NATIONAL HIGH MAGNETIC FIELD LABORATORY

NHMFL

FLORIDA STATE UNIVERSITY

TITLE: CHEMICAL SAFETY PROCEDURE

SP-13

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1.0 PURPOSE

The purpose of this procedure is to establish policy and procedure to be observed by all lab personnel at the National High Magnetic Field Laboratory including all employees, users, visitors, contractors, or other persons when handling hazardous chemicals and materials.

The Occupational Safety and Health Administration (OSHA) have legal authority in matters concerning employee safety. In most cases, employees are protected by OSHA's General Industry Standards (29 CFR 1910). One of the primary standards is the Hazard Communication Standard (29 CFR 1910.1200) which requires employers to disclose toxic and hazardous substances in workplaces and provide appropriate training needed to understand health and safety risks.

Since the National High Magnetic Field Laboratory at Florida State University (Maglab) employs workers engaged in the use of hazardous chemicals and materials, the Maglab is required to comply with the provisions of another OSHA standard: 29 CFR 1910.1450 Occupational Exposure to Hazardous Chemicals in Laboratories. This standard is commonly referred to as "The OSHA Lab Standard." It was developed to provide increased protection to Maglab employees above that provided in the General Industry Standard.

Understanding the moral and legal obligation to provide for the safety of Maglab employees is the first step in complying with the OSHA Lab Standard. The backbone of the OSHA Lab Standard is its requirement for the Maglab to develop and carry out the provisions of a written Chemical Hygiene Plan (CHP). The Maglab's required Chemical Hygiene Plan is found in Chapter 5.0 of this safety procedure (SP-13).The CHP OSHA requirements are outlined in APPENDIX B.

2.0 SCOPE

This document applies to all personnel working with hazardous chemicals and materials that are under the control of the Maglab. It is to be used as part of the overall Maglab Safety Program.

This procedure is to be used by all personnel at the NHMFL, including employees, and contractors. This procedure identifies the specific requirements for the management, use and disposal of hazardous chemicals and materials. This procedure also establishes responsibilities as applicable for the administration and implementation of the Chemical Hygiene Plan (CHP).

3.0 POLICY

The policy of the NHMFL is to provide and maintain a safe and healthful working environment that insures everyone at the Maglab are protected against exposure to hazardous materials possessing the potential to harm people, property, or the environment. Employees and lab personnel alike shall assist in ensuring safety is not compromised. The safety and health of employees and personnel are the inherent responsibilities of each employee, user, management, and all levels of supervision.

4.0 INTEGRATED SAFETY MANAGEMENT (ISM)

All Maglab employees, users and contractors that work with hazardous chemicals or materials must assess the risk hazard of their processes before work can proceed.

Residual risk categories after all controls are in place define how the work will proceed:

A. **Low**: proceed using ISM
B. **Low Medium**: proceed with caution using ISM. A second worker is in the vicinity.
C. **Medium**: Seek guidance from Safety Department before proceeding. Two authorized workers must be in place before work can proceed. Limited number of authorized workers as maintained by the Safety Department.
D. **Medium High**: Seek guidance from Safety Department before proceeding. Two authorized workers must be in place before work can proceed. Limited number of authorized workers as maintained by the Safety Department. Work can only proceed if authorized by the Director or his designee.
E. **High**: Work will not be performed.

Refer to APPENDIX A for ISM risk assessment.

5.0 CHEMICAL HYGIENE PLAN (CHP)

CHP Index:

5.8.0 Special Precautions for Work with Particularly Hazardous Substances

5.8.1 Working with Particularly Hazardous Chemicals and Materials
5.8.2 Working with Highly Reactive Chemicals
5.8.3 Working with Chemicals of High Acute Toxicity, including Carcinogens
5.8.4 Working with Chemicals that are Reproductive Hazards
5.8.5 Working with Hydrofluoric Acid

5.1.0 STANDARD OPERATING PROCEDURES: HANDLING TOXIC CHEMICALS

5.1.1 Chemical Purchases

Estimate the amount of chemical required for each experiment or project and order only what is necessary. Older stocks should be used first. Excess chemicals are very expensive to dispose of and can create a hazard if stored too long.

Understand the hazards associated with each chemical and plan appropriate protective measures. Safety Data Sheets can be found at FSU Safety Data Sheet Online Database, through your chemical vendor, or consult other resources. Contact your supervisor or the NHMFL Safety Department for information about safe handling and disposal of your chemicals.

Plan experiments with safety in mind. Substitute less hazardous chemicals in procedures whenever possible. Utilize green chemical alternatives whenever possible. A useful reference is the MIT Green Chemical Alternatives Purchasing Wizard that contains over 200 journal references and case studies to provide useful alternatives for some of the most common hazardous solvents and substances found at the Maglab. Remember to purchase minimal amounts of chlorinated solvents. Minimize the use of mercury and replace mercury-containing devices with non-mercury options whenever possible.

When your order arrives, inspect the packaging carefully for any signs of breakage or leakage of contents. If there are any signs of leakage, place package in a safe location, such as in an impervious and compatible secondary container within a chemical fume hood, protect personnel from exposure, and call the NHMFL Safety Department for assistance.

5.1.2 Chemical Storage

The following are general requirements for chemical storage at the Maglab; contact the NHMFL Safety Department at safety@magnet.fsu.edu for specific guidance.

Chemicals should be stored based on compatibility with other chemicals in the storage unit; compatible chemicals can be stored alphabetically. Acids, flammable liquids, oxidizers and highly reactive chemicals should all be separated and stored properly to avoid an unwanted chemical reaction.

Go here for an Incompatible Chemical Storage Guide. This list should be used only as a guide. Consult the MSDS for specific incompatibilities.

Acids should be stored in nonmetal corrosives cabinets, separated from flammable and combustible material, bases, active metals (sodium, potassium, magnesium), or chemicals that could generate toxic gases upon contact, such as silver cyanide, iron sulfide, etc. Incompatible acids may be stored in separate cabinets or by placing in separate secondary containers; information about incompatible acids can be found on the FSU Corrosive Storage Guidelines site. Bottle carriers should be used during transport of acids.

Bases should be stored in a separate corrosives cabinet from acids, and stored away from metals, explosives, organic peroxides and easily ignitable materials. Inorganic hydroxide solutions should be stored in polyethylene containers.

Flammable Liquids in volumes of 10 gallons (37.8 liters) or more should be stored in flammables cabinets. Flammables should be stored away from sources of ignition, and segregated from oxidizing acids and oxidizers. Fire extinguishers must be available. Standard refrigerators are not suitable for flammables storage because the electrical components may produce a spark. However, flammable chemicals may be stored in refrigerators designed for this storage in accordance with NFPA 45 Refrigeration. Contact the NHMFL Safety Department for information.

Reactive chemicals should be stored appropriately, away from other reactants. Chemicals that react with water should be sealed and kept in a container with absorbent material. Secondary containment should be labeled.

Long term storage of **peroxide forming chemicals** creates a hazardous situation for lab workers and the NHMFL safety staff, and may result in high waste disposal costs for highly unstable chemicals. Always use or dispose of these chemicals on or before the expiration date on the label.

Toxic compounds and carcinogens should be stored according the hazardous nature of the chemical, using appropriate security. Researchers must contact the NHMFL Safety Department before purchasing highly toxic gases.

Pyrophoric chemicals should be stored in a cool, dry place with an airtight seal. Researchers must contact the NHMFL Safety Department before purchasing pyrophoric gases.

Always label chemicals in English with the exact contents, if appropriate include date of receipt, and, expiration date.

Storage areas should be properly ventilated and should be adequately designed and constructed.

Large containers of reagents should be stored on low shelving, preferably in trays to contain all leaks and spills. Chemicals should not be stored on the floor, on bench tops, and only minimally inside fume hoods if required for some toxic compounds.

The quantity of chemicals that are stored should be reduced to an absolute minimum.

5.1.3 Chemical Labeling

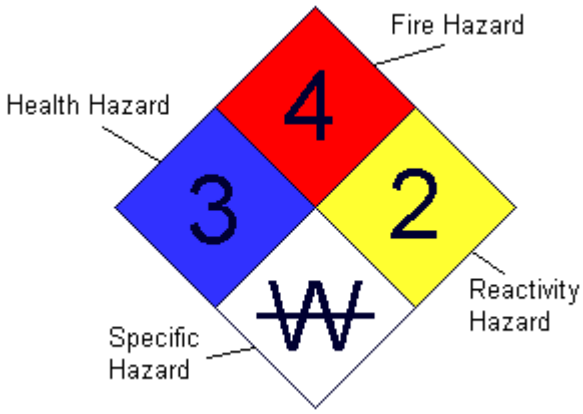
All original containers must be labeled with the chemical constituents and hazard. Labels on original containers must not be removed or defaced until disposal. It is recommended that all chemicals are dated when received, but dating is crucial for compounds which have a specified shelf life, such as those that will form peroxides (e.g. ethyl ether). Failure to label chemicals and waste greatly increases disposal costs. All Maglab personnel who are leaving the University are responsible for identifying and properly disposing of the chemical waste prior to their departure.

The OSHA Lab Standard requires that commercially labeled hazardous chemicals must identify:

- The identity of the material.
- Known immediate and delayed hazards.
- Manufacturer or suppliers contact information
- Precautionary hazard warnings.

NFPA Labeling

NFPA 704 labels indicate chemical hazards within a laboratory building or chemical storage area, and are often included on chemical labels or the Safety Data Sheets (SDS). The NFPA diamond summarizes the hazards within a posted area, and is used primarily to alert emergency response personnel to acute chemical hazards that are present. The NFPA diamond indicates:



Health –the following applies for chemicals present in small amounts:

4 – fatality likely
3 – permanent injury
2 – serious injury
1 – minor injury
0 – injury unlikely

Flammability

4 - Vaporizes completely at normal Pressure & Temperature, also it burns readily
3 – Can be ignited under almost all ambient conditions
2 – Ignition requires moderate to high heating
1 – Ignition requires substantial preheating
0 – Not combustible

Reactivity- at standard Temperature & Pressure

4 - Explosive detonation, decomposition or reaction
3 – explosive reaction requires heat or water initiation
2 – readily violent decomposition or reaction w/water but no detonation
1 – normally stable unless elevated heat, pressure…H20 reaction potential
0 – normally stable, not H_20 reactive

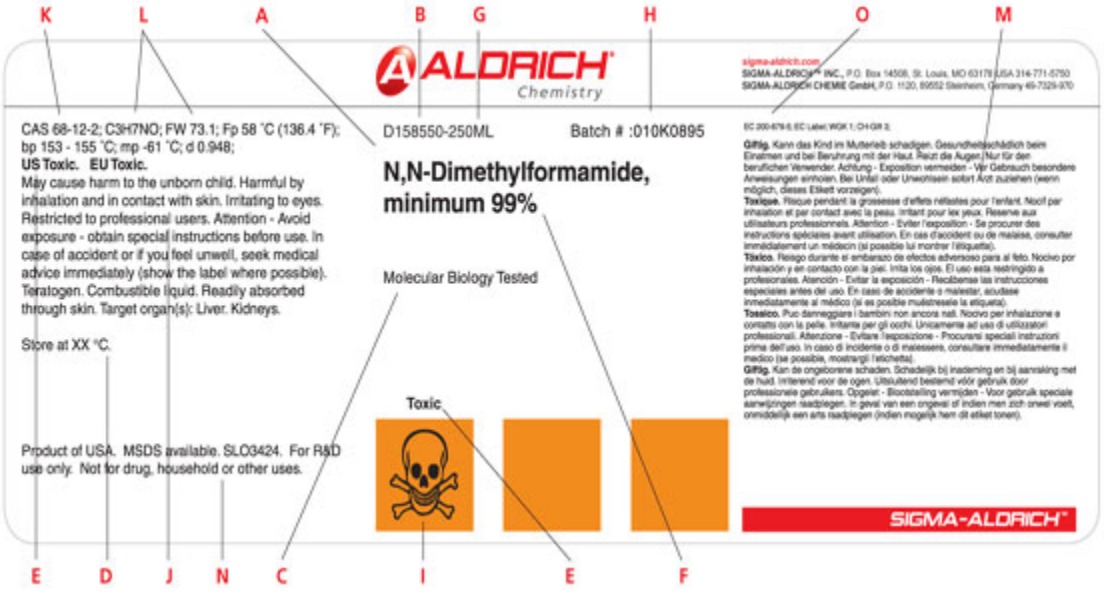
White – refers to a specific hazard.

ANSI Labeling

American National Standard Institute (ANSI) has published a voluntary labeling standard (ANSI Z129.1-1988) followed by most chemical manufacturers that includes:

- Signal words - DANGER, WARNING, CAUTION (highly toxic materials shall be marked POISON).
- Precautionary measures useful in preventing physical harm to the individual.
- Instructions in case of exposure.
- Notes to physician for emergency treatment.
- Instructions in case of fire or chemical spill.
- Instructions for chemical handling and storage.

Example of an ANSI compliant chemical label



A. Product Name and Description
B. Product Number
C. Further Descriptive Information
D. Recommendations on Handling and Storage: Storage temperatures indicated are for long-term storage of products. Products may be shipped under different conditions to reduce shipping costs, while still ensuring product quality.
E. Hazard Statement
F. Indication of danger
G. Lot Analysis
H. Data on activity, purity, degree of hydration, etc., for this lot.

I. Package Size: Unless the material is described as pre-weighed, the package will normally contain at least the indicated quantity, and usually somewhat more. For some products, the actual quantity at time of packaging is also shown. The user should always measure the amount needed from the container.
J. Lot Number
K. Hazard Pictogram – see Chemical Hazard Pictograms below: Lets you know at a glance what safety hazards are involved in the use of this product.
L. Further Hazard Information: More complete description of actual hazards, handling precautions, and emergency management procedures.
M. CAS Number: Chemical Abstract Service number shown wherever available. CAS numbers vary in how specifically they define the material. We make every effort to provide the most specific CAS number which applies. Where a CAS number is provided for a mixture or solution, it is usually the CAS number of the solute or component referred to in the main label name.
N. Chemical Formula and Formula Weight: Unless water of hydration is indicated in the formula, the formula weight is for the anhydrous material.
O. Risk and Safety Statements: Information is provided in multiple languages.
P. Safety Data Sheet Available: A Safety Data Sheet is available for this product.
Q. EC Number: EC Number (EINECS or ELINCS), products without an EINECS number will carry the warning statement, "Caution: Substance Not Yet Fully Tested.

Chemical Hazard Pictograms

HAZCOM STANDARD PICTOGRAMS

Health Hazard  • Carcinogen • Mutagenicity • Reproductive Toxicity • Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity	**Flame**  • Flammables • Pyrophorics • Self-Heating • Emits Flammable Gas • Self-Reactives • Organic Peroxides	**Exclamation Mark**  • Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity (harmful) • Narcotic Effects • Respiratory Tract Irritant • Hazardous to Ozone Layer (Non-Mandatory)
Gas Cylinder  • Gases Under Pressure	**Corrosion**  • Skin Corrosion/ Burns • Eye Damage • Corrosive to Metals	**Exploding Bomb**  • Explosives • Self-Reactives • Organic Peroxides
Flame Over Circle  • Oxidizers	**Environment** (Non-Mandatory)  • Aquatic Toxicity	**Skull and Crossbones**  • Acute Toxicity (fatal or toxic)

5.1.4 Transportation of Chemicals

Personnel who move hazardous chemicals and materials from one campus location to another need to be aware that chemicals and other hazardous materials should only be handled or transported by trained personnel who are familiar with the specific hazards and safety precautions associated with the particular products. For large amounts of chemicals or for transport of acutely toxic chemicals, personnel must always work in teams.

Use the following guidance when transporting chemicals or any hazardous material on University property:

- Contact the NHMFL Safety Department in advance of the move.
- Be ready for emergencies -- if there is a spill that has the potential to endanger human health, immediate call 911 and take appropriate steps to ensure the safety of those in the immediate area.
- If a spill has the potential to impact storm drains, take immediate action to protect the storm drain (dirt dike).
- In the event of a spill, notify a supervisor and the NHMFL Safety Department at **855-SAFEMAG** regardless of the perceived extent of the spill.
- Move hazardous chemicals and materials during regular working hours.
- Only trained Maglab personnel may move chemicals and other hazardous materials.
- Commercial movers or departmental staff can move lab supplies but NOT hazardous materials.
- Do not attempt to move outdated ethers or other potentially unstable/reactive compounds
- Chemicals that are outdated and potentially unstable; in corroded containers; having cracked or missing lids; are unknown or unlabeled should not be moved.
- Do not move chemical waste.
- Use proper protective equipment as appropriate.
- Where possible, heavy or bulky quantities of hazardous materials should be transported by elevator, preferably one reserved exclusively for freight.
- Personnel should not ride in elevators with bulky quantities of hazardous materials.
- Pack hazardous chemicals (solvents, corrosives, toxic chemicals) and all liquids with compatible chemicals.
- Make sure that all chemicals are securely capped.
- Place in a secondary container like a tub or bin that could adequately contain the entire contents if the primary container failed. Contact the NHMFL Safety Department for bins for moves between Innovation Park and FSU campuses.
- Individual chemical containers not in original packaging must be placed in a secondary plastic container when transporting.
- Do not place incompatible chemicals together in the same bin.
- Glass bottles containing hazardous chemicals should be packed in vermiculite or other absorbent materials and have sufficient cushioning.
- Relatively non-hazardous dry chemicals may be packed in boxes.
- DO NOT MOVE hazardous chemicals or materials in personal vehicles .
- Hazardous chemicals and materials must not be left unattended or stored in corridors, departmental offices, or other non-Maglab locations.

- If chemicals are to be shipped off-site, contact the NHMFL Safety Department at 644-0233 or 644-6955 for guidance on packaging and shipping regulations.

Transporting materials with specific hazards

- Compressed gas cylinders should only be transported with the protective cap in place and on approved carts.
- Cylinders must always be secured to these carts using chains or straps.
- Cryogens - Personnel should never occupy an elevator being used for the transportation of cryogens; a release of cryogenic material will displace oxygen and can create an asphyxiating environment – 1L of liquid N_2, if completely sublimated where there is no air exchange, will displace 700L of air.
- This type of transport should be accomplished by securing the material in the elevator, exiting the elevator and connect safety chain with "**NEVER ride in elevators with compressed gas cylinders or dewars**" sign attached.
- Solvents – Special consideration should be made of the potential for an accident when transporting solvents as these may be highly toxic and have other hazardous properties.
- Corrosives – Concentrated acids are usually transported in rubber protective sleeves.
- It is unsafe to carry concentrated acids for long distances, even if protected by rubber sleeves, without a cart and secondary containment (tub).
- Reactive, old or potentially unstable chemicals - Do not attempt to move outdated ethers or other potentially unstable/reactive compounds.

5.1.5 Working with Organic Solvents

A solvent is a liquid that dissolves a solid, liquid, or gaseous solute resulting in a solution. The term organic solvent refers to most other solvents that are organic compounds and contain carbon atoms. In addition to the handling of solvents for flammable, corrosive or other properties; toxicity and carcinogenicity must be considered when working with organic solvents. Solvents usually have a low boiling point and evaporate easily or can be removed by distillation, thereby leaving the dissolved substance behind. Solvents are usually clear and colorless liquids and most of them have a characteristic smell.

Most organic solvents are combustible, often highly volatile and extremely flammable and they should always be handled with care. Some solvents produce vapors, which are heavier than air. These may move on the floor or ground to a distant ignition source, such as a spark from welding or caused by static electricity. Vapors of solvents can accumulate in confined places and stay there for a long time, presenting risks for health and property. The NHMFL Safety Department recommends that solvents be used in a fume hood for these reasons.

Solvents enter the body by inhalation, by swallowing and through the skin. The effect depends on several factors, such as:

- How easily the solvent evaporates at the ambient temperature.
- The characteristics of that solvent; is it water soluble or able to dissolve fats.
- The concentration of the solvent in the air at the place of work.
- The type of work is involved, i.e. light or heavy.
- How long the exposure lasts.

Solvents, including their vapors and mists, have various effects on human health. Solvents irritate the eyes and the respiratory tract and many of them have a narcotic effect, causing fatigue, dizziness and intoxication. High doses may lead to unconsciousness and death. Work with solvents should be done within a fume hood for these reasons.

Solvents may damage the skin by removing the fat. This is a very common cause of skin disorders and dermatitis. Some solvents penetrate the skin and enter the blood circulation. Solvents may damage the liver, kidneys, heart, blood vessels, bone marrow and the nervous system. Certain solvents, such as benzene, are carcinogens.

Personal Protective Equipment for Organic Solvent Handling

If gloves, goggles, or other protective clothing are needed to keep solvents away from skin, eyes, and clothing, make sure gloves are made of material that is not permeable to the solvents you are using. Personal protective equipment such as aprons, gloves and eye protection equipment should be stored in a clean place away from possible contact with solvent vapors. Workers must know safe work methods and emergency procedures (fire, spill, first aid) for the specific chemicals they use.

Many organic solvents are flammable. Refer to flammable liquids for more information. Equipment (fire extinguishers, absorbent material, etc.) should be provided for situations such as spillage or emergency.

Solvent Containers

Each vessel containing chemical stocks or solutions should have a label showing the chemical. If chemicals must be transferred from the original containers, the new containers should be labeled with the chemical name. Containers are closed or covered when not in use. Compatible containers must be used. Transfer of solvents between containers may require grounding to prevent discharge of static electricity.

Solvent Disposal

The NHMFL Safety Department will provide containers to dispose of solvents on request. Once you have received a container, and filled it, simply contact us at safety@magnet.fsu.edu and we will take them to our waste facility and return your waste receptacle.

5.1.6 Working with Flammable Liquids

Fire hazards are associated with vapors from the flammable liquid. In order for a fire to occur, the following conditions must be met:

- Concentration of the vapor must be between the upper and lower explosion limit (See Table below)
- An oxidizing material must be present
- Source of ignition must be present

Flammability Characteristics of Some Common Solvents

Flammable Limits (%)			
Chemical	Flashpoint (°C)	Lower %	Upper %
Acetaldehyde	-37.8	4	60
Acetone	-17.8	2.6	12.8
Benzene	-11.1	1.3	7.1
Carbon Disulfide	-30	1.3	50
Cyclohexane	-20	1.3	8
Diethyl Ether	-45	1.9	36
Ethyl Acetate	-4	2	11.5
Ethylene mine	-11	3.6	46
Gasoline (approximate)	-38	1.4	7.4
n-Heptane	-3.9	1.05	6.7
n-Hexane	-21.7	1.1	7.5
Methyl Acetate	-10	3.1	16
Methyl Ethyl Ketone	-6.1	1.8	10
Pentane	-40	1.5	7.8
Toluene	4.4	1.2	7.1
CRC Handbook of Lab Safety, 5th Edition, page 265.			

Working safely with flammable liquids

- Order only the amounts that are necessary.
- Remove all nearby sources of ignition.
- Heat flammable liquids with safe heating equipment (e.g. mantles) or explosion safe equipment.

- When transferring flammable liquids using metal containers, ground both containers.
- Store flammable liquids in safety cans, flammable storage cabinets or flammable storage refrigerators.
- Do not leave solvent distillation processes unattended.

Storage of Flammable Liquids

Limits for the storage of flammable solvents are based on fire hazards associated with each liquid. The following requirements must be followed:

- Flammable liquids stored at the laboratory should be kept to a minimum.
- Flammable liquids should not be stored next to incompatible chemicals.
- Storage of flammable liquids outside approved flammable storage cabinets and safety cans must not exceed 10 gallons per 100 square feet of laboratory space, including waste (See the NFPA tables below for details).
- If you have flammable storage cabinets and approved safety cans, total storage must not exceed 20 gallons per 100 square feet of laboratory space (See the NFPA tables (4) and (5) below for details).

There are maximum container size requirements for different classes of flammable liquids and limits for the maximum amounts stored, as indicated in the tables below. Consult the NHMFL Safety Department for more information.

Is it flammable or combustible…what NFPA classification applies?

To understand OSHA requirements for the safe storage of flammable and combustible liquids, we must begin by defining the two. A flammable liquid is any liquid having a flashpoint below 100° F (37.8° C) (except any mixture having components with flashpoints of 100° F (37.8° C) or higher, the total of which make up 99 percent or more of the mixture)(1910.106(a)(19)).

Flammable liquids are categorized into three groups, as follows:

Class IA - Liquids having flashpoints below 73° F (22.8° C) and having boiling points below 100°F (37.8°C) (1910.106(a)(19)(i)). Examples: Acetaldehyde, ethyl ether and cyclohexane.

Class IB - Liquids having flashpoints below 73° F (22.8° C) and having boiling points at or above 100° F (37.8°C) (1910.106(a)(19)(ii)). Examples: Acetone, benzene and toluene.

Class IC - Liquids having flashpoints at or above 73° F (22.8° C) and below 100° F (37.8°C) (1910.106(a)(19)(iii)). Examples: Hydrazine, styrene and turpentine.

A combustible liquid is any liquid having a flashpoint at or above 100° F (37.8° C) (1910.106(a)(18)). Combustible liquids are divided into two classes:

Class II - Liquids having flashpoints at or above 100° F (37.8° C) and below 140° F (60° C), except any mixture having components with flashpoints of 200°F (93.3°C) or higher, the volume of which make up 99 percent or more of the total volume of the mixture (1910.106(a)(18)(i)). Examples: Acetic acid, naphtha and stoddard solvent.

Class III - Liquids having flashpoints at or above 140°F (60°C) (1910.106(a)(18)(ii)). Class III liquids are subdivided into two subclasses:

- **Class IIIA** - Liquids having flashpoints at or above 140°F (60°C) and below 200°F, except any mixture having components with flashpoints of 200°F (93.3°C) or higher, the total volume of which make up 99 percent or more of the total volume of the mixture (1910.106(a)(18)(ii)(a)). Examples: Cyclohexanol, formic acid and nitrobenzene.
- **Class IIIB** - Liquids having flashpoints at or above 200°F (93.3°C) (1910.106(a)(18)(ii)(b)). Examples: Formalin and picric acid.

The flashpoint and boiling point determine the class of a liquid. However, these should not be the only criteria used to determine the hazards of a liquid. Many other factors should also be considered for the proper use and storage of hazardous liquids. These factors include: ignitions temperature, explosive limits (LEL or UEL), vapor pressure, specific gravity and vapor density.

Table 1: Flash point/Boiling points for NFPA Categories

	Flash Point		**Boiling Point**	
TYPE	Fahrenheit	Celsius	Fahrenheit	Celsius
Class IA	< 73	< 22.8	< 100	< 37.8
Class IB	< 73	< 22.8	> 100	> 37.8
Class IC	73 - 100	22.8 - 37.8		
Class II	100 - 140	37.8 - 60		
Class IIIA	140 - 200	60 - 93.3		
Class IIIB	> 200	> 93.3		

Table 2: Maximum Quantities of Flammable and Combustible Liquids and Liquefied Flammable Gases in Sprinklered Lab Units Outside of Inside Liquid Storage Areas

Lab Unit Fire Hazard Class	Flammable and Combustible Liquid Class	Maximum Quantity per 9.3 m2 (100 ft2) of Lab Unit		Maximum Quantity per Lab Unit		Maximum Quantity per 9.3 m2 (100 ft2) of Lab Unit		Maximum Quantity per Lab Unit	
		Excluding Quantities in Storage Cabinets or Safety Cans				Including Quantities in Storage Cabinets or Safety Cans			
		L	Gal	L	gal	L	gal	L	gal
A (High)	I	38	10	2270	600	76	20	4540	1200
	I, II and IIIA	76	20	3028	800	150	40	6060	1600
B (Moderate)	I	20	5	1136	300	38	10	2270	600
	I, II and IIIA	38	10	1515	400	76	20	3028	800
C (Low)	I	7.5	2	570	150	15	4	1136	300
	I, II and IIIA	15	4	757	200	30	8	1515	400
D (Minimum)	I	4	1.1	284	75	7.5	2	570	150
	I, II and IIIA	4	1.1	284	75	7.5	2	570	150

Table 3: Maximum Quantities of Flammable and Combustible Liquids and Liquefied Flammable Gases in Nonsprinklered Lab Units Outside of Inside Liquid Storage Areas*

Lab Unit Fire Hazard Class	Flammable and Combustible Liquid Class	Maximum Quantity per 9.3 m2 (100 ft2) of lab Unit		Maximum Quantity per Lab Unit		Maximum Quantity per 9.3 m2 (100 ft2) of Lab Unit		Maximum Quantity per lab Unit	
		Excluding Quantities in Storage Cabinets or Safety Cans				Including Quantities in Storage Cabinets or Safety Cans			
		L	gal	L	gal	L	gal	L	Gal
A (High)	I	Not permitted		Not permitted		Not permitted		Not permitted	
	I, II and IIIA	Not permitted		Not permitted		Not permitted		Not permitted	
B (Moderate)	I	Not permitted		Not permitted		Not permitted		Not permitted	
	I, II and IIIA	Not permitted		Not permitted		Not permitted		Not permitted	
C (Low)	I	7.5	2	284	75	15	4	570	150
	I, II and IIIA	15	4	380	100	30	8	760	200
D (Minimum)	I	4	1.1	140	37	7.5	2	284	75
	I, II and IIIA	4	1.1	140	37	7.5	2	284	75

Table 4: Maximum Quantity Permitted Excluding Storage Cabinet and Safety Cans

Lab unit fire hazard class	Flammable or combustible liquid class	Excluding Quantities in Storage Cabinets or Safety Cans		
		Maximum quantity per 100 sq. ft. of	Maximum quantity per Lab unit	
		Lab unit	Without sprinklers	With sprinklers
A (High)	1 I, II and IIIA	10 gallons 20 gallons	300 gallons 400 gallons	600 gallons 800 gallons
B (Moderate)	1 I, II and IIIA	5 gallons 10 gallons	150 gallons 200 gallons	300 gallons 400 gallons
C (Low)	1 I, II and IIIA	2 gallons 4 gallons	75 gallons 100 gallons	150 gallons 200 gallons
D (Minimum)	1 I, II and IIIA	1.1 gallons 1.1 gallons	37 gallons 37 gallons	75 gallons 75 gallons

Table 5: Maximum Quantity Permitted Including Storage Cabinet and Safety Cans

Lab unit fire hazard class	Flammable or combustible liquid	Including quantities in storage cabinets or safety cans		
		Maximum quantity	Maximum quantity per Lab unit	
	class	per 100 sq. ft. of Lab unit	Without sprinklers	With sprinklers
A (High)	1 I, II and IIIA	30 gallons 40 gallons	600 gallons 800 gallons	1200 gallons 1600 gallons
B (Moderate)	1 I, II and IIIA	10 gallons 20 gallons	300 gallons 400 gallons	600 gallons 800 gallons
C (Low)	1 I, II and IIIA	4 gallons 5 gallons	150 gallons 200 gallons	300 gallons 400 gallons
D (Minimum)	1 I, II and IIIA	2 gallons 2 gallons	75 gallons 75 gallons	150 gallons 150 gallons

Flammable Storage Cabinets

Flammable storage cabinets are designed to contain a fire for 10 minutes, enough time to allow you to escape. According to the National Fire Protection Association (NFPA), flammable storage cabinets are not required to be ventilated, and the NHMFL Safety Department recommends against ventilation. If there are ventilation openings in the cabinet, then: (1) The ventilation opening must be sealed with materials providing fire protection at least equivalent to that of the construction of the cabinet; or, (2) The cabinet must be vented directly to the outside of the building. Flammable storage cabinets should not be vented by removing bung caps. Contact the NHMFL Safety Department by e-mailing safety@magnet.fsu.edu for guidance.

Follow these procedures when using or considering the use of flammable storage cabinets:

- Flammable storage cabinets should not be located near exits, electrical panels or sources of heat or ignition.
- Do not vent flammable storage cabinets unless approved by the NHMFL Safety Department.
- Flammable storage cabinets must be listed by Factory Mutual, Underwriter's Laboratory or other qualified testing agencies.
- The flammable storage cabinet must be clearly labeled as flammable.
- Materials stored inside of the flammable storage cabinet should be compatible with the cabinet's design and construction.
- Acids should not be stored in a flammable storage cabinet due to possible corrosion of the cabinet and incompatibility with organic solvents.

Flammable Storage Refrigerators

According to Annex A of NFPA 45 – Standard on Fire Protection for Laboratories Using Chemicals:

“The use of domestic refrigerators for the storage of typical solvents presents a significant hazard to the lab work area. Refrigerator temperatures are almost universally higher than the flash points of the flammable liquids most often stored in them. In addition to vapor accumulation, a domestic refrigerator contains readily available ignition sources, such as thermostats, light switches, and heater strips, all within or exposed to the refrigerated storage compartment. Furthermore, the compressor and its circuits are typically located at the bottom of the unit, where vapors from flammable liquid spills or leaks could easily accumulate.”

Flammable storage refrigerators are specially designed to prevent internal explosions caused by flammable vapors coming in contact with ignition sources (e.g. the temperature control switch or the light). These refrigerators and freezers must meet UL, NFPA, and OSHA standards.

Due to these concerns, flammable liquids (Class I, IA, IB, and IC) are prohibited in ordinary household-type refrigerators at the Maglab.

Please contact the NHMFL Safety Department at safety@magnet.fsu.edu for labels. In laboratories storing or using flammable liquids, internal procedures must ensure that lab refrigerators are being properly used.

5.1.7 Working with Corrosive Chemicals

Corrosive chemicals include strong acids and bases, dehydrating agents, nonmetal chlorides and halogens. These chemicals may be acute health hazards and present problems in handling and storage. In addition to general procedures for handling of chemicals detailed in this procedure, the following measures should be followed:

- Purchase corrosives in containers with a protective plastic coating, if available.
- Store corrosives under the hood, on low shelving or in non-metal storage cabinets.
- Gas cylinders (lecture size) should not be stored in the same cabinet with corrosive liquid, because of possible cylinder/valve damage.
- Properly segregate hazardous materials to prevent fire, explosion or toxic gas release.

5.1.8 Working with Compressed and Liquefied Gases

Compressed gases may present both physical and health hazards. Gases may be flammable, reactive, corrosive or toxic and these properties must be considered when developing experimental procedures and designing apparatus. In addition, compressed gases, when not handled properly or not contained in properly designed vessels, can be extremely hazardous with a high potential for explosion. Although each approved gas cylinder is designed, constructed, and tested to safely contain its contents, the procedures listed below should be taken in handling and storing of compressed gases.

General Procedures for Proper Handling of Gas Cylinders

- Compressed gases must be handled by trained personnel only.
- Personnel must use appropriate PPE.
- Regulators must be used to safely reduce pressure using an appropriate pressure regulator, and must include two gauges indicating cylinder pressure and outlet pressure.
- Pressure gauges should not be used above 75% of its maximum face reading.
- Any pressurized system (piping, manifold) that can be isolated or closed off and has the potential to build pressure must have its own pressure relief device and should vent to safe locations.
- Cylinder contents must be clearly identified on the cylinder.
- Cylinders must have manual shutoff. Handles for shutoffs may not be removed or altered.
- Cylinders and tanks must be protected from physical damage by means of protective caps, collars, or similar devices (capped when not in use).
- Compressed gases must be separated from each other by chemical compatibility and must be separated from materials or conditions that are not compatible with safe storage (by 20 ft distance or 5 ft. high 30-minute rated fire resistant barrier in accordance with NFPA 55 Section 7).

- Trucks, carts or hand trucks used for movement of cylinders must be designed for secure transport.
- Cylinders on trucks, carts or hand trucks must be caped for transport.

Guidelines for Compressed Gas Systems and Regulators

- Never use a compressed gas cylinder without a pressure reducing regulator or device to safely reduce pressure to the system.
- The regulator used MUST be appropriate for the specific compressed gas.
- Never use a gauge above 75% of its maximum face reading.
- A 3000psi system should use at least a 4000psi gauge. A system that has a 75 psi maximum pressure should use a gauge that can read to 100 psi.
- Regulators should be replaced immediately if the gauge does not return to the zero point when the pressure is removed.
- Never use an unapproved adaptor between a cylinder and a pressure reducing regulator.
- Valves should be accessible at all times, unless the valve cap is in place.
- Teflon tape should not be used on regulator connection to cylinder.
- All cylinders should have adequate pressure relief devices.
- Backflow check valves should be used when oxidizing gases and flammable gases are connected to a common piece of equipment.
- Regulators, valves, piping, tubing, fittings and other apparatus must be appropriate for the type of gas.
- Never change a CGA cylinder connection type on a regulator.

Procedures for Attaching a Pressure-Reducing Regulator

- Turn the regulator's adjustment screw out counter-clockwise until it feels loose.
- Stand behind the cylinder with the valve outlet facing away from you.
- Watch the pressure gauge on the regulator from an angle, do not pressurize the gauge looking directly at the faceplate.
- Open the value on the regulator slowly until you hear the gas filling the space between the cylinder valve and the regulator.
- When you are ready to use the cylinder fully open the cylinder valve until you feel it stop. Then close it one quarter turn.

Gas Cylinder Storage General Requirements

- Cylinders must be secured from tipping over.
- Cylinders must be stored in a cool, dry area away from ignition sources, electrical supply sources and heat.
- Compressed gases must be protected from heat, open flames, heat sources, and weather.
- Considered "in use" when connected via regulator to lab equipment, manifold or lab operation OR may be a single reserve cylinder.
- Cylinder valve should be closed when not in use or when being stored full or empty.
- Valves should be accessible at all times even when cylinders are being stored full or empty.
- Cylinders should always be stored in the upright position.

- Do not store cylinders with acids and/or bases.
- Do not store cylinders on the tops of shelves or cabinets.
- Keep flammable gases away from doorways and emergency exits.
- Store oxidizing gases away from flammable gases.
- Oxygen cylinders should not be stored with cylinders that contain flammable gases.
- Oxygen cylinders should be separated from combustible materials 20 feet or by a fire barrier.

Gas Cylinder Maximum Storage at 21°C & 1 atm

- Flammable or Oxidizing gases – no more than 6 ft^3 for ≤ 500 ft^2 lab unit; contact the Safety Department for storage limitations in larger lab units (cylinder 53" tall by 8" diameter = 1.4 ft^3).
- Liquefied Flammable gases – no more than 1.2 ft^3 for ≤ 500 ft^2 lab unit; contact the Safety Department for storage limitations in larger lab units.
- Toxic (NFPA Health Hazard 3 or 4) – no more than 0.3 $ft^3$for ≤ 500 ft^2 lab unit; contact the Safety Department for storage limitations in larger lab units.

Gas Cylinder Outdoor Storage

- A weather protection structure is permitted to be used for sheltering outdoor storage of compressed gas cylinders.
- Hazard identification signs shall be placed at all entrances to locations where compressed gases are stored.
- The structure shall allow for natural ventilation to prevent accumulation of hazardous gases.
- Ignition sources in area where flammable gases are stored should be controlled or eliminated if possible.
- Signs should be posted in area communicating that smoking or open flames should not be permitted in area.
- Static producing equipment in storage area shall be grounded.

Lecture Bottles

- Must be stored in a continuously ventilated enclosure if gas is NFPA health hazard 3 or 4; gas is NFPA health hazard 2 with no physiological warning property; or gas is pyrophoric.
- No more than 25 lecture bottles are permitted within a research lab in accordance with NFPA 45.
- Lecture bottles containing non-flammable gases are permitted to be stored horizontally.

Gas Cylinders of Toxic, Corrosive, or Pyrophoric Gases

- Cylinders larger than lecture bottles that contain gases with NFPA health hazard 3 or 4; gas with NFPA health hazard 2 and no physiological warning properties; MUST be stored in a continuously ventilated gas cabinet.
- Cylinders containing pyrophoric gases must be stored within continuously ventilated and sprinklered gas cabinets.
- Health and fire protection requirements must be met for storage and use of toxic, corrosive or flammable gases in accordance with NFPA 55 Section 6.
- Cylinders of corrosive or unstable gases should be returned to the vendor by the expiration date.
- Lecture bottles containing Anhydrous Hydrogen Fluoride (AHF) has the potential to over pressurize over time.
- Carbon steel cylinders containing AHF must not be stored for more than (2) years.

5.1.9 Working with Cryogenic Materials

Cryogenics is the study and use of materials at ultra-low temperatures (less than -150°C), and includes chemicals which are normally gases at room temperature. The following cryogenic materials are used at the Maglab:

1. Liquid Helium
2. Liquid Nitrogen
3. Liquid Argon
4. Liquid Oxygen
5. Dry Ice

Please refer to Safety Procedure: SP4 - CRYOGENIC SAFETY FOR LABORATORY PERSONNEL for additional material on these topics.

- Cryogenic Hazards.
- Cryogen Storage.
- Safe Handling of Cryogens.
- Release or Spill of Cryogens.
- Online Cryogen Safety Training.

5.1.10 Working with Nanomaterials (Nanoparticles):

Nanoparticles are ultrafine particles measuring in one dimension between 1 – 100 nanometers (nm). Nanotechnology comprises the study of processes, applications and materials related to biological, chemical, electronic, physical or engineering applications. In addition to the novel size of nanoparticles or structures, uses are derived from unique properties related to reactivity or conductivity.

Safety Issues

Concerns with safety regarding the use of nanotechnology have arisen primarily from the recognition of several unique attributes of nanoparticles:

- The ultra-small particle size permits the particles to be carried deeply into tissues – particles may be deeply respired into the lungs; may pass through the blood-brain barrier; or translocate between organs.
- The molecular structure of nanoparticles and the relatively greater surface area confer on these particles different chemical reactivities than for larger structures made from the same elements or molecules.
- Some evidence suggests that nanoparticles may be more toxic to tissues than larger molecular structures.
- In addition to concerns about toxicity of nanoparticles that are inhaled, ingested, or absorbed through dermal exposure during initial contact, nanoparticle waste may present a hazard in the environment.
- The widespread use of nanoparticles in research and development for manufacturing and biomedical purposes has outpaced research of safety issues.
- The National Institute of Occupational Health and Safety (NIOSH) and other agencies are currently studying this issue, and improved guidelines for handling and disposal are emerging slowly.

Nanomaterial Handling Requirements:

- Total enclosure of the particle handling process - Nanoparticle stocks that are dry should be handled inside an appropriate chemical hood or glove box.
- Workers should wear personal protective equipment, including safety goggles, lab coats, and gloves if handling or transporting materials.
- Total enclosure of stored stocks of nano-materials must be maintained.
- Contact the NHMFL Safety Department to determine if stocks can be handled outside of a glove box, using local exhaust ventilation with HEPA filtration.
- Nanoparticle solutions, or nanoparticles bound in a matrix or to proteins may be handled on the lab bench like any non-volatile chemical once placed in solution.
- Workers should wear protective equipment, including safety glasses, lab coats, and gloves.
- Transport of nano-materials should employ a sealed secondary containment device.
- Limit access in areas where processes are being carried out.

- Only trained personnel may be permitted to work in these areas while nanomaterials are being used.
- Training procedures and operating procedures must be implemented before beginning work with nano-materials.
- The NHMFL Safety Department will provide postings for laboratories working with nanoparticles.
- Nanoparticle spills should be cleaned immediately using spill mitigation procedures developed by the laboratory.
- Regular cleaning of bench-tops, floors and other surfaces should be implemented; cleaning schedule should be documented.
- Cleaning solution should be compatible with the vehicle in which the nanoparticles are suspended.
- Equipment used for handling of nanoparticles must be evaluated for safety concerns before it may be repaired, reused for other laboratory purposes or released for disposal.
- The use of respirators is not generally required for worker protection when work is performed in a fume hood or glove box.
- If the use of respiratory protection is warranted the use of HEPA filtered respirators for protection against nanoparticle exposure must be evaluated by the NHMFL Safety Department prior to implementation.
- Prohibition of eating and drinking in laboratories and controlled areas.
- To request an evaluation of safety protocols or development of safe handling protocols or cleanup protocols in your research program contact the NHMFL Safety Department at safety@magnet.fsu.edu.
- Remember that waste comprised of organic solvents or other chemicals that may be used in your process must be contained for Hazwaste pickup.
- Contact the Safety Department at safety@magnet.fsu.edu to report any safety concern regarding nanomaterials.

Specific waste management guidance is as follows:

- Paper, wipes, PPE and other items with loose contamination are collected in a plastic bag or other sealable container stored in a laboratory hood.
- Label the container as hazardous waste. The content section of the label must indicate that it contains nano sized particles and indicate what they are .
- Characterize the other hazards of the waste: the disposal requirements for the base materials are considered first when characterizing these materials (If the base material is toxic, such as silver or cadmium, or the carrier is a hazardous waste, such as a flammable solvent or acid, they should be identified).
- Many nanoparticles may also be joined with toxic metals or chemicals.

5.1.11 Chemical Emergencies, Exposures, and Spills

Note: Always contact the safety department at 855-SAFEMAG to report an emergency, chemical exposure or spill.

First Aid Procedures for a Chemical Exposure:

Eye Contact:
If a chemical has been splashed into the eyes, immediately wash the eye and inner surface of the eyelid with copious amounts of water for 15 minutes. Check for and remove any contact lenses at once. Seek medical attention immediately.

Ingestion:
Consult SDS, a chemical first aid manual or call the Florida Poison Information Center: 1-800-222-1222. Follow directions and seek medical attention immediately.

Minor Skin Contact:
Promptly flush the affected area with water and remove any contaminated clothing. If symptoms persist after washing, seek medical attention.

Major Skin Contact:
If chemicals have been spilled over a large area of the body, quickly remove all contaminated clothing while using the shower. Repeat if pain returns. Wash off chemicals by using a mild detergent or soap and water, do not neutralize chemicals or apply salves. Seek medical attention immediately.

Fire:
If clothing is on fire, help the individual to the floor and roll him around to smother the flames. If a safety shower is immediately available, douse the person with water; running to a remote shower will only fan the flame.

Note:
Remember that for some chemicals, such as hydrofluoric acid, effects resulting from exposure may not become apparent until hours or days later. Consult the SDS for any chemical to which someone has been exposed, even if no immediate injury is apparent.

Handling of a Chemical Spill:

COMPLETE THESE STEPS ONLY IF SAFE TO DO SO

- Alert all persons nearby. Acquire assistance, if needed.
- If you understand the properties of the chemical and know how to safely clean it up and the amount spilled is small, proceed with cleaning.
- Wear appropriate PPE, including eye protection, gloves and lab coat and other PPE if needed. Prevent spread of dusts and vapors.
- Neutralize acids and bases if you have an acid/base spill kit. Avoid contact or splashing during neutralization.

- Control the spread of liquid – make a dike around outside edges of the spill. Use absorbent materials such as vermiculite, spill pads or pillows.
- Absorb the liquid – Add absorbents like vermiculite, spill pads or pillows to the spill, working from the edges toward the middle (Special absorbents are required for hydrofluoric and sulfuric acids).
- Gently sweep solid chemicals (do not make airborne).
- Decontaminate the area and equipment with a safe, compatible solution.
- Collect and clean up residues – materials should be placed in a hazardous waste container .provided by the NHMFL Safety Department or in a compatible container.
- Wash hands after cleanup.
- Report spill to supervisor and the NHMFL Safety Department of highly toxic or hazardous chemicals.

IF THE SPILL IS TOO LARGE OR HAZARDOUS TO CLEAN BY YOURSELF OR THERE IS A RISK OF SPREADING INTO THE ENVIRONMENT

- Avoid breathing vapors of the spilled material.
- If safe, extinguish all sources of ignition.
- Evacuate all occupants from the area safely.
- Call the NHMFL Safety Department to report at: 855-SAFEMAG.
- If hazardous conditions develop (toxic vapors, fire or explosion risk), evacuate all occupants and call 911.
- If there is a risk of spreading into the environment, call the NHMFL Safety Department at 855-SAFEMAG for assistance.
- Block drains or doorways if safe to do so, and call the NHMFL Safety Department for assistance.
- For additional assistance call the NHMFL Safety Department at 855-SAFEMAG or FSU EH&S at 644-7682 and 644-6895.

5.1.12 Hazardous Waste

The first step in the disposal of chemical waste is the determination of whether or not it is indeed a hazardous waste. The Environmental Protection Agency (EPA) has instituted waste lists and/or characteristics that can assist in the determination of hazardous waste. You should never place any waste chemical in the trash or dump it down the drain unless you know that it is not a hazardous waste and that it is acceptable for disposal through such means. Introduction of any hazardous chemical into a storm sewer is prohibited.

Hazardous Waste Identification

Hazardous Waste Characteristics:

Ignitability:

- It is a liquid with a flashpoint below 140ºF (e.g.: acetone or gasoline), or
- It is not a liquid and is capable of causing fire through friction, absorption of moisture, or spontaneous chemical changes (e.g.: sodium), or
- It is a compressed ignitable gas (e.g.: acetylene or propane), or
- It is an Oxidizer (e.g.: ammonium nitrate or sodium perchlorate).

Corrosivity:

- It is an aqueous waste with a pH less than or equal to 2 or greater than or equal to 12.5 (e.g.: hydrochloric acid or sodium hydroxide), or
- It is a liquid that corrodes steel at a rate greater than 6.35mm per year (e.g.: stannic chloride or elemental mercury).

Reactivity:

- It is normally unstable and readily undergoes violent changes (e.g.: butyl lithium), or
- Reacts violently with water to evolve flammable or toxic gases (e.g.: potassium or lithium), or
- It is a cyanide or sulfide compound (e.g.: nickel cyanide or sodium sulfide), or
- It is capable of detonation (e.g.: 2,4-Dinitrophenol or TNT).

Toxicity:

- Any waste which contains a contaminant from the "TCLP" list above its specified limit. The contaminants are:

Arsenic	Silver	Methoxychlor
Barium	1,4-Dichlorobenzene	Methyl Ethyl Ketone
Benzene	1,2-Dichloroethane	Nitrobenzene
Cadmium	1,1-Dichloroethylene	Pentachlorophenol
Carbon Tetrachloride	2,4-Dinitrotoluene	Pyridine
Chlordane	Endrin	Selenium
Chlorobenzene	Heptachlor (and its epoxide)	Tetrachloroethylene
Chloroform	Hexachlorobenzene	Toxaphene
Chromium	Hexachlorobutadiene	Trichloroethylene
o-Cresol	Hexachloroethane	2,4,5-Trichlorophenol
m-Cresol	Lead	2,4,6-Trichlorophenol
p-Cresol	Lindane	2,4,5-TP (Silvex)
Cresol	Mercury	Vinyl Chloride

Listed Hazardous Wastes

There are four different lists depending on the type of waste produced. For a more complete listing view the EPA Hazardous Waste Listings.

F List: These are spent wastes generated from non-specific sources (e.g.: spent non-halogenated or halogenated solvents).

K List: These are spent wastes generated from specific sources.

P List: These are acutely hazardous unused chemicals. These chemicals are typically highly toxic. (e.g.: osmium tetroxide or phosgene).

U List: These are unused hazardous chemicals (e.g.: cacodylic acid or phenol).

Chemical Waste Containers

The Maglab has the following requirements for chemical waste containers in accordance with Florida Statutes under the Florida Department of Environmental Protection (FDEP):

- Labeling: The label must contain a list of chemicals and the words "Hazardous Waste".
- Packaging: The chemical waste container must have a cap in place at all times, except when actively filling or discharging the bottle or can.
- For particularly hazardous chemicals, place the primary, chemical container into a secondary container for additional protection.
- Flip-top funnel waste containers must be latched closed.
- Storage: The chemical waste must be properly packaged and stored in an appropriate “satellite accumulation area”.
- Hazardous waste that is not properly packaged and labeled cannot be removed by NHMFL Safety staff.

Satellite Accumulation Area (SAA)

- A satellite accumulation area is a storage location at or near any point of generation where hazardous wastes initially accumulate, which is under the control of the operator of the process generating the waste [40 CFR 262.34(c)(1)].

- Federal regulatory requirements applicable to satellite accumulation areas specify that up to 55 gallons of non-acutely hazardous waste or one quart of acutely hazardous waste may accumulate and be stored in a satellite area.

- Do not accumulate more than 55 gallons of waste (or 1 quart of acutely hazardous waste) at any one time at a SAA.

Chemical Waste Disposal and Pickups

Chemical waste pickups can be arranged by e-mailing the NHMFL Safety Department at: safety@magnet.fsu.edu.

Waste Reduction

By law, the University is required to strive to reduce the amount of hazardous waste it generates; therefore, the Maglab should take the following measures:

- Buy only those amounts of hazardous materials that can be used before the expiration date of the material.

- Use up the hazardous material by using it for the purpose for which it is intended.

- Determine if someone else in the lab has a legitimate need for, and can use, the product.

5.2.0 CONTROL MEASURES: REDUCING CHEMICAL EXPOSURE

Safe work with hazardous chemicals can only be accomplished through the use of proper control measures. Proper control measures include the use of engineering controls, personal protective equipment, proper storage and handling of chemicals, and proper use and maintenance of safety equipment. Use of proper control measures reduces the risk of employee exposure to hazardous chemicals. Particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous.

5.2.1 Engineering Controls:

Ventilation is the most common and most important form of engineering control used to reduce exposures to hazardous chemicals. There are two types of ventilation: general ventilation and local exhaust.

- General Ventilation:

General ventilation for laboratory operations should be designed such that the laboratory is under a slightly negative pressure relative to other parts of the building. This prevents odors and vapors from leaving the lab. Ideal Lab ventilation should be 6 to 8 room air changes per hour. It should be noted that this rate will not necessarily prevent the accumulation of chemical vapors in "dead spots" or "eddies," which should be minimized during the design of the laboratory.

- Local Exhaust:

Local exhaust ventilation, like that provided by a chemical fume hood, is the recommended method for reducing employee exposures to hazardous dusts, fumes and vapors. Also, with the hood sash closed or lowered to an appropriate working level, the hood can provide some protection from chemical splashes and fires. The maximum working level of the hood sash is identified by a yellow sticker to the left of the hood opening; the sticker contains the maximum working height, hood face velocity, date of inspection and the inspectors' initials. The fume hoods are certified annually. If there are problems with the hood the NHMFL Safety Department should be notified. A hood is not designed to withstand explosions but can provide some limited protection. When using a fume hood, always keep your work at least 6 inches inside the hood face. This simple step can reduce vapor concentrations at the face of the hood by as much as 90 percent. Reference section 5.3.0 titled "Fume Hood Performance" for more information on hood usage.

5.2.2 Personal Protective Equipment:

The purpose of requiring Personal Protective Equipment at the Maglab is to protect employees from work place hazards and the risk of injury through the use of personal protective equipment (PPE). PPE is not a substitute for more effective control methods and its use will be considered only when other means of protection against hazards are not adequate or feasible. It will be used in conjunction with other controls unless no other means of hazard control exist.

Safety glasses, disposable gloves, laboratory coats and other protective clothing are standard for routine laboratory activities when working with hazardous materials. Laboratories must also provide personal protective equipment (i.e. safety glasses, laboratory coat) for visitors and post signs indicating what PPE is required where hazardous materials are in use.

The NHMFL Safety Department will assist with recommendations on the following specific types and uses of protective equipment.

Gloves:

Gloves should be carefully selected for their degradation and permeation characteristics to provide proper protection. The thin, latex, vinyl, or nitrile gloves, popular for their dexterity, are not appropriate for highly toxic chemicals or solvents. When using chemicals, consult the chemical compatibility information that is provided in the Safety Data Sheet (SDS) or manufacturer's catalogs to help select proper gloves. Gloves should be replaced immediately if they are contaminated or torn. If using extremely hazardous chemicals, double disposable gloves or special materials gloves are recommended.

The following Internet links are manufacturers that may supply gloves to laboratories at the Maglab. These links contain chemical compatibility charts for the gloves supplied by each specific manufacturer. It is recommended that users select the glove that will offer the best protection for the specific chemical that is being handled. Please note that similar gloves supplied by different companies may not offer the same level of protection, therefore it is important that the compatibility chart for the manufacturer of the glove being used be referenced.

Regardless of glove selection, it is imperative that the user be aware that many factors affect the breakthrough times of glove materials including, but not limited to:

- Thickness of glove material.
- Concentration of the chemical worked with.
- Amount of chemical the glove comes in contact with.
- Length of time which the glove is exposed to the chemical.
- Temperature at which the work is done.
- Possibility of abrasion or puncture.

Chemrest

Ansell Edmont

Microflex

Kimberly-Clark

Eye and Face Protection:

Eye and face protection must be worn in the laboratory when there is a potential for contact with hazardous chemicals or other agents (e.g. non- ionizing radiation, biohazardous materials, aerosolized material, flying objects.). Please note that all protective eye and face wear should meet ANSI Z87.1-1998 and ANSI Z136.1-2000 standards.

The type of protection needed depends on the hazard (e.g. chemical, ultraviolet light, laser, impact). For instance, when laboratory chemicals are used, approved eye protection is mandatory and chemical splash goggles are recommended. Ordinary prescription glasses do not meet these standards. Face shields should be worn when working with an agent that may adversely affect the skin on the face and/or when proper eye protection is not enough. Face shields are not a substitute for safety goggles or glasses. When using a face shield protective eyewear must still be worn. Safety glasses that fit over prescription glasses may be used where dusts or flying particulates are present. Goggles or a face shields is recommended for those workers wearing contact lenses.

Eye, skin and face protection are required when working with severely corrosive or strongly reactive chemicals, with glassware under extreme pressures, in combustion and other high temperature operations and whenever there is a possibility of an explosion or implosion. Special safety glasses and face shields may be required for work with UV light and lasers (see SP-21 LASER SAFETY PROCEDURE).

Body Protection including Laboratory Coats and Other Protective Clothing:

Employees may be required to wear additional clothing to protect their body from work place hazards and exposures. Many types and forms of clothing exist to give employees additional protection from work place hazards. Therefore, it is important to select protective clothing based on the type of hazard and/or tasks performed in the work area.

Laboratory coats and shoes must be worn when performing laboratory work when working with hazardous materials (open toed-shoes, sandals, flip-flops, clogs, crocs, etc. are prohibited). Depending on the type of work, additional personal protective equipment, such as gloves or clothing for thermal protection, face shields, or aprons may be necessary. Appropriate PPE for laboratory work must be worn to address all anticipated hazards. Laboratory coats and other protective clothing are essential for protection from chemical splashes and splatters, or contamination with radioactive or biohazardous agents. Long sleeved, full-length lab coats or gowns should be worn to protect skin and street clothing from contamination. All protective coats should adequately protect from the hazardous agents used. In general, coats made of 100% cotton are utilized for work with flammable/combustible liquids, radioactive materials, biological agents and mildly corrosive substances. Flame retardant laboratory coats must be worn for work with pyrophoric chemicals (for example Nomex, Indura, Excel) Aprons, corrosives-resistance coats, or additional protection may be required for work with concentrated corrosives or toxic chemicals.

Respiratory Protection:

If respirator use is being considered, the first step is to contact the NHMFL Safety Department so a hazard evaluation can be conducted and an appropriate respirator selected, if necessary. If after a hazard evaluation, safety determines use of a respirator is warranted the procedures outlined in the FSU Respiratory Program must be followed. Periodic medical monitoring, specific training, and fit testing are required. To provide proper protection, respirators must be the right type, must be worn correctly at all times, and must be maintained properly.

Go to the FSU Respiratory Program site for more information.

In most instances respirators will not be needed if adequate engineering and administrative controls are applied. Properly operating laboratory fume hoods and glove boxes provide the best overall protection from chemical or other airborne hazards in the laboratory. Respirators are generally discouraged as a primary means of protection because they protect only the wearer, they are prone to leakage, depend heavily on the behaviors of individual users and require maintenance and management oversight. This is why they are considered the least favored option to protect employees from airborne hazards.

5.2.3 Safety Equipment:

The following safety items shall be readily available or easily accessible to all laboratories:

- Fire Extinguishers.
- Eyewash/Safety Showers.
- First Aid Kits.
- Laboratory posting with listed hazards and emergency numbers.

All laboratory personnel need to know the location and how to use their safety equipment. All safety equipment needs to be unobstructed and operational at all times.

Fire Extinguishers and eyewash/safety showers are inspected annually by FSU Fire Techs and NHMFL Safety Department personnel. Discharged, overcharged, or missing fire extinguishers need to be reported, immediately, to the NHMFL Safety Department. Malfunctioning eyewash/safety showers and fume hoods are to be reported immediately to the NHMFL Safety Department. Laboratory operations should be restricted until safety equipment is repaired; no chemical work is to be performed in a malfunctioning fume hood.

Other control measures may be used to reduce the risk of employee exposure to hazardous materials and chemicals. Some of these control measures are:

Glove Boxes

Glove boxes are ideal for work with particularly hazardous substances including select carcinogens, reproductive toxins, air reactive chemicals and substances which have a high degree of acute or chronic toxicity. When correctly used, these units prevent vapors, gases and particulates from escaping into the laboratory.

Gas Cabinets

Toxic gases with NFPA health hazard ratings >3 (or >2 if they have no physiological warning properties) and pyrophoric gases above specified concentration or quantity thresholds are required to be stored in an approved gas storage cabinets in accordance with NFPA 45.

Enclosures must meet the following minimum requirements:

- Gas cabinets operate at a negative pressure in relation to surrounding areas.
- Have self-closing limited access ports.
- Have non-combustible windows to give access to equipment controls.
- Provide an average velocity at the face of access ports or windows of not less than 200 feet per minute with a minimum of 150 feet per minute.
- Must be connected to an exhaust system.
- Have self-closing doors.
- Must be constructed of not less than 12 gauge steel.

Biological Safety Cabinets

Biological Safety Cabinets (BSC) are designed to provide personnel, environmental, and product protection when appropriate microbiological practices and procedures are followed. There are three classes of BSCs (I, II, III). The Maglab only uses classes I and II for research and clinical needs.

Class I

The Class I BSC provides personnel and environmental protection, but no product protection. It is similar in terms of air movement to a chemical fume hood, but has a HEPA filter in the exhaust system to protect the environment. Unfiltered room air is drawn in through the work opening and

across the work surface. Personnel protection is provided by this inward airflow as long as a minimum velocity of 75 linear feet per minute (lfpm) is maintained.

Class II

The Class II (Types A1, A2, B1 and B2) BSCs provide personnel, environmental and product protection. Airflow is drawn into the work opening, providing personnel protection and downward flow of HEPA-filtered air also provides product protection by minimizing the chance of cross-contamination across the work surface of the cabinet.

Class II cabinets are designed for work involving microorganisms assigned to any of the four biosafety levels, though BSL-4. Biosafety levels at the Maglab do not exceed the BSL-2 category.

Class II BSCs have HEPA filters that are effective at trapping particulates effectively removing all potentially infectious agents but they do not capture volatile chemicals or gases. The BSC exhaust air may be recirculated back to the laboratory.

Laminar Flow Devices

A laminar flow cabinet, also known as a clean bench, is a partially enclosed device designed to prevent particle contamination of biological samples or other sensitive media. These devices exist in many different types, configurations, airflow patterns and are built for a variety of uses. They are similar in appearance to Biological Safety Cabinets but these afford no protection to personnel as air is drawn through a HEPA filter and blown in a very smooth, laminar flow towards the user. Since users must sit directly in the exhaust from the clean bench this equipment must never be used for the handling of toxic, infectious or sensitizing materials, including toxic chemicals and hazardous materials.

Flexible Exhaust Ducting

This includes snorkels, spot ventilation, fume extractors, and similar devices.

The laboratory version of these types of devices is comprised of flexible or articulating ductwork that is connected to the general laboratory exhaust system. These generally have isolation valves, so that they can be shut off when not in use, located near a rigid open end intake. To ensure adequate capture efficiency, the point of discharge must be placed near the center of the duct intake, and have a flow rate/velocity that is less than 70 - 90 percent of that of the exhaust device.

HEPA Filters

High efficiency particulate air (HEPA) is a term that is used to describe a filter's ability to remove 99.97% particles exceeding 0.3 micron diameter particles. HEPA filters are also used for filter protection against particles smaller than 0.3 microns, including nanomaterials. The adequacy of the use of HEPA filtering systems for a particular application must be verified, especially when working with particularly hazardous materials. Temporary and portable products such as dust masks or vacuum cleaners can legally claim that they contain HEPA filters but this is very loosely defined and regulated. The level of afforded protection potentially offered by these product designations should not be relied upon without independent verification and certification, especially for permanently installed systems where these filters will be depended on to control actual hazards.

5.3.0 FUME HOOD PERFORMANCE

5.3.1 Yearly Certifications

- The NHMFL Safety Department certifies chemical fume hoods annually to ensure that they are functioning properly. Each hood will be marked with maximum sash height that provides adequate face velocity across the hood opening.
- Biological Safety Cabinets will be certified by appropriately trained and competent external vendors. Biological Safety Cabinets to be used with "Class 2" organisms must be certified prior to use.

5.3.2 Inspections by Users

- Users must ensure that fume hoods are working before using them.
- All fume hoods should be equipped with a low airflow alarm to detect hood malfunctions.
- If the low air flow alarm malfunctions a small piece of tissue paper can be taped to the sash to indicate the presence of airflow; however, this should not be relied on as a measure of adequate airflow.
- Ensure that such hoods are not operated at sash heights above those marked by the NHMFL Safety Department.
- Do not use a hood if the inspection label is missing or out-of-date (more than 1 year since last inspection).

5.3.3 Hood Failures

- For a variety of reasons: electrical problems, service, mechanical problems, or maintenance; fume hoods may malfunction..
- If a fume hood malfunctions secure chemicals and shut down operations. Then close the sash and report it to the Maglab Facilities using the facilitates work order page and Safety Department safety@magnet.fsu.edu.

- If a hazardous condition exists in a malfunctioning fume hood, close the sash and call the NHMFL Safety Department.
- Place a warning sign on the hood to prevent others from using it until it is repaired and re-certified by the NHMFL Safety Department to ensure the unit is working properly.
- In the event of scheduled maintenance or service, where the power is to be disrupted, the NHMFL Safety Department shall notify the affected laboratories.
- Notification should include the work schedule and how long the hood will be inoperative.

5.4.0 EMPLOYEE INFORMATION AND TRAINING

5.4.1 Training

Any employee, user, visitor, or contractor who works with, or is potentially exposed to, a hazardous material or chemical will receive training on the Hazard Communication Standard and the Florida Right-to-Know Act under the requirements of this procedure. The training program will be administered by the Safety Department and will consist of an online training module, classroom instruction, or hands-on training. The training will be presented to employees upon initial assignment to a work area where there are known hazards, and refresher training will be provided annually or when new hazards are introduced to the work environment. The NHMFL Safety Department shall provide this training and any other assistance in meeting the requirements of this procedure. The training program will emphasize these items:

- Summary of the requirements of the Hazard Communication Standard, the Right-to-Know Act and this procedure.
- How to obtain, read, and understand the information on a Safety Data Sheet.
- The proper labeling requirements for containers.
- Chemical and physical properties of hazardous material (e.g., flashpoint, reactivity) and methods that can be used to detect the presence or release of chemicals.
- The proper use of personal protective equipment (PPE) and devices designed to protect the worker from hazards.
- Methods to mitigate chemical emergencies, exposures and spills.
- How to safely transport hazardous chemicals and materials.

The NHMFL Safety Department shall review the employee training programs and advise all managers and supervisors of training and retraining of personnel.

5.4.2 **Safety Data Sheets**

The Safety Data Sheet is a general summary of safety information for a hazardous substance or material. The Occupational Safety and Health Administration (OSHA) require manufacturers and importers of hazardous chemicals and materials to develop an SDS for materials they provide to their customers. The SDS must include the chemical and common names of all ingredients that have been determined to be health hazards if they constitute 1% or greater of the product's

composition (0.1% for carcinogens). The SDS typically includes information about a chemical's toxicity, health hazards, physical properties, fire and reactivity data, as well as storage, spill and handling precautions. Safety Data Sheets can be found at FSU Safety Data Sheet Online Database, through your chemical vendor or by request from the NHMFL Safety Department.

Users should always avoid any unnecessary chemical exposures and should never rely solely on SDS sheets to understand how to protect themselves from specific chemical.

5.4.3 **Lab Safety Hazwaste Training**

Lab Safety Hazwaste Training is required for all new personnel working with or around hazardous chemicals or materials. This online course is also required if your scope of work changes and you start working with hazardous chemicals or materials. All Maglab affiliated employees will be asked to take an assessment every two years or when they change position.

Hazwaste Refresher Training is required annually.

5.4.4 **Hazard Communication Training**

Hazard Communication Training provides general information concerning employee rights on hazardous chemicals or materials in their work area. If a NHMFL employee works with or around hazardous chemicals or materials it will also cover physical and health hazards of hazardous chemicals or materials, signs and symptoms of exposure and measures that employees can take to protect themselves. This training is part of the following courses:

- General Safety Training.
- Lab Safety Hazwaste Training.
- Hazwaste Refresher Training.

5.5.0 REQUIREMENTS FOR PRIOR APPROVAL OF MAGLAB ACTIVITIES

In order to protect the health and safety of Maglab employees, building occupants, and the community at large; certain laboratory activities will require prior approval from a designated approval point before work can begin.

Work tasks must be evaluated using Integrated Safety Management (ISM) to determine how the work should proceed. Scope of work determined to fall in the Low-Medium or above risk requires a second worker to be present. This includes all work with hazardous chemicals or materials The NHMFL Safety Department must be consulted before work begins if the risk is Medium or higher.

Refer to APPENDIX A for ISM risk assessment.

Activity	**Approval Point**
ISM Risk Level Low-Med	Principal Investigator/Lab Manager
ISM Risk Level Medium	The NHMFL Safety Department
ISM Risk Level Med-High	NHMFL Director or Designee
ISM Risk Level High	Approval will not be given at any point
Radiological Material	FSU EH&S Radiation Safety Office
Lasers	Maglab Laser Safety Committee
Human/Primate blood, tissues, human, animal and plant pathogens and recombinant DNA.	FSU EH&S
Laboratory Animals	ISM Dictates Approval Point
New experimental protocol procedures	ISM Dictates Approval Point
Change(s) to existing protocol, scope or procedures.	ISM Dictates Approval Point
Unattended operations	ISM Dictates Approval Point
Working alone in lab after hours	ISM Dictates Approval Point

5.6.0 MEDICAL CONSULTATION AND EXAMS

Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed at the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.

Whenever an event takes place in the work area such as a spill, leak, over-pressurization or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

All consultations/examinations will be conducted or supervised by a licensed physician. These consultations and/or examinations will be provided to the employee at no cost. The consultation or examination must be at a University approved medical facility.

In cases where laboratory employees seek medical attention for possible overexposure to hazardous chemicals, the Principal Investigator, supervisor, or Lab Manager must provide the following information to the attending physician:

- The identity of the hazardous chemical(s) to which the employee may have been exposed;
- A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and
- A description of the signs and symptoms of exposure that the employee is experiencing, if any.

If at all possible, a copy of the Safety Data Sheet(s) for the chemical(s) involved should also be given to the physician.

Principal Investigators, supervisors, Lab Managers, or other responsible parties must notify the NHMFL Safety Department of all cases of possible overexposure to hazardous chemicals. The NHMFL Safety Department will then conduct an exposure assessment and collect all relevant information regarding the situation. All incidents of overexposure must be fully documented.

For any consultation/examination provided under this program, the person responsible for the employee must ensure that the attending physician provides a written opinion regarding the case to the NHMFL Safety Department and FSU EH&S. The written opinion must include the following:

- Any recommendation for further medical follow-up;
- The results of the medical examination and any associated tests;
- Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace; and
- A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

The written opinion must not reveal specific findings or diagnoses that are unrelated to the occupational exposure.

Reference Laboratory Accidents and Injuries for more information on both Workers' Compensation and Injury Reporting.

5.7.0 RESPONSIBILITIES UNDER THE CHEMICAL HYGIENE PLAN

An Environmental Health and Safety Professional shall be designated as the Chemical Hygiene Officer for the National High Magnetic Field Laboratory. Proper qualifications for this individual are very important and should include a background in chemistry and safety.

The Chemical Hygiene Officer (CHO) will be responsible for working with administrators, managers, principal investigators and other employees to develop and implement appropriate chemical hygiene policies and practices.

The CHO will work with administrators, managers, principal investigators and other employees to ensure that Maglab employees know and follow the chemical hygiene rules, that protective equipment is available and in working order, and that appropriate training has been provided.

The CHO will perform regular, formal chemical hygiene and housekeeping inspections.

The CHO will chair the Chemical Hygiene Sub-Committee. The sub-committee will be responsible for:

- Providing continuing support for institutional chemical hygiene.
- Ensuring that OSHA standards are met and that the chemical hygiene program is being followed.
- Ensuring chemical health and safety in the laboratory is maintained.
- Discussing and updating the chemical hygiene program when necessary.

5.8.0 SPECIAL PRECAUTIONS FOR WORK WITH PARTICULARLY HAZARDOUS SUBSTANCES

5.8.1 Working with Particularly Hazardous Materials

The NHMFL Chemical Safety Plan requires provisions for additional employee protection be included for work involving particularly hazardous substances. These substances include “select carcinogens”, reproductive toxins, and substances which have a high degree of acute toxicity.

The OSHA Lab Standard states that for work involving particularly hazardous substances, specific consideration must be given to the following provisions where appropriate:

- Establishment of a designated area and use of containment devices such as fume hoods or glove boxes.
- Procedures for decontamination and safe removal of contaminated waste.
- Establish guidelines for working with particularly hazardous materials.
- Circumstances that require prior approval and provisions that may include additional employee protection.

The NHMFL Safety Department can assist researchers by providing information on working with particularly hazardous substances. General guidelines and recommendations for the safe handling, use, and control of hazardous chemicals and particularly hazardous substances can be found in Safety Data Sheets and other references such as Prudent Practices in the Laboratory and Safety in Academic Chemical Laboratories.

A partial list of particularly hazardous chemicals can be found at OSHA "particularly hazardous substances" list. In the research laboratory, it is possible that researchers may work with particularly hazardous chemicals that have not been defined as such through OSHA or NIOSH. If products Maglab personnel are working with have the characteristics of select carcinogens, reproductive toxins, or substances with a high degree of acute toxicity, those products should be treated with the same level of responsibility by personnel.

Establishment of a Designated Area:

For work involving particularly hazardous substances, laboratories should establish a designated area where particularly hazardous substances can only be used. In some cases, a designated area could be an entire room out of a suite of rooms, or could mean one particular fume hood within a lab. The idea is to designate one area so that everyone in the Maglab is aware of where the particularly hazardous substances can only be used.

In establishing designated areas, Principal Investigators and Maglab supervisors should restrict the use of a particularly hazardous substance to a fume hood, glove box or other containment device.

Establishing a designated area not only provides better employee protection, but can help minimize the area where potential contamination of particularly hazardous substances could occur. Once a designated area is established, a sign should be posted (on a fume hood for example) indicating that the area is designated for use with particularly hazardous substances and naming the substance(s). Special PPE requirements and/or special waste and spill cleanup procedures should be posted or documented. Once the experiment has ended, decontamination should be implemented before removing the posting.

Decontamination & Safe Removal of Contaminated Materials and Waste:

Some particularly hazardous substances may require special procedures for safe disposal of both waste and/or contaminated materials. Appropriate decontamination methods (while wearing PPE) should be employed after chemical use. When in doubt, contact the NHMFL Safety Department to determine proper decontamination and disposal procedures. These methods should be included as part of the lab's procedures and everyone working in the lab should be trained on those procedures.

Best Practices for Working with Particularly Hazardous Materials:

Maglab staff should always practice good housekeeping, use engineering controls, wear proper PPE, develop and follow their procedures, and receive appropriate training when working with any of these chemicals. The following special guidelines should be adhered to when working with particularly hazardous substances:

- Substitute less hazardous chemicals if possible to avoid working with particularly hazardous substances and keep exposures to a minimum.
- Always obtain prior approval from the Principal Investigator, supervisor or lab manager before ordering any particularly hazardous substances.
- Review the use of these materials with the research supervisor. Identify potential routes of exposure and identify containment and protective measures, including the use of a fume hood or glove box, and the use of appropriate PPE.
- Review emergency response procedures for spills or chemical exposures.
- Review whenever a procedural change is made.
- Plan your experiment in advance, including layout of apparatus and chemical and waste containers that are necessary.
- Ensure that you have the appropriate PPE; particularly gloves (check glove selection charts or contact the NHMFL Safety Department. PPE should include gloves, a lab coat and safety goggles.
- Always wash hands after chemical use.
- Always use the minimum quantities of chemicals necessary for the experiment.
- If possible, purchase premade solutions to avoid handling powders. If you have to use powders, weigh them in a fume hood or glove box.

- Always use a fume hood or other containment device for procedures that may result in the generation of aerosols, vapors or particulates.
- Confirm that the fume hood is functioning properly before use.
- Particularly hazardous substances should be stored by themselves in clearly marked trays or secondary containers indicating what the hazard is i.e. “Carcinogens,” Reproductive Toxins”, etc.
- Do not work alone with chemicals of high acute toxicity (examples include cyanide and hydrofluoric acid.
- Always practice good personal hygiene, especially frequent hand washing, even if wearing gloves while handling chemicals.
- If a major spill occurs outside a fume hood or glove box, evacuate the area and contact the NHMFL Safety Department.
- Contact the NHMFL Safety Department for proper disposal instructions. Store contaminated waste in closed, properly labeled impervious containers.
- Store waste containers in such a manner that they will not break (use compatible absorbent materials or secondary containers).
- Notify the supervisor or any incidents of exposure or spills.

Circumstances that require prior approval and provisions that may include additional employee protection:

The OSHA lab Standard requires Chemical Hygiene Plans to include information on “the circumstances under which a particular lab operation, procedure or activity shall require prior approval”, including “provisions for additional employee protection for work with particularly hazardous substances” such as "select carcinogens," reproductive toxins, and substances which have a high degree of acute toxicity. Prior approval ensures that Maglab workers have received the proper training on the hazards of particularly hazardous substances or with new equipment, and that safety considerations have been taken into account BEFORE a new operations begins.

While the NHMFL Safety Department can provide assistance in identifying circumstances when there should be prior approval before implementation of a particular Maglab operation, the ultimate responsibility of establishing prior approval procedures lies with the Principal Investigator or supervisor and the implementation of the ISM process:

Refer to 4.0 Integrated Safety Management (ISM):

All Maglab employees that work with hazardous chemicals or materials must assess the risk hazard of their processes before work can proceed.

Principal Investigators or supervisors must identify operations or experiments that involve particularly hazardous substances (such as "select carcinogens," reproductive toxins, and substances which have a high degree of acute toxicity) and highly hazardous operations or equipment that require prior approval. They must establish the guidelines, procedures, and approval process that would be required.

Examples where Principal Investigators or supervisors should consider requiring their workers to obtain prior approval include:

- Experiments that require the use of particularly hazardous substances such as "select carcinogens," reproductive toxins, and substances that have a high degree of acute toxicity, highly toxic gases, cryogenic materials and other highly hazardous chemicals or experiments involving radioactive materials, high powered lasers, etc.
- Where a significant change is planned for the amount of chemicals to be used for a routine experiment such as an increase of 10% or greater in the quantity of chemicals normally used.
- When a new piece of equipment is brought into the lab that requires special training in addition to the normal training provided to Maglab workers.
- When a Maglab worker is planning an experiment that involves highly hazardous chemicals or operations.

5.8.2 Working with Highly Reactive Chemicals

Highly reactive chemicals are inherently unstable and can react in an uncontrolled manner to liberate heat, toxic gases or explosion. These include shock sensitive chemicals, high-energy oxidizers and peroxide forming chemicals. Before working with these materials, safety information should be reviewed to evaluate proper storage and handling procedures. In addition to common chemical handling guidelines, the following procedures are recommended:

- Use a chemical fume hood with the sash or other containment/exhaust, for all reactions;
- Secure reaction equipment properly.
- Use impact protection (shields and guards) in addition to chemical splash protection (i.e. eye protection, face shields, gloves, and laboratory coats).
- Handle shock-sensitive chemicals gently to avoid friction, grinding and impact.
- Dispose of reagents with suspect purity and age.

5.8.3 Working with Chemicals of High Acute Toxicity, including Carcinogens

Certain chemicals have been identified as causing acute health effects or long-term chronic health effects. Substances of high acute toxicity cause immediate health effects at very low concentrations.

The following are definitions of toxicity for ingested chemicals:

- Moderately toxic: LD50 of 500-5,000 mg/kg.
- Very toxic: LD50 of 50-500 mg/kg.
- Extremely toxic: LD50 of 5-50mg/kg.
- Super toxic: LD50 <5mg/kg.

Substances that have high chronic toxicity cause damage after repeated exposure over a period of time. These may include carcinogens, reproductive toxins, mutagens, teratogens and sensitizers (see Reproductive Hazards, Teratogenic Agents and Pregnancy for other resources). Maglab personnel (male and female), especially those of childbearing age, should be notified of any reproductive toxins being used in the lab. Any employee who is pregnant or planning to become pregnant should contact the NHMFL Safety Department and a personal physician to assess potential exposures.

Handling Highly Toxic & Carcinogenic Chemicals

Because chemicals with high acute toxicity and those with high chronic toxicity are hazardous at very low concentrations, the following practices must be observed:

- Notify all employees of the particular hazards associated with this work.
- Minimize contact with these chemicals by any route of exposure (inhalation, skin contact, mucous membrane contact or injection).
- Work only in a properly operating chemical fume hood or glove box.
- Decontaminate work surfaces after completing procedures.
- Remove all protective clothing before leaving the area and decontaminate it or if disposable, place it in a plastic bag, label and secure it.
- Wash hands and any exposed skin before exiting the work area.
- Establish an emergency plan for procedures involving highly toxic chemicals.
- Do not conduct normal laboratory work in the designated area until decontaminated.

5.8.4 Working with Chemicals that are Reproductive Hazards

Substances or agents that affect the reproductive health of women or men or the ability of couples to have healthy children are called reproductive hazards. A teratogen is a substance which interferes with embryonic or fetal development and women of child bearing potential should take care to avoid exposure. A fetotoxin is a substance that can poison or cause degenerative effects in a developing fetus or embryo.

A reproductive hazard may cause one or more health effects, depending on the time and duration of the exposure. For example, exposure to harmful substances during the first 3 months of pregnancy may cause a birth defect or a miscarriage. During the last 6 months of pregnancy, exposure to reproductive hazards could slow the growth of the fetus, affect the development of its brain, or cause premature labor.

Reproductive hazards may not affect every person or every pregnancy in the same way. Whether a woman or fetus is harmed depends on how much of the hazard they are exposed to, when they are exposed, how long they are exposed, and how they are exposed.

Principal Investigators and supervisors are responsible for training and instructing Maglab personnel in the appropriate ways to protect themselves from the hazards. Students, employees,

users and visitors are responsible for learning about the hazards in their workplace, using personal protective equipment, and following proper work practices. Employees, students, users and visitors should take the following steps to ensure their own safety:

- Review the SDS and other resources for each hazardous chemicals used at the laboratory to become familiar with any reproductive hazards.
- Guests and Visitors who will not be working in the lab should be accompanied/supervised by a trained laboratory worker.
- Restrict access to area where chemicals are being used.
- Store chemicals that are reproductive hazards in sealed containers when they are not in use.
- Wash hands after contacting hazardous substances and before eating, drinking, or smoking.
- Avoid skin contact with chemicals.
- If chemicals contact the skin, follow the directions for washing and decontamination as described in the safety data sheets (SDS) and other resources.
- Use personal protective equipment (e.g., gloves, lab coat, and personal protective clothing) to reduce exposures to workplace hazards.
- Follow appropriate work practices and procedures to prevent exposures to reproductive hazards.
- Consult a health care provider with any concerns about reproductive hazards in the workplace.
- Participate in all relevant safety and health education, training, and monitoring programs offered by FSU.
- Discuss proper work practices with the PI, laboratory supervisor or contact the NHMFL Safety Department.

- **5.8.5 Working with Hydrofluoric Acid (Refer to APPENDIX C)**

7.0 APPENDIX

APPENDIX A: INTEGRATED SAFETY MANAGEMENT SYSTEM

All MagLab employees that work with hazardous chemicals or materials:

Work tasks must be evaluated using Integrated Safety Management (ISM) to determine how the work should proceed. Hazardous chemical and material use determined to fall in the Low-Medium or above risk requires a second worker to be present. The NHMFL Safety Department must be consulted before work begins if the risk is Medium or higher.

Specific requirements are defined below:

The ISM Process:

1. **Define the Scope**
2. **Analyze the hazards**
3. **Develop and implement hazard controls**
4. **Perform work within the controls**
5. **Feedback and improvements**

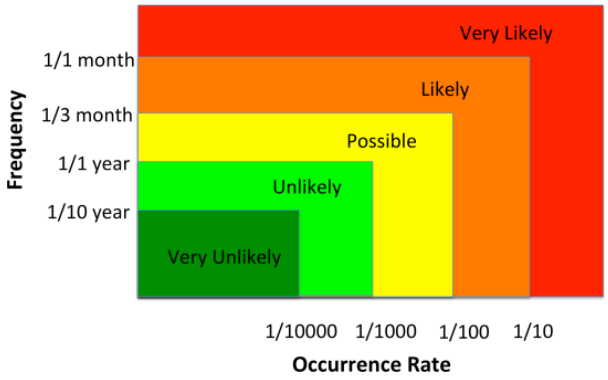
		Consequences				
		A	B	C	D	E
Likelihood		Negligible	Minor	Moderate	Significant	Severe
E	Very Likely	Low Med	Medium	Med Hi	High	High
D	Likely	Low	Low Med	Medium	Med Hi	High
C	Possible	Low	Low Med	Medium	Med Hi	Med Hi
B	Unlikely	Low	Low Med	Low Med	Medium	Med Hi
A	Very Unlikely	Low	Low	Low Med	Medium	Medium

Consequences, in a worst case scenario if something goes wrong:

A. Negligible: minor injury resulting in basic first aid treatment that can be provided on site.
B. Minor: minor injury resulting in advanced first aid treatment administered by a physician.
C. Moderate: injuries that require treatment above first aid but do not require hospitalization.
D. Significant: Severe injuries and hospitalization.
E. Severe: Death or permanent disability.

Likelihood, whichever is the greater risk (see graphic):

A. Very Unlikely: less than once in a ten thousand times (<0.01%) and less frequently than once per 10 years.
B. Unlikely: less than once in a thousand times (<0.1% of the time) and less frequently than once per year.
C. Possible: less than once in a hundred times (<1% of the time) and less frequently than once per 3 months.
D. Likely: less than once in ten times (<10% of the time) and less than once per month.
E. Very likely: more than once in ten times and more frequently than once per month.



Residual risk categories <u>after all controls are in place</u> define how the work will proceed:

A. **Low**: proceed using ISM
B. **Low Medium**: proceed with caution using ISM. A second worker is in the vicinity.
C. **Medium**: Seek guidance from Safety Department before proceeding. Two authorized workers must be in place before work can proceed. Limited number of authorized workers as maintained by the Safety Department.
D. **Medium High**: Seek guidance from Safety Department before proceeding. Two authorized workers must be in place before work can proceed. Limited number of authorized workers as maintained by the Safety Department. Work can only proceed if authorized by the Director or his designee.
E. **High**: Work will not be performed.

APPENDIX B: **29 CFR 1910.1450 - OCCUPATIONAL EXPOSURE TO HAZARDOUS CHEMICALS IN LABORATORIES Part (e) CHEMICAL HYGIENE PLAN**

The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection;

5.1 **Handling Toxic Chemicals:** Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals.

5.2 **Reducing Chemical Exposure:** Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous.

5.3 **Fume Hood Performance:** A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment.

5.4 **Training:** Provisions for employee information and training: The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area. Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.

5.5 **Prior Approval -- using ISM process:** The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation.

5.6 **Medical**: Provisions for medical consultation and medical examinations: The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary.

5.7 **Chemical Hygiene Officer and Committee Responsibilities:** Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer, and, if appropriate, establishment of a Chemical Hygiene Committee. The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

5.8 Particularly Hazardous Substances: Provisions for additional employee protection for work with particularly hazardous substances. These include select carcinogens, reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:

a. Establishment of a designated area;
b. Use of containment devices such as fume hoods or glove boxes;
c. Procedures for safe removal of contaminated waste; and
d. Decontamination procedures.

APPENDIX C HYDROFLUORIC ACID SAFETY PROTOCOL

Hydrofluoric acid (HF) is an extremely corrosive acid used for many purposes including mineral digestion, surface cleaning, etching, and biological staining. HF's unique properties make it significantly more hazardous than many of the other acids used on at the Maglab.

HEALTH HAZARDS: The health hazards of HF are dependent upon the type of exposure and the concentration.

Eye and Skin Exposure -- HF is corrosive and readily destroys tissue. Exposure of the eyes to HF may result in blindness or permanent eye damage. HF readily penetrates human skin, allowing it to destroy soft tissues and decalcify bone. Chemical burns from HF are typically very painful and slow to heal. Skin exposure to high concentrated HF (approximately 50% or greater) immediately results in serious and painful destruction of tissue. Not only can skin contact cause burns, but systemic fluoride poisoning may also result.

One of HF's most insidious properties is that skin contact at lower concentrations may not produce pain or burning sensations until hours after the exposure. Because of the ability of HF to produce delayed serious tissue damage without necessarily producing pain, all skin, eye, or tissue contact with HF should receive immediate first aid and medical evaluation even if the injury appears minor or no pain is felt.

Inhalation of HF Vapor -- Inhaling HF vapors can seriously damage the lungs. Delayed reactions up to and including fatal pulmonary edema (flooding of the lungs with body fluids) may not be apparent for hours after the initial exposure. Airborne concentrations of 10-15 ppm will irritate the eyes, skin, and respiratory tract. 30 ppm is considered "Immediately Dangerous to Life and Health" (IDLH) and may have irreversible health effects.

Chronic HF Exposure --Long-term or chronic exposure to HF may result in fluorosis, a syndrome characterized by weight loss, bone embrittlement, anemia, and general ill health.

SAFETY PRECAUTIONS FOR HF USE:

Ventilation -- HF should be used with adequate ventilation to minimize inhalation of vapor and should always be handled inside a properly functioning chemical fume hood.
Eye Protection -- Always use chemical goggles together with a face shield when handling concentrated HF. Due to HF's highly corrosive nature, safety glasses with side shields do not provide adequate eye protection.
Body Protection -- Wear a laboratory coat with a chemical splash apron made out of natural rubber, neoprene, or viton. Never wear shorts or open-toed shoes when handling HF.

Gloves -- Typically, medium or heavyweight viton, nitrile, or natural rubber gloves are worn when working with HF. A second pair of nitrile exam gloves should be worn under the gloves for protection against leaks. Always consult the manufacturer's glove selection guide when selecting

a glove for HF. If you have any questions about selecting a glove to use for handling HF, contact the NHMFL Safety Department.

Eyewash/Shower Combination -- Since HF is corrosive and rapidly damages tissue. The NHMFL Safety Department requires a combination eyewash/shower to be nearby and accessible. The combination eyewash/shower should be used to rinse the exposed area for 5 minutes, and then treatment of skin with calcium gluconate gel should be initiated.

Calcium Gluconate Gel -- Calcium gluconate gel is a topical antidote for HF skin exposure. Calcium gluconate works by combining with HF to form insoluble calcium fluoride, thus preventing the extraction of calcium from tissues and bones and the resulting burns. The NHMFL Safety Department will supply the established work area with the calcium gluconate gel.

The NHMFL Safety Department recommends that immediate medical evaluation be sought after an HF exposure, even when calcium gluconate is used to ameliorate injury.

Safe Work Practices -- Never work alone when you're using HF. Do not eat or drink where HF is handled, since the chemical can be swallowed. Wash hands thoroughly after handling HF.

REQUIRED TRAINING BEFORE WORKING WITH HF:

Training from the NHMFL Safety Department is required before an employee can work with HF. Training will include the hazards of HF, its proper storage, handling, and cleanup procedures.

REQUIRED POSTING AT APPROVED WORK AREA:

A HF Emergency Procedure placard must be permanently posted or available at a place where the procedure can be easily seen and used by Maglab employees when engaged in HF work.

See below for: **Hydrofluoric Acid (HF) Exposure Emergency Procedures Placard**

I certify that I have read and understand the policies outlined in this safety protocol. I understand that I am responsible for complying with this safety protocol and that noncompliance will result in either retraining or revocation of my HF work authorization.

_____ _____ _____

Name (Print) Date Signature

HYDROFLUORIC ACID (HF) EXPOSURE EMERGENCY PROCEDURES

All exposure to or contact with HF should receive immediate first aid and medical evaluation even if the injury appears minor or no pain is felt. HF can produce delayed effects and serious tissue damage without necessarily producing pain.

In the event of an HF exposure, immediately start the first-aid procedures described below to avoid HF burns or other permanent damage. Once first aid has been started, get medical assistance by calling 911 – advise operator of HF exposure.

FIRST AID FOR SKIN CONTACT

- Immediately (within seconds) proceed to the nearest eyewash/shower combination and wash affected area for 5 minutes.

Remove all contaminated clothing while in the shower.

- Massage calcium gluconate gel into the affected area (wearing gloves!!!). If calcium gluconate gel is not available, wash area for at least 15 minutes or until emergency medical assistance arrives.
- Re-apply calcium gluconate gel and massage it into affected area every 15 minutes until assistance arrives.
- Calcium gluconate gel is provided by the NHMFL Safety Dept.

FIRST AID FOR EYE CONTACT

- Immediately (within seconds) proceed to the nearest eyewash station
  - Thoroughly wash eyes with water for at least 5 minutes while holding eyelids open.
- Do ***not*** apply calcium gluconate gel to eyes.
- Call 911 for emergency medical assistance.

FIRST AID FOR INGESTION

- Dilute the acid by drinking large quantities of milk (preferable) or water.
- Call 911 for emergency medical assistance.
- Do ***not*** induce vomiting.

FIRST AID FOR INHALATION

- Get medical assistance by calling 911 – advise of HF exposure.

Revisions

Date	Revision #	Section	Description
05/01/17	**001**	**All**	**Review for signatures**
06/05/18	**002**	**4.5**	**Added instruction for THA, SOP, and PSOP**
08/22/18	**003**	**Front**	**Updated names and titles**