymes*
    - *Sugars*
    - *Proteins*
    - *Citric Acid* and its Na, K, Mg, Ca, and Ammonium salts
    - Lactic Acid and its Na, K, Mg, Ca and Ammonium salts
- Acids and bases that have been neutralized and fall within the 5-12 pH range.
- Biological liquids that have been treated with disinfectant or autoclaved.
- Chemicals within the defined limits established in Section 4.
- Mop water

ACCIDENTAL DISCHARGE

Accidental discharges into the sewer have reporting requirements. It is the responsibility of the person causing any accidental discharge to IMMEDIATELY notify HSE at

hse@kaust.edu.sa if prohibited chemicals or solutions containing prohibited chemicals are accidently poured or spilled down the drain via sink, plumbing equipment or floor drains. Notice of any accidental discharge from construction activities or utilities should be directed to HSE at hse@kaust.edu.sa.

Notifications should include:

- Building, level, area, and LFO number
- Detailed description of what went down the drain (including):
    - Names of chemical(s)
    - Concentration and percent in solution
    - Volume lost
- Any corrective actions taken

Faculty, staff and students should be made aware of their roles and responsibilities regarding accidental discharge by in-house training and/or signage posted in a central communication area.

APPENDIX B- LIQUID BIOHAZARDOUS WASTE STERILIZATION GUIDELINES

- Adding a disinfectant to a contaminated liquid (containing a biological agent) will decontaminate the liquid. Examples of useful liquids are sodium hypochlorite (i.e., household bleach);
- The solution should be left standing for one hour;
- Then dispose it by pouring it down the sink;
- Bleach working dilution is 1:10 - 1:100 in water;
    - Effective against vegetative bacteria, fungi, most viruses at 1:100 dilutions;
    - Effective against bacterial spores at 1:10 dilution;
- The bleach solution is rapidly inactivated by organic matter; and
- Solutions decompose rapidly; fresh solutions should be made daily.

Dilution in Water	%Available Chlorine	Available Chlorine(mg/l or ppm)
Not Diluted	5.25	50000
1/10	0.5	5000
1/100	0.05	500

Bleach solutions decompose at room temperature and should be made fresh daily. However, if stored in tightly closed brown bottles, bleach solutions retain activity for 30 days. The use concentration is dependent on the organic load of the material to be decontaminated. Use a 1% solution to disinfect clean surfaces, and 10% solution to disinfect surfaces contaminated with a heavy organic load. To disinfect liquid biological waste before disposal, add concentrated bleach to a final concentration of 1%.

APPENDIX C- MANAGEMENT PROCEDURES FOR SPECIFIC HAZARDOUS WASTE TYPES

The following management procedures are for specific types of hazardous wastes. If you generate large quantities of specific types of chemical wastes not listed here, then please contact HSE for assistance: hse@kaust.edu.sa

C-1 CONCENTRATED SOLUTIONS OF ACIDS AND BASES

Corrosive acids and bases are common wastes generated in laboratories on campus.

Generators of corrosive wastes which have no other hazardous characteristics (such as restricted metals) should neutralize the wastes to a pH of 5 - 12 The neutralized non-hazardous waste may then be drain disposed followed with a large water flush (20 parts of water).

Procedures for neutralizing acids and bases are described in the following three sections. You should only perform the neutralization of corrosives if you have been trained, you have the proper personal protective equipment, you feel confident that you understand the process, and are comfortable doing so.

C-1.1 GENERAL NEUTRALIZATION PROCEDURES

- Do neutralizations in a fume hood behind a safety shield, as vapors and heat may be generated. Wear lab coat or apron, gloves and goggles. A face shield in combination with safety goggles is recommended. Please note, a face shield alone is not sufficient protection, safety goggles must be worn when using a face shield;
- Keep containers cool during the process (e.g., place a beaker in a bucket with slushy ice;
- Work slowly; and
- After neutralization is complete, dispose down the drain followed by 20 parts water to the neutralized solution.

- Follow the specific neutralization procedures below for the acid or base you are trying to neutralize.

C-1.2 Acid Neutralization

- While stirring, add acids to large amounts of an ice water solution (1:10) of base such as sodium carbonate, calcium hydroxide, or sodium hydroxide for concentrated acids.
- When a pH of at least 5 to 12 is achieved, dispose of the solution down the drain followed by 20 parts water to the neutralized solution.

C-1.3 Base Neutralization

- Add the base to a large vessel containing water (1:10). Slowly add a 1m solution of hydrochloric acid.
- When a pH of 5 to 12 is achieved, dispose of the solution down the drain followed by 20 parts water to the neutralized solution.

C-1.4 Chromic Acid

Chromic Acid is a powerful oxidizing agent that is both toxic and corrosive and can explode on contact with organic materials. Chromium (VI), or hexavalent chromium, is also classified as a carcinogen. Accidents involving Chromic Acid cleaning solutions can result in burns to both skin and clothing.

Chromic Acid cleaning solutions leave a residue of chromium (VI) on the glass surface, which is difficult to remove. This residue has been known to interfere with certain research procedures since the material can leach into solutions. HSE highly recommends that you consider using Chromic Acid alternatives such as “NOCHROMIX”, “Alconox”, or similar type products which can be ordered through the KAUST Portal. Due to the reactive and toxic nature, do not attempt to neutralize Chromic Acid. Chromic Acid waste must be disposed of through the regular hazardous waste management program.

C-1.5 HYDROFLUORIC ACID

Hydrofluoric Acid is a strong corrosive and highly toxic chemical that causes severe burns from diluted solutions and can be fatal upon exposure of concentrated solutions. Bench top use of Hydrofluoric Acid is not permitted; it must only be used in a fume hood.

Anyone using Hydrofluoric Acid should contact the Chemical Warehouse and purchase a tube of Calcium Gluconate gel, which is used as an initial response to skin exposure of Hydrofluoric Acid. The quantities of Hydrofluoric Acid that are used and stored should be kept to an absolute minimum. All users of Hydrofluoric Acid should attend HSE Hydrofluoric Acid training. More information on Hydrofluoric Acid can be found in the KAUST Laboratory Safety Manual.

Due to its toxic nature, do not attempt to neutralize Hydrofluoric Acid – dispose of Hydrofluoric Acid waste through the standard hazardous waste management program. Because of Hydrofluoric Acid's ability to etch glass, the chemical and waste must be stored in plastic containers. As a safety precaution, HSE recommends that Calcium Hydroxide be added to any mixtures or diluted solutions of Hydrofluoric Acid waste to help bind the fluoride ions.

C-1.6 PERCHLORIC ACID

Perchloric Acid is a strong oxidizer and corrosive acid. Perchloric Acid can react with metal to form shock sensitive metal perchlorates. This can occur when Perchloric Acid is used in a regular (non-Perchloric Acid) fume hood. More information on Perchloric Acid can be found in the KAUST Laboratory Safety Manual. Due to its reactive nature, do not attempt to neutralize Perchloric Acid – dispose of Perchloric Acid waste through the regular hazardous waste management program.

C-2 ORGANIC SOLVENTS

Even if they are miscible, do not dispose of organic solvents down the drain if they meet the criteria established in Section 4.1 (Ignitable). On the hazardous waste tag, include the approximate percentages of all waste solvents.

C-3 AQUEOUS SOLUTIONS OF TOXIC CHEMICALS

Aqueous solutions containing heavy metals and/or other toxic chemicals must be disposed of through the regular hazardous waste management program. Do not dispose this type of waste down the drain. Dispose these chemicals through the regular hazardous waste management program.

C-4 REACTIVE AND POTENTIALLY EXPLOSIVE CHEMICALS

Reactive chemicals such as strong oxidizers and reducers (and air/water reactive chemicals) must be disposed of through the hazardous waste management program. Because of their reactive nature, it is important to minimize the quantity of reactive chemicals in storage. If the integrity of the container appears to be compromised, then promptly dispose of the chemicals as hazardous waste. Never dispose of reactive chemicals such as Sodium metal, regardless of the quantity, down the drain or in the normal trash. Such practices can result in fires, toxic vapors and gases being released, and subsequent injury to people. When disposing of these compounds, please note any special hazards on the Hazardous Waste Label.

Some of these compounds can become unstable and potentially explosive over time due to contamination with air, water, other material, or when the chemical dries out. If you come across any chemical that you suspect could be potentially explosive, do not attempt to move the container as some of these compounds are shock-, heat-, and friction-sensitive. Be sure to let others in the lab or work area know the chemical exists and the potential explosion hazard and contact HSE for more assistance: hse@kaust.edu.sa.

Examples of potentially explosive chemicals include, but are not limited to:

- Benzoyl Peroxide (dry)
- Peroxide forming compounds
- Diazo compounds
- Picric Acid (dry)
- 2,4-Dinitrophenyl Hydrazine (dry)
- Sodium Amide
- Nitrocellulose
- Trinitro- compounds

C-5 PEROXIDE FORMING CHEMICALS

Many commonly used chemicals (organic solvents in particular) can form shock-, heat-, and friction-sensitive peroxides upon exposure to oxygen through concentration, evaporation, and distillation.

Compounds that are suspected of having very high peroxide levels because of age, unusual viscosity, discoloration, or crystal formation should be considered extremely dangerous. If you discover a container that meets this description, **DO NOT** attempt to open or move the container. Make other people working in your area aware of the potential explosion hazard and contact HSE immediately.

You will find extensive information related to peroxide-forming chemicals, including a list of peroxide formers, and how to test for peroxides in the KAUST Laboratory Safety Manual.

C-6 SILICA GEL

Silica gel contaminated with solvents, heavy metals, or other toxic chemicals should be accumulated in leak proof containers such as one gallon (4 liter) plastic wide-mouth containers or a five gallon (20 liter) bucket. These containers can be obtained at the chemical warehouse.

C-7 AEROSOL CANS AND PROPANE CYLINDERS

Aerosol cans and small Propane cylinders can contain flammable, corrosive, and toxic chemicals and propellants. These items can be collected, emptied of their contents, depressurized, and recycled for scrap metal. Aerosol cans and small Propane cylinders are collected during regular hazardous waste pickups.

If you have a large 1m -1.75m (2 - 5 ft.) high-pressure gas cylinder and would like to have it removed, then please contact HSE for assistance: whsorder@kaust.edu.sa.

C-8 PAINT, PAINT THINNER, ADHESIVES, AND PRINTSHOP CHEMICALS

Paint (oil-based), paint thinner, adhesives, and many print shop chemicals are flammable and regulated as hazardous waste. These items cannot be poured down the drain or left out to evaporate. They must be disposed of through the hazardous waste management program. Latex paint that has solidified completely **can** be placed in the normal trash. You can speed up the solidification of latex paint by adding absorbent material (i.e. vermiculite, kitty litter, sand, etc.) and leaving it out to solidify.

C-9 PHOTOGRAPHIC CHEMICALS

Some photographic chemicals contain heavy metals such as Silver, Chromium, and Selenium that may be above regulatory levels. These must be handled as hazardous waste.

Used photographic fixer contains Silver above regulatory levels and, thus, cannot be poured down the drain. However, some photographic developers and other chemicals may be disposed of down the drain depending on the chemical constituents. If you are unsure whether a photographic chemical is acceptable for drain disposal, then please contact HSE to determine eligibility: hse@kaust.edu.sa.

C-10 ETHIDIUM BROMIDE

Mutagenic chemicals, such as Ethidium Bromide, pose a threat to organic life due to their ability to modify an organism's genetic material, which may be passed along to future generations. Where possible, labs are encouraged to use less toxic materials (e.g., SYBER Green, etc.).

Active Ethidium Bromide waste may not be disposed of via the sanitary sewer without first being deactivated. Ethidium Bromide waste that does not fluoresce is considered to be inactive and would be acceptable for drain disposal (depending on the chemical constituents of the dye). There are a variety of options for disposal depending on the type of waste.

C-10.1 ETHIDIUM BROMIDE LIQUIDS (NON-FLAMMABLE)

- Aqueous dye solutions that do not fluoresce under UV light may be disposed of down the drain.
- Absorb the Ethidium Bromide waste on filter media (activated carbon) and dispose as Chemically Contaminated Items.
  - Carbon 'tea' bags
  - BondEX Maxi Ethidium Bromide Detoxification Cartridges

C-10.2 ETHIDIUM BROMIDE LIQUIDS (FLAMMABLE)

Any Ethidium Bromide waste that contains a flammable liquid (such as butanol) should be managed as Hazardous Waste. No additional treatment is necessary.

C-10.4 DRY ETHIDIUM BROMIDE WASTE, INCLUDING GLOVES, PAPER, AND GELS

This should be disposed as Chemical Contaminated Items and identified as Ethidium Bromide).

C-11 CONCENTRATED MUTAGENIC DYES

Concentrated mutagenic dyes that are unusable may be submitted for Hazardous Waste disposal. This includes mutagenic dyes that are concentrated by absorption onto a filter media.

C-12 CONTAMINATED PIPETTE TIPS

Pipette tips are a common laboratory waste material and require special disposal consideration. This is partially because of the chemicals but also because the sharp point can puncture plastic bags. Because of this potential threat, KAUST prohibits the direct disposal of pipette tips into the Chemical Contaminated Items waste stream. KAUST recommends choosing one of three disposal alternatives, a) dispose as broken glass, b) dispose in sharps containers, or c) dispose into a rigid-sided container and dispose as Chemical Contaminated Items.

C-13 MERCURY

Metallic Mercury can be collected and recycled. It should be packaged in a tightly sealed and leak-free container such as a bottle or vial with a screw top lid. Place broken Mercury thermometers in a leak proof container or a secured plastic bag. When collecting metallic Mercury, DO NOT mix with other chemicals or waste if at all possible.

Do not use the past practice of adding sulfur, Nitric Acid, or water in an attempt to contain vapors. This only results in more hazardous waste being generated and rendering the metallic Mercury as non-recyclable. However, the use of commercial 'Hg Absorb' powder found in "Mercury spill kits" is acceptable. *Commercial "Mercury spill kits" can be found through the KAUST Portal.*

Mercury is a highly toxic chemical and any Mercury spills, including broken thermometers, must be cleaned up and the spill debris disposed through the hazardous waste management program. If you have a spill of Mercury outside of the fume hood, leave the room and contact HSE to report the spill.

Never use a regular vacuum cleaner to clean up a Mercury spill, this will only cause the Mercury to vaporize and disperse into the air. HSE has a Mercury detection meter to determine if all Mercury has been cleaned up from a spill.

C-14 Osmium Tetroxide Neutralization

2% Osmium Tetroxide (OsO_4) solutions should be neutralized in a fume hood prior to placing for disposal. Neutralization can be achieved by mixing oil at the ratio of two parts oil to one part 2% OsO4 solution. Oil with a high proportion of unsaturated bonds (such as corn oil) should be used. For instance; for every 10ml of 2% Osmium Solution, 20ml of corn oil is required.

1. Do all work under fume hood.
2. Pour twice the volume of corn oil into the used Osmium Tetroxide solution.
3. Wait for the oil to completely turn black.
4. Test to check that complete neutralization has taken place.
5. To confirm neutralization; take either a glass cover-slip coated in corn oil or a piece of filter paper soaked in corn oil and suspend it over the solution. Blackening indicates OsO_4 is still present.

APPENDIX D- WASTE MANAGEMENT PROCEDURES FOR UNIVERSAL WASTE AND OTHER MATERIALS

D-1 ELECTRONIC WASTE

Electronic wastes ("E-Waste") are those electronic products at the end of their lifecycle or "useful life" (e.g., computers, televisions, VCRs, stereos, copiers, and fax machines. Discarding electronic devices is one of the fastest growing waste stream segments that many nations produce. Due to the large amount of the material, many of these products can be reused, refurbished, or recycled.

Contact campus recycling to arrange a pick up of E-waste materials: recycle@kaust.edu.sa.

D-2 FLUORESCENT TUBES (UNIVERSAL WASTE LAMPS)

Fluorescent bulbs and other hazardous lamps (such as Mercury vapor) cannot be placed in the normal trash. Broken fluorescent tubes must be handled as hazardous waste. Every attempt should be made to keep these items intact and to prevent breakage.

KAUST Custodial Services collect and dispose of all Universal Waste Lamps. Contact HSE if you have questions about disposal requirements and procedures for any of these items: hse@kaust.edu.sa.

D-3 BATTERIES

Receptacles for the collection of batteries (alkaline, Ni-Cad, Lithium, Lead-acid, Mercury, and button batteries) are located throughout campus. Contact campus recycling to arrange a pickup in the event that you have a significant number of batteries to recycle that would overwhelm the collection points: recycle@kaust.edu.sa.

D-4 USED OIL

Uncontaminated used oil should be collected and recycled. Do not mix other chemical wastes with used oil. When hazardous wastes (such as flammable solvents or heavy metals) are added to used oil, the resulting mixture cannot be recycled and must be handled as hazardous waste. Be sure to note any contaminants on the Hazardous Waste Label when disposing of **contaminated** used oil.

D-5 BROKEN GLASS

Laboratory glassware is assumed to be contaminated material and will be incinerated. This includes the disposal of the following items:

- Broken glass;
- Pasteur pipettes;
- Glass slides;
- Plastic pipette tips; and
- Glass vials.

Broken glass equipment shall be placed in broken glass receptacles or placed in a puncture resistant container, such as a rigid plastic container or corrugated cardboard box.

Because of the puncture hazard presented by plastic pipette tips and the fact that the materials are incinerated, labs are encouraged to use the broken glass containers as one of the options for disposal.