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1.0 PURPOSE

The purpose of this standard is to provide guidelines for the safe handling of reactive/explosive materials. Consult the MSDS for specific information about a particular reactive.

2.0 DEFINITIONS

Explosive materials are chemical compounds or mechanical mixtures that, when subjected to heat, impact, friction, detonation, or other suitable initiation, undergoes rapid chemical change. It evolves large volumes of highly heated gases that exert pressure on the surrounding medium. The term applies to materials that either detonate or deflagrate. Heat, light, mechanical shock, and certain catalysts initiate explosive reactions. Examples include organic peroxides, perchloric and picric acids (dry state), and metal azides.

Organic peroxide formers react with oxygen to form peroxy compounds (usually hydroperoxides) that are very unstable and decompose continuously. These organic peroxides are sensitive to light, heat, friction, and impact, as well as to strong oxidizing and reducing agents, and they are extremely flammable. There are four main groups of peroxide formers:

a. Ethers with primary and/or secondary alkyl groups attached to the oxygen, including open chain and cyclic ethers, acetals, and ketals.

b. Hydrocarbons with allylic, benzylic, or propargylic hydrogens.

c. Conjugated dienes, eneynes, and diynes.

d. Saturated hydrocarbons with exposed tertiary hydrogens.

Pyrophoric materials ignite spontaneously when exposed to air at a temperature of 130 deg. F (54.4 deg. C) or below. Reaction by-products are toxic fumes or gases and liberation of heat. Many pyrophoric materials are water reactive as well. Examples include white phosphorus, many finely divided metals, some metal hydrides, and certain silanes.

Reactive (unstable) materials are chemicals that will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.
STANDARD OPERATING PROCEDURE: Reactive/Explosive Materials

Water reactive materials react violently with water to produce toxic, corrosive, or flammable gases and the liberation of heat. Some examples are listed.

- Alkali metals
- Non-metal Halides (e.g. BCl$_3$, BF$_3$, BPCl$_3$, SiCl$_4$, S$_2$Cl$_2$)
- Alkali metal hydrides
- Inorganic acid halides (e.g. POCl$_3$, SOCl$_2$, SO$_2$Cl$_2$)
- Alkali metal nitrides
- Anhydrous metal halides (e.g. AlCl$_3$, TiCl$_4$, ZrCl$_4$, SnCl$_4$)
- Calcium carbide
- Organic acid halides and anhydrides of low molecular weight
- Phosphorus pentoxide
- Metal and non-metal hydrides (borane, LiAlH$_4$)

3.0 EXPOSURE HAZARDS

3.1 Contact/Absorption
Contact with eyes may cause irritation, corneal damage; skin: may cause burns, or deep penetrating ulcers. Chronic exposure may lead to anemia and digestive tract effects.

3.2 Inhalation
Inhalation may cause: respiratory tract irritation; sore throat; possible burns; central nervous system effects such as nausea and headache; shortness of breath, coughing; and delayed pulmonary edema.

3.3 Ingestion
Ingestion may cause: severe gastrointestinal tract irritation with nausea and possible burns; severe and permanent damage to the digestive tract; heart, liver, and kidney damage; and death.

4.0 PERSONAL PROTECTIVE EQUIPMENT
Use chemical splash goggles for eye protection in combination with a full-length face shield to fully protect the face and throat. Heavy, non-reactive gloves should be worn when handling reactive compounds or in the event it is necessary to reach behind a shielded area while a hazardous experiment is in progress. Check glove manufacturer for recommendations on a suitable glove for the specific chemical.

Wear a lab coat (100% cotton) and closed-toe shoes (non-fabric) with non-slip soles.

If a respirator is needed, then user must follow guidelines of the Respiratory Protection Program.

5.0 ENGINEERING AND VENTILATION CONTROLS
All procedures involving reactive/explosive materials must have engineering controls in place (e.g., fume hood with blast shield, inert atmosphere chamber, or other suitable protective equipment) to guard against runaway reactions and protect against hazardous exposure.

6.0 SPECIAL HANDLING PROCEDURES
1. CONDUCT PROCEDURES IN A FUME HOOD or other suitable, protective equipment.
2. Use a blast shield in combination with the hood sash to protect personnel and equipment from injury or damage from a possible explosion or fire.
3. Minimize the quantity of reactive (unstable) materials used and stored in the work area.
4. Label incoming containers with the date of receipt. Do not use reactive materials past their expiration date.
5. Exercise due care when handling peroxide formers. Visually inspect bottle cap and threads of container (without handling) for presence of organic peroxide crystals. If present, evacuate area and deny entry.
Contact EH&S, Laboratory Safety, and DPS. If container appears free of encrustation, test for peroxides using the methods below. If peroxides are detected, contact EH&S for disposal. NOTE: Test should be conducted semi-annually.

a. Add 1 to 3 milliliters (mL) of the liquid to be tested to an equal amount of acetic acid, add a few drops of 5% aqueous potassium iodide solution, and shake. The appearance of a yellow to brown color indicates the presence of peroxides. Alternatively, addition of 1 mL of a freshly prepared 10% solution of potassium iodide to 10 mL of an organic liquid in a 25-mL glass cylinder should produce a yellow color if peroxides are present.

b. Add 0.5 mL of the liquid to be tested to a mixture of 1 mL of 10% aqueous potassium iodide solution and 0.5 mL of dilute hydrochloric acid to which has been added a few drops of starch solution just prior to the test. The appearance of a blue or blue-black color within a minute indicates the presence of peroxides.

c. Use commercially available peroxide test strips.

7.0 LABELING REQUIREMENTS
1. Label storage cabinets or areas with appropriate descriptor: WATER REACTIVE, PYROPHORIC, OR EXPLOSIVE.
2. Label all incoming containers with the date of receipt.

8.0 STORAGE REQUIREMENTS
1. Minimize the amount of reactive materials used and stored.
2. Store peroxide formers in tightly sealed metal containers in areas away from oxidizers.
3. Do not return unused material to the original container.

9.0 FIRST AID
Consult MSDS of specific chemical for first aid treatment.

9.0.1 Eye/Skin Contact
1. Immediately go to the emergency shower/eye wash facility and remove all contaminated clothing.
2. Flush affected body area with water for at least 15 minutes.
3. Do not use neutralizing chemicals, creams, abrasives, or lotions.
4. If the eyes have been contaminated, forcibly hold them open and flush for least 15 minutes.
5. Resume flushing area with water if pain continues.

9.0.2 Inhalation
1. Move exposed person to fresh air if safe to do so.
2. If victim is breathing, loosen victim's clothing and maintain the airway.
   a. Lay victim flat on their back.
   b. Place one hand under the neck and lift.
   c. With the heel of other hand on victim's forehead, rotate or tilt the head backward into maximum extension.
   d. If additional airway opening is required, it can be achieved by thrusting the lower jaw into a jutting-out position.
3. If the victim is not breathing, contact DPS, and perform CPR (if certified) until medical assistance arrives. Be careful to avoid exposure to chemical poisoning via mouth-to-mouth resuscitation. If available, use a mouth-to-mask resuscitator.
9.0.3 Ingestion
1. Contact DPS and request medical assistance.
2. If possible, determine what material was ingested by victim.
3. If victim begins to vomit, turn head or entire body to one side to avoid choking.
4. Do not induce the victim to vomit or drink any beverage unless instructed to by qualified medical personnel.
5. If victim stops breathing, see Inhalation, step 3.

9.0.4 Injection
Contact DPS and request medical assistance.

10.0 SPILL AND ACCIDENT PROCEDURES
For all spill emergencies contact the Department of Public Safety (DPS).

In the event of a large chemical spill, follow these guidelines:
1. Notify everyone in the immediate area and the supervisor.
2. Evacuate personnel from the spill area.
3. Deny entry.
4. Alert other building occupants. NOTE: Evacuation of the building and its occupants may be necessary depending on the volume of chemical/biological material spilled and its relative hazard.
5. Notify DPS from a safe location and provide the following information:
   a. Your name, telephone number, and location;
   b. Type of incident, location, and time of occurrence;
   c. Name and quantity of material involved, to the extent known;
   d. If victims are involved, relay the victim(s)' name(s) and extent of injuries, if any;
   e. If exposed to a hazardous spill, see 7.9.2 Chemical Exposure

10.1 Chemical Spill Clean-Up
Chemical spill clean-up must not be attempted if the employee does not have the proper training and experience, the necessary spill kit supplies, and personal protective equipment. Contact DPS for large chemical spill clean-up.

10.1.1 Corrosive Liquids
1. Neutralize the spill. Apply neutralizer from a spill clean-up kit to the perimeter of the spill. If a spill clean-up kit is not available, sodium bicarbonate can be used on acid spills and 2% hydrochloric acid or citric acid powder can be used to neutralize caustic spills.
2. Mix thoroughly until fizzing and evolution of gas ceases. NOTE: It may be necessary to add water to the mixture to complete the reaction. Neutralizer has a tendency to absorb acid before fully neutralizing it.
3. Check mixture with pH strips or pH paper. Ensure that the final pH is between 6 and 10.
4. Once the chemical is completely neutralized, cover with an absorbent material (e.g. paper towels, pads, etc.)
5. Collect the absorbent and place it in a Ziploc bag.
6. Label the bag, place it in the fume hood and call EH&S immediately.
10.1.2 Other Hazardous Liquids

1. Prevent the spill from spreading by depositing absorbent material such as Super Fine, sand, or vermiculite (paper towels do not control the vapor release as well as sand) at its outer edges.
2. Cover the entire spill with the absorbent by working from the edge toward the center in a circular motion.
3. Mix the absorbent until it has absorbed all of the flammable liquid.
4. Collect the absorbent and place it in a Ziploc bag.
5. Label the bag, place it in the fume hood, and call EH&S immediately.

10.1.3 Solids

1. Solid material of low toxicity may be swept onto a dust pan and deposited into a Ziploc bag. Any powder clinging to the dust pan may be wiped with a lab tissue and the tissue disposed of in the Ziploc bag. Ensure that fine powder or dust from the spilled material does not become airborne.
2. Label the bag, place it in the fume hood and call EH&S immediately.
3. If the spilled material is highly toxic, contact EH&S or Laboratory Safety.

11.0 WASTE DISPOSAL

Chemical waste is segregated into the following groups:

- Flammable/combustible solvents e.g. acetone, xylene, methanol;
- Halogenated solvents e.g. chloroform, methylene chloride;
- Nitrogenous hydrocarbon e.g. trimethylamine, diisopropylamine;
- Sulfurous hydrocarbon e.g. dimethylsulfoxide, dimethylsulfate;
- Corrosives. A separate stream must be started for each of the following:
  - Mineral acids e.g. hydrochloric acid, sulfuric acid
  - Organic acids e.g. trichloroacetic acid, formic acid
  - Bases e.g. calcium oxide, sodium hydroxide
- Aqueous solutions e.g. metal salts, ethidium bromide; and
- Oils e.g. vacuum pump oil, motor oil.

1. Collect the chemical waste in appropriate containers described in the table below. Do not commingle or mix dissimilar waste streams.

<table>
<thead>
<tr>
<th>Waste type</th>
<th>Waste container</th>
</tr>
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<tbody>
<tr>
<td>Flammable liquids</td>
<td>glass bottles, steel cans, safety cans, high density plastic containers</td>
</tr>
<tr>
<td>Concentrated acids &amp; bases</td>
<td>2.5 liter “acid” bottle. <em>Note: one gallon glass bottles are unacceptable for acids and bases; the high specific gravity of the substance and the thinness of one gallon glass containers increases the likelihood of container breakage.</em></td>
</tr>
<tr>
<td>Trace contaminated solid waste</td>
<td>contaminated paper, gloves, etc. should be double-bagged using polyethylene bags</td>
</tr>
<tr>
<td>Aqueous solutions</td>
<td>glass bottles, plastic bottles, plastic cans</td>
</tr>
</tbody>
</table>
Broken mercury thermometers

| broken thermometers without free-flowing mercury may be packaged in the same manner as trace contaminated solid waste. Broken thermometers with mercury should be contained in a glass or plastic bottle with a tight cap |

2. Containers must be sealed airtight with a screw-on lid. Rubber stoppers, corks, and parafilm are not allowed. They must also be in sound condition, leak-proof, and appropriate for the waste type.

3. Do not fill liquid containers to more than 80% capacity. This is to prevent spillage on top of the container. The top and sides of the container must be free of liquid residue.

4. Solid chemical waste can be collected in plastic bags, fiber boxes or plastic containers.


12.0 PROGRAM APPROVAL AND REVIEW

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<th>Date prepared: 03/24/2004</th>
<th>By: Alfred M. Bouziane</th>
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<td>Date revised: 09/22/2009</td>
<td>By: Alfred M. Bouziane</td>
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