Content

Revision Matrix

Rev. No	Date of Issue	Issue by HSE	Approved By HSE Council	
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Rev. No	**Date of Issue**	**Issue by HSE**	**Nature of Revision**	**Approved by HSE Council**
1				
2				
3				
4				
5				
6				
7				

1. INTRODUCTION

The safe storage of hazardous chemicals is an essential part of an environmental, health, and safety program. Chemical storage facilities must meet certain minimum standards to satisfy diverse regulations, such as those of ADNOC as well as the local regulations. This manual provides guidelines to assist personnel to store chemicals in a manner that is safe and in accordance with the related Standards and regulations.

The primary purpose of the proper chemical storage is to control health or physical hazards posed by chemical compounds during the storage in the lab.

The proper chemical storage shall be designed to:

- Protect flammables from ignition,
- Minimize the potential of exposure to poisons,
- Segregate incompatible compounds to prevent their accidental mixing

Laboratories and work areas on PI premises must observe several requirements that incorporate safe storage:

- Keeping an up-to-date **chemical inventory** (Ref: PI Policy on *Chemical Handling*)
- Maintaining a **chemical hygiene plan** and documenting staff training
- Conducting monthly **self-inspections** for chemical storage area

2. INVENTORY OF THE STORAGED CHEMICALS

Safe storage begins with an up-to-date inventory of hazardous chemicals that can be used to apprise personnel of the dangers in a laboratory, shop, or work area.

An accurate inventory is also necessary if emergency responders are to respond effectively to a fire or chemical release in the area.

The PI HSE Department will compile the inventory by gathering together inventories of hazardous chemicals stored in the laboratories. Laboratory supervisor shall submit the inventory at least annually to HSE department for updating the record.

The annual review of chemical inventory is a prime opportunity to clean out unwanted chemicals. All unwanted chemicals will either be picked up and disposed off or collected for reuse.

3. LABELS FOR CHEMICALS

3.1 All hazardous chemicals must be clearly labeled for the benefit of current users, emergency personnel, and future users. Unknown chemicals can be expensive to dispose of. It is compulsory that all labels are legible and in good condition. Repair or replace of damaged or missing labels is a must.

3.2 Manufacturers' Labels

Normally manufacturers provide labels with the following information:

- Contents of the container
- Physical and health hazard information
- Name, address, and emergency phone number of the manufacturer or other responsible party

Original manufacturers' labels must not be removed or defaced.

3.3 Additional information

For your own benefit and that of anyone else who may use the chemical storage in future, the date on which the material was acquired and the storage location should be added to all labels.

Adding the date will allow easy selecting of overage substances. As manufacturing and purification processes generally improve with time, the date of purchase is an additional indication of quality.

Storage location shall indicate storage room, the cabinet or set of shelves, and the individual shelf.

Hazardous chemicals that are not in the manufacturer's original container (e.g., working solutions prepared in the lab) must, at a minimum, be labeled with the contents of the container. If the contents are hazardous, a label indicating the hazard to warn individuals in the work area shall be attached. *It is not necessary to label containers that will be used temporarily (during one work shift) and are under immediate control of laboratory staff.*

3.4 Label material

The best way to add additional information is with a small label, stuck over a corner of the manufacturers' label, or just above it.

If the original label has disintegrated or otherwise been lost, a new one should be made, containing as much of the necessary information as possible. A good quality paper or polyethylene labels shall be used.

Labels, both own and the manufacturers', should be protected against spills and fading.

Lab supply houses sell label lacquers that are chemical-resistant; an easy-to-use option is a clear polyester tape that is water-resistant and also will stand up to casual exposure to acids, bases, and organic solvents.

All chemicals, whether commercial materials or samples prepared in the laboratory, must be labeled.

4. GENERAL RULES FOR STORAGE OF CHEMICALS

Chemical storage within research and teaching laboratory is not recommended. Hence buy the minimum practical quantity of chemicals, use it promptly after purchase, and dispose of any excess.

Rooms chosen for chemical storage should be well ventilated and *accomplish at least six air changes per hours.*

Significant quantities of chemicals should not be stored in a room that is regularly occupied by students or faculty who are not conducting experiments.

Consumption or storage of food or beverage of any kind **is strictly forbidden** in rooms where chemicals are stored or used.

Generally, storage areas must be equipped with fire extinguishers, eyewash fountains and material for cleaning up spills.

Fume hoods normally should not be used for storage of chemicals. When such storage cannot be avoided because properly ventilated cabinets are not available, or because the compounds are particularly odiferous, the bottles must be placed in a plastic tub or tray to contain any leakage or spill. Hoods being used for storage may not be used for experimentation, **and should be labeled clearly as storage hoods**.

4.1 Containers

Except for flammable solvents, which should be transferred to safety cans if proper cabinets are unavailable, the containers, usually of glass, in which chemicals are received from the supply house, are appropriate for storage for reasonable periods of time. Materials received in sealed glass ampoules should be used completely or the excess should be disposed of. Only a professional should attempt to reseal an ampoule.

In the past, however, chemicals often were received in inappropriate containers or were transferred locally into inappropriate containers. The best method of dealing with these materials is to dispose of them, especially if the cap is corroded. If you must keep the material, transfer it carefully to a new container purchased for the purpose from a lab supply house. Label it clearly, including the information that it has been repackaged and both the date of

acquisition (if known) and the date of repackaging. Supply houses also sell Teflon cap liners, which can be used to protect older containers not yet deteriorated.

The law requires that damaged containers have to be disposed of appropriately. "Damaged" includes: cracked or broken caps; chipped threads on bottle necks; and corrosion of metal containers, even if an interior glass container is intact.

Storage has to be provided only in sealed, air-impermeable containers. Containers with tight-fitting caps are necessary. Containers with loose-fitting lids or glass stoppers should not be used. An exception to this is mixtures that may produce gases that can pressurize the container.

Either mix fresh batches and use these mixtures on the same day, or fit containers with vented caps to prevent over-pressurization.

4.2 Chemical Storage cabinets

Only approved corrosive storage cabinets constructed of chemically resistant components shall be used for storing acids and bases.

The secondary containment for all liquids shall be used. Storage of aqueous sodium and potassium hydroxide solutions in aluminum drip trays is not acceptable. These will corrode aluminum and compromise its integrity.

Cabinets shall not be located:

- One above the other
- When they can jeopardize emergency escape (minimum 3 m away from exit)
- Under stairs or in corridor

The appropriate flammable storage cabinets have to be provided for storage of flammable liquids.

4.3 Refrigerators

Refrigerators used for storing chemicals or samples must be labeled with words to the effect as follows: "Caution—Do Not Store Food or Beverages in This Refrigerator."

Refrigerators and freezers for storing flammable liquids must be designed, constructed, approved, and labeled for that purpose. NOTE: This applies to ethanol and aqueous solutions greater than or equal to 15%.

Domestic refrigerator/freezers as well as units that have been modified to remove spark sources are not acceptable alternatives.

Flammable materials must never be stored in non-appropriate refrigerators. Only explosion – proof or flammable refrigerators should be used for storage of these materials.

Refrigerators may not be used for food storage.

Labels may be fabricated by users provided they are legible and securely affixed to the refrigerator.

Refrigerators used for food and beverages that are located in lunchrooms and office buildings where there is no shop- or laboratory-type chemical usage, require no posting.

4.4 Shelves / racks

Storing chemicals above shoulder height should be avoided.

Large containers (one gallon or larger), liquids, and corrosive materials should be stored on lower shelves below eye level.

Ensure that shelves are capable of storage. Do not store chemicals on unsteady shelves.

Shelves should be impervious to spilled liquids. This can be accomplished by coating the shelves with an epoxy coat. The storage shelves shall not be overcrowded.

Shelves/trays used for chemical storage shall be restrained against lateral movement and shall have lips on them to prevent containers being pushed through to the other side.

The guidelines for the storage on shelves/trays shall be established for each laboratory.

Note that Polypropylene and high density polyethylene trays are subject to attack by some aromatic and halogenated hydrocarbons.

Stainless steel and Pyrex Trays are resistant to a broader spectrum of chemicals. However they aren't available in as many different sizes and configurations.

The storage should be developed to ensure that incompatible chemicals are not stored together. **Alphabetical storage occasionally brings incompatibles into contact and should be avoided.**

If this method for storage is chosen, secondary containers must be used to separate incompatibles.

4.5 Maintenance

At monthly intervals, the storage area shall be inspected. Check list available at \\pi-fp1\Shared\HSE_Resources\Forms

Make sure that all chemicals are in their proper locations. Remove for disposal any substances with leaking containers, and repackage or dispose of any with caps that show signs of corrosion.

Unless you are certain that you will use them in the near future, remove for disposal bottles with only small amounts of material remaining in them, and anything more than two years old.

If you store volatiles that represent long-term health hazards, such as benzene and chlorinated solvents, regular air-sampling is needed.

4.6 General Storage Guidelines

Observe the following general storage guidelines:

- Use sources such as MSDSs for guidance on storage, incompatibility, reactivity and stability for chemicals.
- Do not tip bottles when returning them to a shelf. Shelves must have enough clearance to accommodate the largest container.
- Do not store chemicals (except cleaners) under sinks. Use approved flammable storage lockers, corrosive storage lockers, shelves or cabinets.
- Avoid stockpiling chemicals.
- Purchase only what is needed.
- Conduct periodic cleanouts to prevent accumulating unnecessary chemicals.
- Do not sort and store chemicals alphabetically unless they have first been separated into hazard classes
- Ensure that caps and lids on all chemical containers are tightly closed to prevent evaporation of contents. A Teflon or PVC cap liner may be used to provide a better seal.
- Avoid exposure of chemicals to heat or direct sunlight. This may lead to the deterioration of storage containers and labels, as well as the degradation of the chemicals. Some time-sensitive chemicals such as peroxide–formers can be affected as well.
- Store solids on shelves or in cabinets.
- Shelves used for chemical storage shall be restrained against lateral movement
- Install appropriate lips or use equivalent means to prevent materials from falling off storage shelves.
- Avoid storing chemicals on countertops or in fume hoods except for those being currently used.
- Store in a cool, dry environment free from extremes of temperature and humidity.
- Store acids and bases separately from each other and from other incompatible chemicals. For example, store oxidizing acids (such as nitric, perchloric, and sulfuric acids) separately from combustible and flammable liquids/materials.
- Nitric and hydrochloric acids can be stored in the same cabinet but in separate drip trays. These two acids can combine to form chlorine and nitrosyl chloride gases. Both are toxic.
- Store acetic acid as a flammable liquid. This is a combustible organic (carboxylic) acid that will react if it comes in contact with an oxidizing acid.
- Chemicals must never to be stored on the floor, not even temporarily.
- Maximum holding capacity of the shelving system shall not be exceeded
- Chemical storage cabinets for the storage of dangerous goods are required where storage exceed limits and shall comply with design and requirements of AS 1940 or design criteria in the relevant standard

4.7 Segregation and Storage of Chemicals According to Hazard Class

Chemical storage guidelines are presented below. Use these to segregate and a store chemical according to their hazard class. It is recommended color coding the edges of the shelves to match the category of substance stored. Materials can be returned to proper storage at glance within each category materials can be arranged alphabetically.

This prevents an undesirable chemical reaction from occurring should two or more chemicals accidentally mix.

4.7.1 Chemical Incompatibility Matrix

The chemical incompatibilities shown below are not exhaustive. As a result, it is important for laboratory personnel to research the properties of the chemicals being used. Sources such as **Material Safety Data Sheets** (MSDSs) may be used for guidance on chemical incompatibility. Also, the container's label should also have storage guidelines.

	Acids, inorganic	Acids, oxidizing	Acids, organic	Alkalis (bases)	Oxidizers	Poisons, inorganic	Poisons, organic	Water-reactives	Organic solvents
Acids, inorganic			X	X		X	X	X	X
Acids, oxidizing			X	X		X	X	X	X
Acids, organic	X	X		X	X	X	X	X	
Alkalis (bases)	X	X	X				X	X	X
Oxidizers			X				X	X	X
Poisons, inorganic	X	X	X				X	X	X
Poisons, organic	X	X	X	X	X	X			
Water-reactives	X	X	X	X	X	X			
Organic solvents	X	X		X	X	X			

X = Not compatible—do not store together

4.7.2 Segregation and Storage With Respect To Hazard Class

Acids

- Segregate acids from reactive metals such as sodium, potassium, and magnesium.
- Segregate oxidizing acids from organic acid and flammable and combustible materials.

- Store acetic acid as a flammable liquid. This is an organic (carboxylic) acid that will react if it comes in contact with an oxidizing acid.
- Nitric acid and hydrochloric acid may be stored in the same corrosive storage cabinet, but they must be kept in separate drip trays. These can combine to form chlorine and nitrosyl chloride gases—both are toxic.
- Segregate acids from chemicals that could generate toxic or flammable gases upon contact, such as sodium cyanide, iron sulfide and calcium carbide.
- Segregate acids from bases.

Bases

- Segregate bases from acids, metals, explosives, organic peroxides and easily ignitable materials.
- Do not store aqueous sodium and potassium hydroxide solutions in aluminum drip trays. These will corrode aluminum.

Solvents (Flammable and combustible liquids)

- Store in approved safety cans and special fire resistant cabinets.
- Segregate from oxidizing acids and oxidizers.
- Keep away from any source of ignition: heat, sparks, or open flames.

Oxidizers

- Keep away from combustible and flammable materials.
- Keep away from reducing agents such as zinc, alkali metals, and formic acid.

Cyanides

- Segregate from aqueous solutions, acids and oxidizers.
- Water-Reactive Chemicals
- Store in a cool, dry place, away from any water source.
- Make certain that a Class D fire extinguisher is available in case of fire.

Pyrophoric Substances

- If in original container store in a cool, dry place, making provisions for an airtight seal.
- Store in a glove box after the material has been opened.

Light-Sensitive Chemicals

- Store in amber bottles in a cool, dry, dark place.

Peroxide-Forming Chemicals

- Most peroxide forming chemicals are also flammable liquids. Therefore, store in airtight containers in a flammable storage locker.
- Segregate from oxidizers and acids.

Toxic Chemicals

- Store according to the nature of the chemical, using appropriate security where necessary.

4.7.3 Chemical Incompatibility Table

Examples of incompatible chemicals are listed below. The material on the left should be stored and handled so that it does not contact the incompatible chemical(s) on the right. Contact with incompatible chemicals would result in a potential violent reaction or toxic reaction products. Like the preceding matrix, this is not exhaustive. Therefore, use sources such as MSDS to determine chemical incompatibility. The container's label should also provide storage guidelines.

CHEMICAL	IS INCOMPATIBLE AND SHOULD NOT BE MIXED OR STORED WITH	CHEMICAL	IS INCOMPATIBLE AND SHOULD NOT BE MIXED OR STORED WITH
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates	**Hydrogen peroxide**	Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, combustible materials
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury	**Hydrogen sulfide**	Fuming nitric acid, oxidizing gases
Accetone	Concentrated nitric and sulfuric acid mixtures	**Hypochlorites**	Acids, activated carbon
Alkali and alkaline earth metals (such as powdered aluminum or magnesium, calcium, lithium, sodium, potassium)	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens	**Iodine**	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Ammonia (anhydrous)	Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)	**Mercury**	Acetylene, fulminic acid, ammonia
Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrates, sulfur, finely divided organic or	**Nitrates**	Sulfuric acid

	combustible materials		
Aniline	Nitric acid, hydrogen peroxide	**Nitric Acid (concentrated)**	Acetic acid, aniline, chromic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, any heavy metals
Arsenical materials	Any reducing agent	**Nitrites**	Acids
Azides	Acids	**Nitroparaffins**	Inorganic bases, amines
Bromine	See Chlorine	**Oxalic acid**	Silver, mercury
Calcium Oxide	Water	**Oxygen**	Oils, grease, gydrogen, flammable liquids, solids, or gases
Carbon (activated)	Calcium hypochlorite, all oxidizing agents	**Perchloric acid**	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils
Carbon tetrachloride	Sodium	**Peroxide, organic**	Acids (organic or mineral), avoid friction, store cold
Chlorates	Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials	**Phosphorus (white)**	Air, oxygen, alkalis, reducing agents
Chromic acid and chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids in general	**Potassium**	Carbon tetrachloride, carbon dioxide, water
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine	**Potassium chlorate**	Sulfuric and other acids
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide	**Potassium perchlorate (see also chlorates)**	Sulfuric and other acids
Copper	Acetylene, hydrogen peroxide	**Potassium permanganate**	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Cumene hydroperoxide	Acids (organic or inorganic)	**Selenides**	Reducing agents

Cyanides	Acids	**Silver**	Acetylene, oxalic acid, tartartic acid, ammonium compounds, fulminic acid
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens	**Sodium**	Carbon tetrachloride, carbon dioxide, water
Fluorine	Everything	**Sodium nitrate**	Ammonium nitrate and other ammonium salts
Hydrocarbons (such as butane, propane, benzene)	Fluorine, chlorine, bromine, chronic acid, sodium peroxide	**Sodium peroxide**	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydrite, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfurl
Hydrocyanic acid	Nitric acid, alkali	**Sulfides**	aAcids
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)	**Sulfuric acid**	Potassium chlorate, potassium perchlorate, potassium permanaganate (similar compounds of light metals, such as sodium, lithium)
		Telurides	Reducing agents