

## SECTION 9 - HAZARDOUS WASTE MANAGEMENT

### 9.A INTRODUCTION

Planning for chemical waste disposal begins in the design-phase of an experiment and before ordering the required chemicals. Civil and criminal statutes govern disposal of hazardous chemicals, and fines for non-compliance can be high.

EOHSS has a comprehensive program in place to identify, collect and disposal of all materials that are considered hazardous waste. Employees working in laboratories should presume that all hazardous chemicals must be disposed through the University's hazardous waste vendor.

### 9.B COST OF HAZARDOUS WASTE DISPOSAL

In most situations, there is no additional cost to the Researcher for disposal of chemicals. Departments are assessed direct charges only when there are extraordinary costs, e.g., for disposal of large quantities of chemicals remaining from a vacated lab.

### 9.C WASTE MINIMIZATION

Each person generating hazardous waste has an obligation to implement practices and procedures that minimize the amount hazardous waste generated. UMDNJ certifies that the University has tried, to the extent feasible, minimized the amount of hazardous waste generated at our institution.

Meeting the objectives of waste minimization at UMDNJ requires the cooperation of everyone producing hazardous wastes. Waste minimization means any process modification that results in the prevention or reduction of hazardous chemical waste. General principles for waste minimization, in order of priority, are:

- **Elimination** - ending a procedure or stopping the use of a hazardous substance that would result in the generation of hazardous waste.
- **Substitution** - replacing a hazardous substance with a less hazardous material, e.g., substituting ethanol for methanol as a solvent, since dilute ethanol is not a hazardous waste.

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- **Scale Reduction** - reducing the amount of a hazardous materials used in a procedure.
  - **Recycling** - the reuse of spent materials either back into the same process or into a different process.
  - **Reclamation** - any process that removes and reuses a hazardous material, e.g., purification, such as solvent distillation.

## 9.D HOW TO DETERMINE IF A WASTE IS HAZARDOUS

Individuals using chemicals must first determine if the resultant chemical waste is a hazardous waste. It is a hazardous waste if it one of 500 chemicals listed by the EPA (listings available from EOHSS) or has one of the following characteristics:

### **Ignitability**

- Flashpoint below 140°F (toluene)
- Solids that can cause fire by friction, absorption of water, burns vigorously when ignited (picric acid)
- Oxidizing chemicals (nitrates)
- Flammable compressed gases

### **Corrosivity**

- pH less than or equal to 2
- pH greater than or equal to 12.5

### **Toxic**

- Contains certain heavy metals or organic constituents

### **Reactivity**

- Substances that react violently with water (sodium)
- Chemicals containing cyanide or sulfide which create toxic gases in contact with pH between 2 and 12.5 (potassium cyanide)
- Explosive or unstable

Contact EOHSS with any questions about whether a chemical waste is considered hazardous waste.

**9.E LABORATORY HAZARDOUS WASTE OPERATING PROCEDURES**

**9.E.1 Storage Containers**

- Chose containers that are chemically compatible with the waste to be stored in them. (For example, hydrofluoric acid should not be stored in a glass container.)
- Empty food containers must never be used to store hazardous waste.
- The best source of suitable containers is the reuse of cleaned, empty 1-gallon chemical bottles. Contact EOHSS if you are in need of a container.
- Never collect waste in a container larger than 5-gallons.
- In most cases, the container will not be returned to the laboratory.

**9.E.2 Labeling of Containers**

Each hazardous waste container must have a UMDNJ Hazardous Waste Label (see Figure 9.1) as soon as you start putting waste into the container. Use the information in Table 9.1 to assist you in determining the hazard class of the substance. Contact the Campus EOHSS office with any questions about the hazard classification.

**Figure 9.1 - Example of a Hazardous Waste Label**

<b>HAZARDOUS WASTE - UMDNJ</b>	
Container Full Date: _____	Campus: _____
Department: _____	Bldg/Rm: _____
Generator Name: _____	Extension: _____
Chemical Name/Constituents	%
<b>Hazard Class (circle):</b> Ignitable Corrosive Toxic Oxidizer Reactive	

- List the percentage that each ingredient makes up of the solution.
- List all ingredients including water. Spell out the full chemical name of each ingredient - No abbreviations.
- Indicate the Hazard Class of each ingredient

**Table 9.1. Hazard Class Listing for Select Chemicals**

Chemical	Hazard Class	Chemical	Hazard Class	Chemical	Hazard Class
Acetaldehyde <sup>1</sup>	I, T	Dichloromethane	T	Mercury <sup>2</sup>	T
Acetic acid	I, C, T	Dimethyl sulfoxide	T	Methanol	I, T
Acetone	I, T	Dimethylformamide	T	Methyl ethyl ketone	I, T
Acetonitrile	I, T	Dioxane <sup>1</sup>	I, T	Nitric acid	C, O, T
Acrylamide	T	Ethanol	I, T	Osmium tetroxide <sup>2</sup>	T, C
Acrylonitrile	I, T, C	Ethidium bromide	T	Perchloric acid <sup>1,3</sup>	O, C, T
Aluminum trichloride	C, R	Ethyl acetate	I, T	Phenol	T, C
Ammonia (anhydrous)	C, T	Ethyl ether <sup>1,3</sup>	I, T	Potassium hydroxide	C
Ammonium hydroxide	C	Formaldehyde	T	Pyridine	I, T
Cacodylic acid	T	Formic Acid	C, T	Sodium azide <sup>2,3</sup>	T, R
Carbon disulfide <sup>2</sup>	I, T	Hexane	I, T	Sodium hydroxide	C
Carbon tetrachloride	T	Hydrazine	I, T	Sulfuric acid	C, T
Chloroform	T	Hydrochloric acid	C, R, T	Tetrahydrofuran <sup>1</sup>	I, T
Chromium trioxide	O, T, C	Hydrofluoric acid	T	Toluene	I, T
Coomassie Blue	T	Hydrogen peroxide	O	Trifluoroacetic acid	C, T
Cyanogen bromide	T	Iodine	T, C	Tryptan Blue Stain	T

**Legend:** I - Ignitable C - Corrosive T - Toxic O - Oxidizer R - Reactive

**Notes:** <sup>1</sup>May form explosive peroxides <sup>2</sup>EPA Acute Hazardous Waste - empty containers should be given to EOHSS without rinsing. See Table 9-2 below for other Acute Hazardous Wastes. <sup>3</sup>Specific information concerning the use and storage of this chemical is located elsewhere in this Plan.

### 9.E.3 Container Storage

- Keep all containers closed with an appropriate lid/cap (not a funnel) on at all times, with the exception of when filling the container.
- Containers do not need to be stored in the chemical hood. Instead, store the containers with compatible chemicals (e.g. acid wastes with acids).
- The outside of the container must be free of precipitate and drips.
- When a container is full, contact EOHSS so that the waste can be moved into the hazardous waste storage room within 3 DAYS of the container full date.

### 9.F PEROXIDE-FORMING CHEMICALS

Most chemicals used in research laboratories are stable and non-explosive at the time of purchase. Over time, certain chemicals can oxidize, become contaminated, dry out, or otherwise destabilize, becoming a potentially explosive chemical (PEC). Such chemicals can then literally detonate when exposed to heat, light, friction, or mechanical shock.

Commonly used chemicals that form peroxides as they age include: ethyl ether, isopropyl ether, butadiene, cyclohexene, tetrahydrofuran and dioxane. Such chemicals will contain a stabilizing agent or inhibitor in them, which extends the shelf life. However, peroxides can still form over time. As a result, many of these chemicals will have an expiration date on the container. **It is incumbent on the laboratory to give peroxide-forming chemicals to EOHSS for disposal at least 3 months before the expiration date, so they can be disposed of properly.**

Please note: Department of Transportation (DOT) regulations forbid transportation of unstable containers of hazardous chemical waste. If a peroxide-forming chemical is past its expiration date, UMDNJ must hire a vendor who handles highly hazardous materials to stabilize the containers. The department generating the waste will be charged for this service.

### 9.G EMPTY CONTAINER DISPOSAL

Bring empty compressed gas cylinders to the loading dock for storage before reclamation to the vendor. All other chemical containers may be disposed of in the trash if they meet the following requirements:

- The container is completely empty (no liquid remains in the container) **AND**;

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- Refer to the Acute Hazard Table (Table 9.2) below to determine if the EPA considers the chemical Acute Hazardous Waste.
    - If **yes**, give the empty container to EOHSS as a hazardous waste.
    - If **no**, rinse bottle out, write "EMPTY" across label and arrange for disposal through Environmental Services.

## 9.H NON-HAZARDOUS WASTE DISPOSAL

Although the majority of chemicals used in a research lab will be treated as hazardous waste, the following materials are non-hazardous waste and may be disposed as described below.

### 9.H.1 Drain Disposal

You may dispose of the following liquid wastes down a sink drain:

- Weak acids and buffers with pH of 5.5 - 9.0 *if no other hazardous components are present.*
- Ethanol/water mixtures of less than 10% ethanol *if no other hazardous components are present.* Do not dilute solutions of greater than 10% ethanol in order to dispose of them via the drain.
- Ethidium bromide aqueous solution **after** filtering through an extractor. The extractor is disposed of as hazardous waste. These extractors are available through lab supply vendors. Contact EOHSS or for more information on ethidium bromide disposal.

### 9.H.2 Trash Disposal

You may dispose of the following solid wastes in the trash:

- Alkaline batteries.
- Ethidium bromide-stained agarose gels (*with trace amounts of Ethidium Bromide and no other hazardous components present*).
- Small quantities of solid *non-hazardous* wastes may be disposed of in the trash. Examples of non-hazardous wastes include: sugars, salts, minerals, starches, amino acids, and enzymes. Contact EOHSS to determine if a waste stream is non-hazardous.

Table 9.2 Acute Hazard Wastes

1-(o-Chlorophenyl)thiourea	Aldrin
1-Acetyl-2-thiourea	Allyl alcohol
1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino)ethyl]-,(R)-	alpha-Naphthylthiourea
1,2-Propylenimine	Alpha,alpha-Dimethylphenethylamine
1,2,3-Propanetriol,trinitrate(R)	Aluminum phosphide (R,T)
1,4,5,8-Dimethanonaphthalene-	Ammonium picrate (R)
1,2,3,4,10,10-hexa-chloro-1,4,4a,5,8,8a-hexahydro-,	Ammoniumvanadate
(1alpha, 4alpha,4abeta,5alpha,8alpha,8abeta)-	Argentate(1-),bis(cyano-C)-,potassium
1,4,5,8-Dimethanonaphthalene,1,2,3,4,10,10-hexa-chloro-	Arsenic oxide As <sub>2</sub> O <sub>3</sub>
1,4,4a,5,8,8a-hecahydro-,(1alpha,4alpha,	Arsenic oxide As <sub>2</sub> O <sub>5</sub>
4abeta,5beta,8beta,8abeta)-2-Propenal	Arsenic trioxide
2-Propen-1-ol	Arsenic acid H <sub>3</sub> AsO <sub>4</sub>
2-Propanone, 1-bromo-	Arsenic pentoxide
2-Cyclohexyl-4,6-dinitrophenol	Arsine, diethyl-
2-Butanone, 3,3-dimethyl-1-(methylthio)-,O-[methylamino	Arsonous dichloride, phenyl-
carbonyl] oxime	Aziridine
2-Methylactonitrile	Aziridine,2-methyl-
2-Propyn-1-ol	Barium cyanide
2,4-Dinitrophenol	Benzenamine, 4-chloro-
2,7:3,6-Dimethanonaphth[2,3-b]oxirene,3,4,5,6,9,	Benzenamine,4-nitro-
9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-,	Benzene, (chloromethyl)-
(1aalpha,2beta,2abeta,3alpha,6alpha,	Benzeneethanamine, alpha, alpha-dimethyl-
6abeta,7beta,7aalpha)- & metabolites	Benzenethiol
2,7:3,6-Dimethanonaphth[2,3-b]oxirene,	Benzyl chloride
3,4,5,6,9,9-hexachloro-1a,2,2a,3,	Beryllium
6,6a,7,7a-octhydro-,(1aalpha,2beta,2aalpha,	Bromoacetone
3beta,6beta,6aalpha,7beta,7aalpha)-	Brucine
2H-1 Benzopyran-2-one,4-hydroxy-3-(3-oxo-1 phenylbutyl)-	Calcium cyanide Ca(CN) <sub>2</sub>
& salts, when present at concentrations greater than 0.3%	Calcium cyanide
3-Chloropropionitrile	Carbon disulfide
3(2H)-Isoxazolone, 5-(aminomethyl)-	Carbonicdichloride
4-Pyridinamine	Chloroacetaldehyde
4-Aminopyridine	Copper cyanide Cu(CN)
4,6-Dinitro-o-cresol, & salts	Copper cyanide
4,7-Methano-1H-indene,	Cyanides (soluble cyanide salts), not otherwise
1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-	specified
5-(Aminomethyl)-3-isoxazolol	Cyanogen chloride (CN) Cl
6,9-Methano-2,4,3-benzodioxathiepin,6,7,8,9,10,10-	Cyanogen
hexachloro-1,5,5a,6,9,9a-hexahydro-,3-oxide	Cyanogen chloride
7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylicacid	Dichloromethyl ether
Acetaldehyde, chloro-	Dichlorophenylarsine
Acetamide, N-(aminothioxomethyl)-	Dieldrin
Acetamide, 2-fluoro-	Diethyl-p-nitrophenyl phosphate
Acetic acid, fluoro-, sodium salt	Diethylarsine
Acrolein	Diisopropylfluorophosphate (DFP)
Aldicarb	Dimethoate
	Dinoseb

**Table 9.2 Acute Hazard Wastes (cont.)**

Diphosphoramid,octamethyl-	Nitrogendioxide
Disphosphoricacid,tetraethylester	Nitrogenoxide NO
Disulfoton	Nitrogenoxide NO2
Dithiobiuret	Nitroglycerine(R)
Endosulfan	Octamethylpyrophosphoramid
Endothall	O,O-Diethyl O-pyrazinyl phosphorothioate
Endrin	Osium tetroxide
Endrin, & metabolites	OsmiumoxideOsO4,(T-4)-
Epinephrine	p-Chloroaniline
Ethanedinitrile	p-Nitroaniline
Ethanimidothioicacid,N-[[[(methylamino)carbon yl]oxy]-,methylester	Parathion
Ethylcyanide	Phenol, 2-methyl-4,6-dinitro-, & salts
Ethyleneimine	Phenol, 2,4,6-trinitro-,ammonium salt (R)
Famphur	Phenol, 2,4-dinitro-
Fluorine	Phenol, 2-cyclohexyl-4,6-dinitro
Fluoroacetamide	Phenol, 2-(1-methylpropyl)-4,6-dinitro
Fluoroacetic acid, sodium salt	Phenylmercuryacetate
Fulminicacid,mercury (2+) salt (R,T)	Phenylthiourea
Heptachlor	Phorate
Hexaethyltetraphosphate	Phosgene
Hydrazinecarbonthioamide	Phosphine
Hydrazine,methyl- Hydrocyanicacid	Phosphoric acid, diethyl 4-nitrophenyl ester
Hydrogencyanide	Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)ethyl] ester
Hydrogenphosphide	Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester
Isodrin	Phosphorodithioicacid,O,O-diethylS- [(ethylthio)methyl]ester
Mercury, (acetato-O) phenyl-	Phosphorofluoridic acid, bis(1-methylethyl)ester
Mercuryfulminate(R,T)	Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester
Methane, oxybis[chloro-	PhosphorothioicacidO-[4-[(dimethylamino)1 sulfonyl]phenyl]O,O-dimethylester
Methane,isocyanato-	Phosphorothioicacid,O,O,-dimethylO- (4-nitrophenyl)ester
Methane,tetranitro-(R)	Phosphorothioicacid,O,O-diethyl-O- (4-nitrophenyl)ester
Methanethiol,trichloro-	Plumbane,tetraethyl-
Methanimine,N-methyl-N-nitroso-	Potassiumcyanide
Methomyl	PotassiumcyanideK(CN)
Methylhydrazine	Potassiumsilvercyanide
Methylisocyanate	Propanal,2-methyl-2-(methylthio)-, O-[(methylamino)carbonyl]oxime
Methylparathion	Propanenitrile, 3-chloro-
N-Nitrosomethylvinylamine	Propanenitrile
N-Nitrosodimethylamine	Propanenitrile,2-hydroxy-2-methyl-
Nickelcarbonyl	
NickelcarbonylNi(CO)4,(T-4)-	
Nickelcyanide	
NickelcyanideNi(CN)2	
Nicotine, & salts	
Nitricoxide	

Table 9.2 Acute Hazard Wastes (cont.)

Propargylalcohol	Thiodiphosphoricacid,tetraethylester
Pyridine,3-(1-methyl-2-pyrrolidinyl)-,(S)-,&salts	Thiofanox
Seleniousacid,dithallium(1+)salt	Thioimidodicarbonic diamide [(H <sub>2</sub> N)C(S)] <sub>2</sub> NH
Selenourea	Thiophenol
Silver cyanide	Thiosemicarbazide Thiourea, (2-chlorophenyl)-
Silver cyanideAg (CN) P105	Thiourea,1-naphthlenyl-
Sodium azide	Thiourea,phenyl-
Sodiumcyanide Sodiumcyanide Na(CN)	Toxaphene
StrontiumsulfideSrS	Trichloromethanethiol
Strychnidin-10-one, 2,3-dimethoxy-	Vanadicacid,ammonium salt
Strychnidin-10-one, & salts	VanadiumoxideV <sub>2</sub> O <sub>5</sub>
Strychnine, & salts	Vanadiumpentoxide
Sulfuricacid,dithallium(1+)salt	Vinylamine,N-methyl-N-nitroso Warfarin, &
Tetraethyldithiopyraphosphate	salts, when present at concentrations
Tetraethyllead	greater than 0.3%
Tetraethylpyrophosphate	Zinccyanide
Tetranitromethane(R)	Zinccyanide Zn(CN) <sub>2</sub>
Tetraphosphoricacid,hexaethylester	Zincphosphide (Zn <sub>3</sub> P <sub>2</sub> ),when
Thallicoxide	present at concentrations >10%(R,T)
Thallium(I)selenite	
Thallium(I)sulfate	
Thalliumoxide (Tl <sub>2</sub> O <sub>3</sub> )	

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## 9.I SPECIAL TYPES OF HAZARDOUS MATERIALS

Certain types of hazardous waste pose particular problems for disposal. They may be impossible to dispose of or may require handling and storage by a specialized hazardous waste vendor. **Therefore, consult EOHSS and the Radiation Safety Officer before generating the following wastes:**

- mixed radioactive/hazardous chemical waste
- mixed radioactive/biological waste
- uranyl acetate and uranyl nitrate/hazardous chemical mixtures

Consult EOHSS in advance before generating chemical wastes mixed with human body fluids, to ensure that a disposal option exists. Treat Petri dishes, syringes, hypodermic needles and test tubes as Regulated Medical Waste. Do not dispose of biological wastes in the chemical waste stream. Do not dispose of chemical waste in the biological (regulated “red bag”) waste stream.

## 9.J RADIOGRAPHIC WASTE AND PHOTOGRAPHIC FILMS

### 9.J.1 Options for Managing Liquid Radiography Waste

- a. Run used fixer solutions through a silver recovery unit, ensuring that the silver recovery unit is changed often enough to ensure the discharge meets the EPA limit.

#### **For Piscataway, New Brunswick and Stratford facilities:**

RWJMS Shared Equipment Services (732-235-4455) has a contract with a vendor to provide silver recovery services at a group rate. Shared Equipment Services will ensure that the silver recovery units are changed as often as necessary, will ensure testing to determine when the cartridges are becoming spent and will maintain copies of all required documentation. (Each department must also maintain documentation).

#### **For Camden facilities:**

Collect and dispose of used fixer solutions through EOHSS. See 9.J.1b, below, for more information.

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Protection as an acute poison. This means that transfer buffer, which typically contains approximately 20% methanol, must be collected and disposed of as a hazardous chemical waste.

### **9.K.1 Use PVDF instead of Nitrocellulose Membranes**

Frequently used, nitrocellulose membranes are highly hydrophilic and bind proteins electrostatically. This requires methanol in the transfer buffer to prevent sample “blow-through.”

PVDF (polyvinylidene fluoride) membranes bind proteins hydrophobically, and a small amount of methanol is necessary to enhance the efficiency of protein binding to the membrane, it is not required in the transfer buffer when using PVDF membranes. Inherent properties of the PVDF membrane, such as higher internal surface area and cationic surface, make the use of methanol in the transfer buffer an unnecessary (and, ultimately expensive) ingredient. However, the PVDF membrane must be thoroughly soaked in 100% methanol for about 15 seconds prior to use with aqueous solutions as dry spots can inhibit protein transfer.

Application-wise, there is no advantage to using nitrocellulose over PVDF. In fact, PVDF will bind samples more tightly than nitrocellulose, making it more preferable for applications such as protein sequencing and mass spectrometry. Additionally, PVDF has chemical-resistant properties which make it resilient against chemicals that are commonly used in de-staining procedures.

### **9.K.2 Switch from a Tank Transfer System to a Semi-Dry Transfer System**

Another option for reducing the amount of methanol waste generated would be to switch from a tank transfer system to a semi-dry transfer system. The advantages and disadvantages of each system is summarized below in Table 9.3.

Table 9.3 Comparing the Use of a Tank-Transfer System to Semi-Dry Transfer

Transfer System	Advantages	Disadvantages
Tank transfer	<ol style="list-style-type: none"> <li>1. The large amount of buffer in the chamber allows long transfer times, since the buffer will not completely evaporate.</li> <li>2. Ample buffer is available for the long transfer times associated with large fragments.</li> </ol>	<ol style="list-style-type: none"> <li>1. The large amount of buffer (up to 4 liters) required to fill the tank can be considered excessive use of materials.</li> <li>2. Tank electroblotters are usually complicated to set up.</li> <li>3. Because of the large chamber, transfer generally takes a long time, even for small fragments.</li> </ol>
Semi-dry transfer	<ol style="list-style-type: none"> <li>1. Very little buffer is needed, just enough to thoroughly soak the blot stack (around 100mL).</li> <li>2. Generally easier to set up.</li> <li>3. Because of the plate design, there is a very high current density and a uniform current path, resulting in fast transfers.</li> </ol>	<ol style="list-style-type: none"> <li>1. Large fragments take longer to transfer, and the limited buffer supply may evaporate before large fragments have enough time to fully transfer. Choosing the proper buffer composition can prevent this.</li> <li>2. Semi-dry electroblotters are more likely to allow the sample to blow through the membrane. This can be minimized with buffer adjustments.</li> <li>3. The blot stack conditions for semi-dry electroblotters can be complicated, depending on many variables including gel composition, buffer composition, fragment size, current density, and type of blotting paper. Once these conditions are optimized, however, transfer is simpler and faster than with tank blotters.</li> </ol>

If you would like to know if PVDF membranes would work for your specific application, call Bio-Rad Laboratories, Inc., at 1-800-424-6723, option 2. To make arrangements for disposal of used methanol-containing transfer buffer, contact your campus EOHSS office.

## 9.L FOR FURTHER ASSISTANCE

Call your campus for EOHSS if you would like assistance on chemical waste issues such as waste minimization, storage, segregation, recycling, labeling, disposal or other details of the University's Hazardous Waste Management Program.