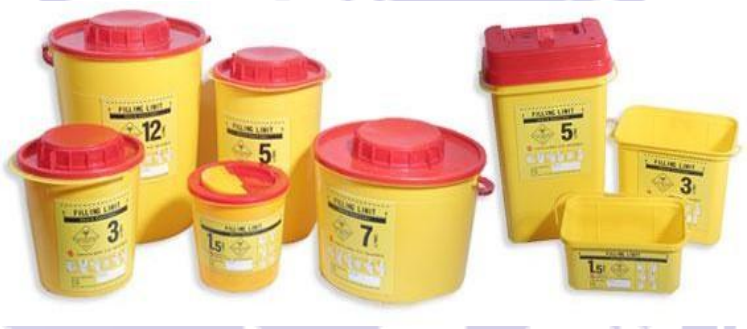
Guidelines and Instructions for Laboratory Waste Management



Instructions for Laboratory Waste Management

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Section 1

Purpose

This guideline has been developed with the aim of providing the correct principles for the disposal of laboratory waste, promoting safety and hygiene, and ensuring the health of staff, students, and other visitors, as well as protecting the environment. Its scope applies to all laboratories in the Faculty of Medicine at Isfahan University of Medical Sciences.

Definitions and Terms

- **Waste**: The waste generated during work.
- **Special Medical Waste**: Refers to all infectious and harmful waste originating from hospitals, healthcare centers, medical diagnostic laboratories, and other similar facilities that require special management due to at least one hazardous characteristic, such as toxicity, pathogenicity, explosiveness, flammability, corrosiveness, and similar properties.
- **Decontamination**: A process that eliminates or kills microorganisms. This term is also used in cases of removing or neutralizing hazardous chemicals and radioactive materials.
- **Treatment**: Referring to processes that reduce microorganisms to a level that cannot cause illness, along with actions that eliminate the hazardous characteristics of medical waste.

Types of Laboratory Waste

1. **Regular or Household Waste**: This type of waste constitutes a large volume of waste generated in laboratories and includes solid or liquid waste from kitchens, non-technical sections, and administrative areas. If contaminated waste is treated properly, it also falls into the category of regular waste.

This category of waste must be separated from infectious waste at the point of generation; otherwise, it will be classified as infectious waste. Additionally, this type of waste must be segregated from various types of sharp, chemical, radioactive waste, and similar materials at the point of origin.

2. **Infectious Waste**: Contains sufficient quantities of bacteria, viruses, fungi, parasites, etc., to cause illness. Examples include contaminated serum and other bodily fluids, feces, microbial cultures, contaminated sharp objects, contaminated swabs, and infected laboratory animals in research laboratories.

3. **Sharp Waste**: These wastes can cause injuries, such as needles, lancets, scalpel blades, microtome blades, broken glass, sample containers, slides, etc., which can be either contaminated or non-contaminated. Contaminated sharp waste poses not only the risk of injury but also the risk of transmitting infections.

4. **Chemical Waste**: Includes various laboratory materials and reagents, diagnostic kits, disinfectants, corrosive and reactive materials, flammable substances, toxic and carcinogenic agents, explosive materials, and more.

5. **Pathological Waste**: Such as tissues, organs, and body parts that are sent to the laboratory for pathological testing.

6. **Radioactive Waste**: Includes waste containing radioactive materials.

7. **Composite Waste**: This type of waste can be a combination of infectious, chemical, and radioactive waste, typically generated in research facilities, making its management complex and challenging.

Section 2

Waste Management Program

This program includes the stages of separation at the point of generation, collection and labeling, transportation to the disposal site, treatment (decontamination), packaging, temporary storage, transportation from the point of generation, loading, and finally, disposal. All stages of this program, designed considering the operational function and scale of the laboratory and the type of tests conducted, must be documented, made available to all staff, including technical and service personnel, and training should be provided on how to implement them.

The waste management program should consider the following actions:

- **Separation of Waste**: Regular and non-contaminated waste must be separated from laboratory waste (infectious, chemical, and sharp objects) at the point of generation.
- **Estimation of Waste Production**: An estimate of the approximate waste generation can greatly assist in planning and execution of waste disposal stages.
- **Monitoring Consumables**: This program should be designed to provide adequate monitoring of the quantities of materials and equipment used.
- **Immediate Replacement of Containers**: Replace used bags and containers immediately with new ones of the same type.
- **Separate Sterilized Items**: Place items that will re-enter the workflow after sterilization in special autoclave bags, separate from items that are to be disposed of after sterilization.
- **Autoclave Infectious Waste**: All laboratory infectious waste should be autoclaved first and then disposed of in a sanitary manner.
- **Safe Sharps Disposal**: Place sharp items like needles, broken glassware, scalpel blades, sampler tips, etc., in safety boxes. When the box is two-thirds full, autoclave it and then dispose of it in a sanitary manner. These containers should have the following characteristics:

  1. They should not be easily punctured or torn.
  2. The lid should be easily closed and sealed.

3. The opening of the container should be large enough so that waste can be disposed of without the need to apply pressure by hand, and items should not be retrievable from the container.
4. The walls of the container must be impermeable, preventing liquids from escaping.
5. After sealing the lid, it should be ensured that no materials can leak out.
6. The container should be easy and convenient to handle and transport.

- **Do Not Use Plastic Bags**: Plastic bags should not be used for collecting and storing sharp or pointed waste.
- The ovens and autoclaves must operate effectively. To verify the proper functioning of the autoclave, **chemical and biological indicators** should be used, and documentation related to quality control must be available under the supervision of the **Biosafety Committee**.
- **Evaluate Single-Use vs. Reusable Items**: The benefits and drawbacks of using single-use items compared to those that re-enter the workflow should be assessed.
- **Use Safer Chemicals**: Chemicals and disinfectants with lower risks to individuals and the environment should be utilized.
- **Personal Protective Equipment (PPE)**: At all stages of collection, transportation, and disposal of waste, protective equipment must be used, especially durable and impermeable gloves, masks, gowns, and specialized aprons.
- **Do Not Compress Waste Packages**: Since packages containing waste generally occupy a large volume, they should not be compacted before treatment or disposal.
- **Manual Handling for Waste Collection and Transport**: All stages of waste collection and transportation should be done by hand, as mechanical equipment can cause bags to tear, leading to the spill and splatter of contaminated materials.
- **Minimize Exposure Risks**: All procedures should be carried out in a way that eliminates the risk of contaminating individuals responsible for waste collection and disposal, both inside and outside the laboratory.
- **Daily Waste Disposal**: Waste disposal should be conducted at least daily.

According to the law, the recycling of waste from medical facilities is not permitted. However, arrangements can be made to collect waste such as plastic containers, glass, and kits and reagent boxes that do not become contaminated with serum and bodily fluids in separate containers for recycling purposes. This requires specific planning and staff training.

Management of Infectious Waste

1. Separation

Infectious waste in the laboratory mainly includes culture media containing various microorganisms, blood, serum, and other bodily fluids, feces, as well as containers holding these samples, skin, hair, and nail samples, pathological waste materials, and sharp objects contaminated with infectious materials that are no longer usable. The separation of contaminated waste from other waste is very important.

2. Collection

The method of waste collection varies based on the type and amount of waste, and different containers and methods can be used for this purpose.
For the packaging and collection of contaminated sharp objects, they should first be placed in safety containers (Safety Box), then autoclaved and disposed of hygienically. All contaminated waste should be placed in special autoclave bags (preferably yellow with a biohazard symbol) and autoclaved. Bags should not be filled more than three-quarters full to allow for easy sealing. Liquids should not be poured directly into the bags; instead, containers holding them must be placed inside the bag. If necessary for disposal, two bags can be used.

3. Labeling

Labels should have the following characteristics:

- No bag containing waste should exit the point of generation without a label indicating the type of contents.
- The labels used on containers or bags should be tear-resistant and durable against damage.
- Bags or containers containing waste must be labeled.
- Labels should be of a readable size and either stuck onto the container or bag or printed directly on it.
- Labels should not be easily removed or erased during contact or transportation.
- Labels must be visible from all sides.

- Hazardous materials must be labeled to indicate the type of waste for infectious waste, radioactive waste, and cytotoxic waste.
- The following information must be included on the label:
  1. Name, Address, and Contact Number of the Producer
  2. Type of Waste
  3. Date of Production and Collection
  4. Date of Delivery
  5. Type of Chemical Substance
  6. Date of Decontamination
- Waste transport personnel must refrain from accepting waste that lacks proper labeling.
- When three-quarters full, containers and bags holding special medical waste must be collected after sealing.

4. Transportation to the Decontamination Site

If the volume of waste is large or the decontamination site is far from the point of waste generation, hand trucks specifically designated for this purpose can be used along with containers that are securely attached to them. The containers and hand trucks used must be leak-proof and should be disinfected and cleaned according to a scheduled program. To remove contamination and disinfect the containers, one of the following methods should be utilized:

- **Washing**: Use hot water at a minimum temperature of 82 ± 5°C (approximately 180°F) for at least 15 seconds.
- **Disinfection**: Use the following chemical solutions for at least three minutes:

  1. **Sodium hypochlorite solution** with 500,000 ppm of available chlorine.
  2. **Phenolic solution** with 500,000 ppm of active ingredient.
  3. **Iodine solution** with 100,000 ppm of available iodine.
  4. **Quaternary ammonium solution** with 400,000 ppm of active ingredient.
  5. **Other approved disinfectants** with a medium spectrum of efficacy.

5. Decontamination Phase

There are various methods for the decontamination or treatment of laboratory waste. Each laboratory must develop specific protocols regarding the disposal of its infectious waste.

Some of these methods, along with their application for making biowaste safe, are described as follows:

1. Autoclaving

Autoclaving is one of the most suitable, simplest, and most common methods, as it is generally available in all research and medical laboratories.

- This method is applicable for all infectious waste, such as sharp objects, contaminated culture media, and other contaminated materials.
- Chemical and pharmaceutical waste should not be treated using this method.
- When using an autoclave, attention must be paid to the type and volume of waste, the use of pressure- and heat-resistant containers and bags, the proper placement of the waste within the autoclave, and the temperature, pressure, and time required for the process.
- The retention time for waste in the autoclave for sterilization at a temperature of **121°C** should be at least **32 minutes**, preferably **62 minutes**, and then disposed of properly.
- To prevent unpleasant odors and potential hazards, it is recommended that the autoclave be located outside the laboratory in an area with adequate ventilation.

It is necessary to ensure the proper functioning of the autoclave regarding the parameters of time, temperature, and pressure by using chemical and biological indicators.

2. Incineration

Incineration is another method for disposing of biological waste. The use of incineration devices, provided they meet the necessary national and international standards to prevent air pollution, is also a suitable solution as it reduces the weight and volume of waste by up to 95%. For this purpose, coordination with other responsible units in this area is necessary.

3. Chemical disinfection with bleach or sodium hypochlorite (Streamid – C) or commercial materials like Doconex

This method is used for liquid biological waste and blood products, as well as for disinfecting surfaces.

4. Dry Heat (Oven)

In this method, conditions for destroying organisms are provided by heating at a temperature of 162-182 degrees Celsius for a duration of two to four hours.

6. Storage

Waste should not be stored for extended periods, and if storage is necessary, it should be done for the minimum duration required. The storage phase of waste can occur depending on the type and volume of waste either before or after the treatment process. It is essential to note that ordinary waste should be stored separately from special waste.

Waste should not be exposed to environmental conditions; therefore, in locations where waste must be stored for a period, completely sealed containers placed in a designated area, refrigerated units specifically for this purpose, etc., can be used. If the volume of generated waste is significant, it is advisable to create a suitable area for their storage with the following specifications:

- It should be located away from public and heavily trafficked areas, with adequate space dimensions, sufficient lighting, appropriate temperature, ventilation, and drainage systems, allowing for cleaning and decontamination of all surfaces. The storage area should also clearly differentiate between types of waste.
- The storage area should be inaccessible to rodents, insects, etc., and should have clear signage. Additionally, this location should have a lockable door and be secured against access by unauthorized individuals.

7. Final Disposal of Waste

- This process can be carried out using various methods, one of the most common being deep burial in the ground. Following the chemical reactions that occur in the waste, the temperature increases (over 55 degrees Celsius) and the environment becomes acidic (pH less than 5), leading to the elimination of pathogenic agents. The disposal of liquid waste, after undergoing treatment or dilution, can be carried out in the sewage system. The role of the Environmental Protection Organization in issuing the necessary permits based on the type, quantity, and concentration of waste discharged into the sewage system is very significant.

Classification of Biological Waste and Necessary Measures for Their Disposal

1. Sharps Waste

This category includes needles and syringes with non-detachable needles, capillary tubes, surgical blades, disposable microtome blades, and broken glass contaminated with biological waste. These wastes must be disposed of in safety boxes. These boxes must:

- Be resistant to impact and puncture.
- Be completely sealed, leak-proof, and autoclavable.
- Be autoclavable when three-quarters full, and then disposed of hygienically.

Needles should preferably be placed with syringes in sturdy containers (safety boxes); otherwise, the needle should be separated from the syringe using designated openings in these containers. Syringes should be placed in a special autoclavable bag, sterilized, and then disposed of in thick black garbage bags. Additionally, needles should not be broken, cut, or bent, as there is a risk of needle-stick injuries and aerosol formation.

The disposal method for blades from devices such as microtomes and cryostats must also be considered, with unusable blades placed in safety boxes and disposed of properly.

2. Pipettes

Pipettes that have been used to handle infectious agents or body fluids should be placed in a specific container for infectious pipettes (biohazard pipette box) and autoclaved in appropriate bags for sterilization, then disposed of correctly after sterilization.

If a pipette or sampler tip is not contaminated with infectious agents, they should be placed in an impermeable container (safety box) and disposed of properly without the need for autoclaving.

3. Microbial Waste

This group includes microbial cultures and stored etiological agents. Disposable containers holding microbial culture media should be placed in autoclavable bags (preferably yellow and marked with a biohazard symbol) and autoclaved under standard conditions before being disposed of in thick black garbage bags.

Disposable tubes containing blood clots and liquid microbial waste should be either sterilized or rendered ineffective through chemical disinfection (using household bleach diluted 1:12 for at least one hour) before being discharged into the sewage system.

4. Disposal of Hazardous Environmental Materials

Hazardous biological materials: Biological samples suspected of containing pathogenic agents may include blood, urine, feces, sputum, cerebrospinal fluid, semen, and other bodily fluids from humans or animals, as well as contaminated animal tissues and all biological waste.

Biological samples and contaminated plastic containers can be sterilized in an autoclave, after which all samples and containers can be placed in the general waste cycle. The use of new disinfectants to eliminate various pollutant compounds (such as strong detergent solutions like Deconex) is also essential.

Students should be trained to use cutters for disposing of syringe needles, and after dissecting laboratory animals that have been injected with toxic or lethal substances, their organs should be carefully removed from the laboratory and incinerated in special furnaces for disposal.

5. Contaminated gloves with blood or serum, cotton soaked in blood, swabs from applicators, contaminated sampler tips, diagnostic discs, and similar items should be placed in a special autoclave bag and autoclaved under standard conditions before being disposed of in thick black garbage bags.

Alternatively, they can be placed in yellow bags (marked with a biohazard symbol) for transport under standard conditions by the municipality, subsequently incinerated, or buried hygienically underground. For swabs, applicators, sampler tips, contaminated diagnostic discs, and similar items, they can be placed in household bleach solution diluted 1:12 for disinfection before being handled by the municipality.

6. Fecal Waste

Since feces can be a significant source of viruses, bacteria, parasites, etc., it is generally recommended to use incineration for the treatment of fecal samples. Therefore, it is advised that immediately after testing, containers containing feces should be placed in a tightly sealed yellow plastic container with a biohazard symbol for further processing.

Containers holding fecal samples should preferably be transported under standard conditions by the municipality and incinerated as waste. To prevent contamination during transport and disposal, a formalin solution (5% or 12%) should be added to fecal containers containing parasites in a ratio of three parts formalin to one part feces and maintained for at least thirty minutes before packaging them in the appropriate container for final disposal.

It is important to note that waste placed in household bleach solution should be completely drained before transport, as chlorinated compounds should not be placed in the waste incinerator.

7. Tissue Culture Waste

All waste must be placed in autoclavable bags and properly disposed of after autoclaving.

8. Anatomical Waste

This type of waste includes parts and components of dissected human bodies, which are buried according to religious principles.

9. Pathological Waste

This type of waste includes organs, amputated parts, etc. All large human tissues that have been separated must be disposed of hygienically and properly, with coordination from the relevant authorities.

The disposal of pathological waste is outlined as follows:

- **Formalin-Fixed Tissue Samples:**

  Formalin-fixed tissue samples, after being preserved for the required time (at least one month), should be packaged in a sturdy plastic container, adhering to the approved color in the country (usually yellow) and labeled with a biohazard symbol for disposal preparation.

  In the case of autopsy samples or body parts, disposal should be conducted according to religious guidelines.

- **Paraffin Blocks:**
  After the designated storage period, these should be disposed of in accordance with the instructions of the health reference laboratory by placing them in a garbage bag.
- **Cytology and Pathology Materials:**
  After the specified storage period outlined in the above instructions, these should be placed in a safe container and disposed of hygienically once three-quarters of the container is full.

10. Non-Infectious Broken Glass:

This waste must be placed in impermeable boxes, and the label should indicate that the waste is non-infectious. It should then be disposed of properly.

Section 3

Management of Chemical Waste

Chemical waste is categorized into three groups: safe, low-risk, and high-risk, and the separation process should be effectively implemented for these wastes as well.

Low-Risk Waste:

This category consists of waste generated from working with certain solutions and diagnostic kits, as well as expired kits. When handling these materials, general safety principles should be considered, and appropriate personal protective equipment such as lab coats, latex gloves, masks, etc., should be used.

High-Risk Chemical Waste:

This waste results from working with chemicals that are explosive, flammable, corrosive, caustic, toxic, highly toxic, reactive, carcinogenic, irritant, and harmful, posing threats to the health of workers, the environment, and even the community during generation and disposal.

Examples of these substances include:

- **Toxic Chemical Waste:** Such as heavy metals, phenol, cyanides, and sodium azide.
- **Reactive Chemical Waste:** Such as sulfates and peroxides that are ready to react with water.
- **Corrosive Chemical Waste:** Such as acids with a pH of less than 2 (mineral acids) or bases with a pH of more than 12.
- **Flammable Chemical Waste:** Such as alcohol and acetone.
- **Explosive Chemical Waste:** Such as substances that are unstable under normal conditions, like ether.
- **Carcinogenic Chemical Waste:** This includes substances with mutagenic and carcinogenic properties, such as formaldehyde, benzene, and ethidium bromide.

- **Chemical waste containing heavy metals** includes hazardous and toxic substances, such as waste that contains mercury.

When working with or treating these materials as waste, in addition to using the aforementioned personal protective equipment, it is essential to use safety glasses, face shields, and, if necessary, masks that provide complete respiratory protection against the inhalation of vapors and contaminated gases. The work environment should also have adequate ventilation, and work should preferably be conducted under fume hoods.

High-risk chemicals should be stored in glass or plastic containers from the outset based on their nature and should be separated accordingly. Generally, peroxide-forming substances, oxidizers, carcinogens, and hydrocarbons should be kept apart from other materials. Additionally, high-risk chemicals should be appropriately labeled with clear hazard indications and must not be disposed of down sinks or sewage systems.

Safe Waste:

This category consists of waste generated from materials such as amino acids, sugars, and others, which do not exhibit the characteristics of low-risk or high-risk wastes.

Low-risk chemical waste can be directly disposed of after dilution with water through a designated drain into the sewage system, depending on the volume produced. Otherwise, they can be first stored in a glass or plastic container (depending on the type of materials) and then prepared for disposal in the sewage system.

Disposal of Chemical Waste

All laboratories must adhere to the guidelines for the proper disposal of chemical waste. Therefore, it is essential to implement an effective management program for chemical waste.

In the chemical waste management program, the following points should be considered:

- In areas of the laboratory where chemicals are used, the point of order for purchasing should be clearly defined, with attention paid to the quantities of chemicals and kits containing these materials to avoid excessive stocking.
- Programs should be implemented to manage waste production and reduce its volume.

- If possible, alternative low-risk diagnostic methods or materials should be used. For example, in the laboratory for concentrating feces, ethyl acetate can replace ether.
- Staff should be completely familiar with the safety warning signs on containers holding chemicals and how to interpret them.
- When preparing chemical mixtures or transferring them from the original container to a secondary container, the following information must be labeled on the container: the name of the individual performing the task, storage location, type and percentage of chemical compounds, safety warning signs and symbols, pH of the substance, date of preparation, expiration date, and a reference number to the Material Safety Data Sheet (MSDS) to ensure that information can be accessed during use and after which they are regarded as waste.
- Waste should be packaged in such a way that prevents the risk of breakage, leakage, puncturing, and tearing.

Principles of Storage and Handling of Chemical Waste

- The lids of containers holding chemical waste must always be closed.
- Containers containing chemical waste must be clearly labeled. The label must include the word "waste" and the name of the chemical substance (e.g., "Waste - Chloroform").
- To prevent breaking and spilling of chemical waste, do not place glass containers containing these materials on the floor or in locations where they may be damaged. If it is necessary to do so, place the glass containers within another secure container.
- Do not store chemical waste in the laboratory for extended periods. It should be properly disposed of no later than 30 days.
- Solvent chemical waste must be separated according to guidelines and collected in appropriate leak-proof containers with chemical labels. These containers should be stored away from heat, sparks, flames, and direct sunlight in a well-ventilated area.

Based on the type of chemical substance to be used in the laboratory, special precautions must be taken.

❖ **Use of Chemical Substance with Known Hazards:**

Working with synthesized chemical substances whose hazards are completely understood (for example, those that are carcinogenic or toxic) should only be conducted under the following conditions:

- Firstly, staff and students must receive appropriate and necessary training regarding the use of these substances.
- Secondly, personal protective equipment must be available in the laboratory, and engineering controls should be implemented where possible.

Engineering controls aim to reduce or eliminate chemical or physical hazards in the workplace and can be accomplished through one of the following methods:

1. **Elimination:** Removing hazardous techniques, procedures, or materials.
2. **Substitution:** Replacing hazardous techniques, procedures, and materials with safer or non-hazardous alternatives.
3. **Segregation:** Separating personnel from hazards.
4. **Enclosure:** Isolating hazards.
5. **Ventilation:** Ensuring proper air circulation in the workplace and sources of pollutants.
6. **Replacement or Repair:** Repairing or replacing defective equipment and machinery.

❖ **Use of Chemical Substance with Unknown Hazards:**

Chemicals that are synthesized and whose hazards are unknown should be treated as special hazardous materials, such as mutagens, carcinogens, teratogens, and toxins, etc.

The laboratory supervisor is responsible for appropriately identifying the potential hazards of newly synthesized chemical substances, ensuring that suitable personal protective equipment and appropriate engineering controls are used based on that assessment.

Management of Hazardous Waste

Waste can be handled according to the recommendations of the manufacturer, distributor, or importer and in accordance with the Material Safety Data Sheet (MSDS). Laboratories can also collect waste in separate glass or plastic containers that are resistant to leaks, based on the type of waste.

Subsequently, according to the recommendations from the manufacturers, distributors, or importers of the chemicals, they may dilute with water, neutralize with neutralizing agents, or employ other methods depending on the type of substance. Implementing these steps requires educational programs.

Neutralizing Some Hazardous Chemicals

Before disposing of chemical waste, it is essential to render active and hazardous chemicals inactive using various methods. Below are the neutralization methods for some hazardous chemicals:

Acrylamide: The 10 to 20 percent acrylamide solution used in molecular laboratories is a very potent toxin, particularly for the central nervous system (neurotoxic). Excess solutions can be transformed into a non-toxic state by adding specific compounds, such as bis-acrylamide and TEMED, which can then be disposed of as municipal waste.

Ethidium Bromide: To detoxify organic soluble and toxic compounds, especially ethidium bromide solution and gels containing this substance, activated animal charcoal (charcoal) can be utilized. The method is as follows:

- The gels containing this substance can be placed in a container with one to two liters of water for a period of twenty-four hours to allow the toxic components to enter the aqueous phase.
- After scanning the agarose gel and confirming that no organic compounds remain in the gel, add one spoonful of charcoal to the diluted toxic solution. After one hour, pass the suspension through a regular filter.
- The filtrate, which is free of the toxic substance, can be disposed of.
- The filter paper containing charcoal and the toxic substance should be incinerated.

Note: This toxic substance will only decompose at a temperature of 650 degrees Celsius.

Osmium Tetroxide: Place waste from the highly dangerous and reactive osmium tetroxide in liquid oil to reduce its oxidizing ability.

Picric Acid: This substance is highly reactive and carcinogenic and should not come into direct contact with air. Therefore, always keep some water on this compound.

Phenol and Formaldehyde: These materials are considered potent, toxic, and carcinogenic. To mitigate the harmful effects of these compounds, limited waste of these substances can be placed in detergents with similar structures, such as Dettol, to reduce their toxicity, followed by disposal.

Organic solvents such as light alcohols, ethers, and acetone should be stored separately in cool storage and used gradually. Limited waste of these solvents should be collected in robust containers and handed over to safety officials for incineration.

For heavy organic solvents such as phenol, propylene oxide, glutaraldehyde, formaldehyde, paraformaldehyde, xylene, etc., collect them under controlled conditions in different containers and locations. Coordinate with the biosafety committee and collaborate with organizations contracted with the Environmental Protection Organization and Atomic Energy Organization to dispose of them away from the laboratory.

To clean or neutralize corrosive materials, utilize the following method:

This category of materials can include: Mineral compounds (concentrated nitric and sulfuric acids, sodium hydroxide, ammonia, etc.) and Organic materials (formaldehyde, picric acid, etc.)

Glass containers holding corrosive materials should be placed inside another container made of plastic or a similar material, stored in a well-ventilated area. The secondary container not only prevents leakage and spillage of corrosive materials but also helps prevent corrosion of other metallic equipment.

Methods for Cleaning or Neutralizing Various Corrosive Materials

Methods of Cleaning Up	Spilled Chemical Substances
• Use sodium bicarbonate to neutralize. • Absorb the material using a sponge or pad.	**Acids and Organic Materials**
• Use sodium bicarbonate, calcium oxide, or sodium bicarbonate for neutralization. • Collect the material with a sponge or pad (exception: hydrofluoric acid).	**Inorganic Acids**
• Do not use water. Collect and absorb using sand or sodium bicarbonate.	**Hydrochloric Acids**
• Absorb and collect using a sponge or pad.	**Aldehydes**
• Use sodium bisulfite. Absorb and collect with a sponge or pad.	**Aliphatic Amines**
• Absorb and collect using a sponge or pad. Avoid skin contact or inhalation.	**Aromatic Amines**
• Absorb and collect using a sponge or pad. Avoid skin contact or inhalation.	**Halogenated Aromatic Amines**
• Absorb and collect using a sponge or pad. Decontaminate with a 10% ammonium nitrate solution.	**Explosive Compounds (N3)**
• Absorb and collect using a sponge or pad.	**Bases (Alkalis)**
• Neutralize with acids or chemical neutralizers, and absorb and collect using a sponge or pad.	**Carbon Disulfide (Flammable and Toxic)**
• Absorb and collect using a sponge or pad. Avoid skin contact or inhalation.	**Chlorohydrins**
• Before sweeping, wet them down or use a vacuum with HEPA filters. Absorb and collect wet materials with a sponge or pad.	**Cyanides**

• Use sodium bicarbonate	**Halides (Organic or Inorganic)**
• Absorb and collect using a sponge or pad.	**Halogenated Hydrocarbons**
• Absorb and collect using a sponge or pad. Avoid using organic materials.	**Hydrazines**
• Calcium carbonate or calcium oxide is preferred over sodium bicarbonate for absorption. • Using sodium bicarbonate results in the formation of sodium fluoride, which is significantly more toxic than calcium fluoride. Be careful in selecting the sponge for absorption; certain sponges containing silicate compounds are incompatible with hydrofluoric acid.	**Hydrofluoric Acid**
• Use soda (sodium carbonate).	**Inorganic Salt Solutions**
• Neutralize with calcium hypochlorite. Absorb and collect using a sponge or pad.	**Mercaptans (Organic Sulfides)**
• Sweep up solid materials. Absorb and collect with a sponge or pad.	**Nitriles**
• Absorb and collect using a sponge or pad. Avoid skin contact and inhalation.	**Nitro Compounds**
• Use sodium bisulfite.	**Oxidizing Agents**
• Absorb and collect using a sponge or pad.	**Peroxides**
• Absorb and collect using a sponge or pad.	**Phosphates**
• Use soda (sodium carbonate) and sodium bicarbonate.	**Reducing Agents**

Commonly Used Methods for Analyzing Different Chemicals

Recommended Methods	Commonly Used Chemicals
• Dispose of in the **sink (sewer)**.	**Acetic Acid (11%)**
• After diluting with water, dispose of in the **sink (sewer)**.	**Fuchsine Acid (1%)**
• If possible, collect and dispose of through a **specialized container** for hazardous biological waste.	**Bovine Albumin Serum**
• Small amounts can be disposed of in the **sink (sewer)**.	**Butanol**
• Dispose of in the **sewer**.	**Bicarbonate Buffer (1.12 Molar)**
• Dispose of in the **sewer**.	**Casein (5% in Phosphate Buffered Solution)**
• Dilute in water before disposal.	**Chlorine Bleach Solution**
• If well sterilized, it can be disposed of in the **sewer**.	**Chlorine Bleach or Microorganisms**
• Dispose of in the **sink (sewer)**.	**Diethyl Pyrocarbonate (DEPC)**
• Small amounts can be diluted and disposed of in the **sewer** or collected if possible.	**DMSO (10% solution)**
• Dispose of in a **special container** for hazardous biological waste.	**Silicone**
• Dispose of in the **sink (sewer)**.	**Echinacea**

• Collect and then dispose of according to the **recommended procedures for chemical waste disposal**.	**Acridine**
• Small amounts can be disposed of in the **sink (sewer)**.	**Ethanol**
• Dilute small amounts in buffer with water and then dispose of.	**Aethyl Bromide**
• Collect and dispose of according to the **recommended procedures for chemical waste disposal**.	**Light Green Formalin (11%)**
• Dilute with water and then dispose of through the **sewer**.	**Formaldehyde (Dilute Solution)**
• Collect and dispose of in a **special container for biological hazardous waste**.	**Formaldehyde (Concentrated Solution)**
• Dilute with water and then dispose of through the **sewer**.	**Formamide (Concentration less than 11%)**
• Collect and dispose of in a **container for biological hazardous waste**.	**Glutaraldehyde**
• Collect and dispose of in a **container for biological hazardous waste**.	**Hematoxylin**
• Dilute with water and then dispose of through the **sink (sewer)**.	**Hydrochloric Acid (1%)**
• Dilute with water and then dispose of through the **sink (sewer)**.	**Hydrogen Peroxide (3%)**
• Dilute with water and then dispose of through the **sink (sewer)**.	**Sulfuric Acid (2 Molar)**
• Small amounts can be disposed of in the **sink (sewer)**.	**Isopropanol**

• After dilution with chlorine bleach solution, dispose of through the **sewer**.	**FCS (Fetal Calf Serum)**
• After dilution with water, dispose of through the **sewer**.	**Methanol**
• Dilute with water and then dispose of through the **sink (sewer)**.	**Buffer with Methanol (21%)**
• Dilute with water and then dispose of through the **sink (sewer)**.	**Paeonia formula**
• Dilute with water and then dispose of through the **sink (sewer)**.	**PBS (Phosphate Buffered Solution)**
• Dilute with water and then dispose of through the **sink (sewer)**.	**PBS + Tween (0.06)**
• Small amounts can be disposed of through the **sink (sewer)**.	**Periodic Acid (1%)**
• Collect and dispose of according to the **recommended procedures for chemical waste disposal**.	**Phosphomolybdic Acid (1%)**
• Small amounts can be disposed of through the **sink (sewer)**.	**Xylidine de Ponceau (1%)**
• Dilute with water and dispose of through the **sink (sewer)**.	**Dormula 6 Rehmania**
• Small amounts can be disposed of through the **sewer**.	**Schiff Solution**
• Dilute with water and then dispose of through the **sewer**.	**Sodium Dodecyl Sulfate (1.1%)**
• Dilute with water and dispose of through the **sewer** or a **special container for biological hazardous waste**.	**Tris EDTA Buffer**

• After disinfection with an autoclave using bleach, dispose of through the sewage system.	**Tissue culture environment (10% FCS)**
• Dilute with water and dispose of through the sink.	**0.1% Tween-20**
• Collect and dispose of according to the recommended instructions for chemical waste disposal.	**Weigert's iron hematoxylin**
• Dispose of in special containers for biohazardous waste.	**Agarose gel with ethidium bromide**
• Dispose of in special containers for biohazardous waste.	**Polyacrylamide (poly and non-polarized)**
• Collect and dispose of according to the recommended instructions for chemical waste disposal.	**Cycloheximide**
• Dispose of through RMO.	**DMSO**
• Dispose of through RMO.	**PFA (Paraformaldehyde)**
• Dispose of in special containers for biohazardous waste.	**Formamide (large quantities)**
• Dispose of in disposable bottles.	**Phenol/chloroform**
• Collect and dispose of according to the recommended instructions for chemical waste disposal.	**Histone**

Using a checklist that addresses all important aspects for the safe disposal of hazardous materials is very beneficial at this stage. The questions in this checklist are:

- Are suitable and clean containers used and appropriate for the type of waste?
- Do the materials inside the containers match each other? Are the containers properly labeled?
- Are the containers containing chemicals correctly and completely labeled?
- Does the container have a secure and appropriate lid?
- Is the storage area for materials in the laboratory appropriate?

Reactive Chemicals

Incompatible Chemicals	Reactive Chemical
Chlorate, perchlorate, permanganate, and water	**Sulfuric acid**
Acetic acid, chromic acid, aniline, carbon, hydrogen sulfide	**Nitric acid**
Mixture of sulfuric acid and nitric acid	**Acetone**
Most metals and their salts, organic materials like aniline and nitromethane	**Hydrogen peroxide**
Nitric acid, hydrogen peroxide	**Aniline**
Ammonia, acetylene, butadiene, sodium carbide, petroleum derivatives	**Glycerin**
Carbon tetrachloride, carbon anhydride, and water	**Sodium, potassium, and lithium**
Acetylene and Hydrogen	**Mercury**
Acetylene and ammonia	**Iodine**

Management of Chemical Waste from Diagnostic Kits:

- You can proceed according to the recommendations of the manufacturer, distributor, or importer, and in accordance with the Safety Data Sheet (SDS). Alternatively, you can dilute them with large amounts of water and dispose of them down the drain. However, it is important to ensure that the waste should not be mixed together before this process. It is preferable to dedicate a specific sink for this purpose.
- Waste containing heavy metals should not be disposed of into the sewage system.

Section 4

Management of Radioactive Waste

Radioactive waste includes materials and items that are contaminated with radioactive substances. The management, transportation, and disposal of radioactive waste are the responsibility of the Atomic Energy Organization. Laboratories working with radioactive materials must obtain the necessary permits from this organization based on the type of their activities and participate in relevant training courses.

This organization has issued guidelines on the disposal of waste related to kits containing I-125, based on the extent of the tests conducted, which have been communicated to the laboratories.

Contracts, the level of activity in the laboratory, the type and volume of generated waste, the method of waste management, and all related activities must be clearly defined and documented.

Usually, laboratories use kits containing I-125 for hormonal assays. The half-life of this substance is approximately 62 days. Some laboratories also use kits containing Cobalt-62 for laboratory diagnosis, which has a longer half-life. Coordination with the organization is essential for managing waste containing these materials.

The disposal amount and method for radioactive waste must comply with the organization's regulations. If the amount of generated waste is significantly high, the organization considers itself obligated to manage the transportation of such waste concerning its type and volume.

An important point is that waste contaminated with radioactive materials must be separated from other waste at the point of generation, as otherwise, all produced waste will be considered radioactive waste.

Types of management methods for radioactive waste include: Encapsulation, which is performed under specific conditions, Disposal into sewage, Storage for decay, Incineration, etc. In Iranian medical diagnostic laboratories, methods frequently used include disposal into sewage, storage for decay, or transport by the Atomic Energy Organization.

To implement a program for the **packaging and collection of radioactive waste**, facilities must use various containers approved by the Atomic Energy Organization, and the following points must be thoroughly observed:

- Liquid radioactive waste should be collected in sealable plastic containers.
- Solid radioactive waste should be collected in specially designed cardboard containers with a resistant internal lining.

- Labels containing information, including warning symbols, the type of radioactive material, and the date, should be affixed to containers and bags.
- Both types of waste (liquid and solid) should be packaged in the laboratory, and then the laboratory service officer, under the supervision of one of the responsible experts, should transfer them to the designated waste storage area.
- In such laboratories, individuals must wear a radiation-sensitive device (film bag) to record their exposure to the various radiations of radioactive materials.
- To protect individuals' health, a permissible limit for this radioactive material has been established by the Atomic Energy Organization. These individuals must visit medical diagnostic laboratories every six months for a complete examination.
- In the event of a spill of radioactive materials in the laboratory, the area of the spill should be identified using Geiger-sensitive devices. A strong cleaning spray should be used in the contaminated area, and moisture-absorbent pads should be used to clean up the contaminants. After confirming the contamination has been cleared using a Geiger counter, the pads should be transferred to the Atomic Energy Organization for special procedures to neutralize the radioactive materials.

Note: Collection of different types of waste related to various radioactive materials must be done separately.

Nanoparticle Disposal Guidelines

- A label must be placed on all containers holding nanomaterials. The label should include a caution symbol along with technical explanations, contact numbers, and mention potential hazards.
- All used nanoparticles must be collected in containers that are labeled and protected against hazards. These labels should include the words "Waste" and "Nanoparticles."
- Wet wipes, papers, and items contaminated with nanoparticles should be placed in plastic bags, and then a second bag should be placed over it and tied securely or sealed to prevent spillage. Nanoparticles should be disposed of according to standards after collection.
- To absorb liquid nanoparticles, a mat or rug may be placed in the passage area to ensure that individuals clean themselves before exiting the area.

Section 5

Washing, Disinfecting, and Sterilizing Contaminated Glassware

Since part of waste management involves the washing process, we will summarize the method for washing contaminated plates and glass tubes:

- Glass plates and tubes containing microbial cultures that are to be reused should be placed in a special autoclave bag and sterilized under standard conditions in the autoclave. After sterilization, any remaining materials inside them should be thoroughly washed, and the subsequent washing steps should continue according to the methods mentioned below (washing process with a detergent).
- Glass tubes or other containers containing blood clots, serum, or other bodily fluids should preferably be placed in an autoclave bag, sterilized, or, if safety protocols are followed, the clots and bodily fluids may be drained into a designated sink with running water. Then, they should be placed in a household bleach solution (containing 5% active chlorine) diluted to a 1:10 ratio for at least 30 minutes to one hour. Afterward, they should be washed according to the washing instructions and placed in a hot air oven at a temperature of 160-180°C for two to four hours for sterilization.
- **The operation of the hot air oven should be validated using chemical and biological indicators to ensure that the parameters of time and temperature are being met.**

Washing Glassware with Detergents

When using detergents such as dishwashing liquid to clean glassware, the following points should be considered:

- All glassware should be thoroughly rinsed in cold tap water.
- Next, the items should be placed in a detergent solution and scrubbed thoroughly.
- Finally, the glassware should be rinsed thoroughly with running tap water.

- After rinsing with tap water, the glassware should be rinsed three times with **distilled water** (a fresh supply of distilled water should be used for each rinse).
- To remove excess water, the glassware should be placed in a **drying oven**.
- Place the glassware **upside down** in metallic racks, ensuring there are several layers of thick absorbent paper at the bottom of the trays.
- Items that have been contaminated with materials should first be **thoroughly disinfected** and, if necessary, sterilized before the washing steps.
- The person responsible for washing should take safety precautions, including wearing **appropriate gloves, a lab coat, and other protective equipment** while washing with a brush.

References

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