

## Natelson Lab abbreviated safety procedures

For full, detailed discussion of lab safety, see Natelson Lab Safety Manual and Chemical Hygiene Plan.

An additional resource is “Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards, Updated Version” published by the National Academies Press, which is Available for free online at

[http://www.nap.edu/catalog.php?record\\_id=12654&utm\\_source=MDR&utm\\_medium=email&utm\\_campaign=PrudentPractices\\_Spring2012%2B#toc](http://www.nap.edu/catalog.php?record_id=12654&utm_source=MDR&utm_medium=email&utm_campaign=PrudentPractices_Spring2012%2B#toc)

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(Based in part on 2012 Tour Lab chemical hygiene plan)

Updated, September, 2013

## Major Medical Emergencies

- If it is not practical to move the ill or injured individual, call the Rice University Police and they will obtain an ambulance and escort it to the location of the emergency.
- DO NOT PLACE A 911 CALL - THE RICE UNIVERSITY POLICE WILL DO THIS.**
- For job sustained injury/illness, all patients should be taken to **Hermann Hospital's Emergency Room, 6411 Fannin (713-704-4060) or their own hospital of choice.** Hospital personnel should be told it is an on-the-job injury for Rice University, if applicable. Proof of Rice employment, such as a campus ID card, will be required. A First Report of Injury Form must also be filed with the Risk Manager, VP for Investments/Treasurer.
- For emergencies that would require ambulance transport, HFD is the transporting agency in this area and they will take you to the closest appropriate (and open) emergency room. Almost always, this is one of the emergency rooms in the medical center:
  - Memorial Hermann – 713-704-4060
  - Ben Taub General Hospital – 713-873-2000
  - Methodist Hospital – 713-394-6000
  - St. Luke's Episcopal Hospital – 832-355-2121
- For emergencies involving serious chemical exposure/spill/inhalation injury, Memorial Hermann is the best facility in the area that can manage these injuries, and REMS/HFD will always recommend this facility.
- In the event of **hydrofluoric acid** contact, calcium gluconate gel is on top of the flammables cabinet. In the event of skin exposure, wash the exposed area immediately and thoroughly with water for several minutes. Then massage the affected area w/ calcium gluconate gel, and seek medical attention. Call the Rice police (x6000), Insist loudly that you need an ambulance, and this is due to a hydrofluoric acid contact, and they do not need to double-check with a supervisor. (The point is that emergency medical services on campus is often operated by undergraduates, and they are not trained for this stuff - they need to know that this is a real emergency, period.) This is **ESPECIALLY** important outside normal business hours. Insist that the ambulance take you to **Memorial Hermann**, because they have a specific Occupational Safety treatment desk where they know what to do.
- For minor emergencies, injuries, or illnesses, any of the emergency rooms are fine, and there are also three stand-alone emergency rooms in the area that are frequented by Rice personnel:
  - St. Luke's Urgent Care (2727 West Holcombe Blvd.; Phone: 832-355-7525)
  - Elite Care (2500 Rice Blvd.; Phone: 713-955-1216)
  - Methodist Urgent Care (2615 Southwest Freeway; Phone: 713-441- 3724).
- When the injury or illness involves a chemical, a Material Safety Data Sheet (MSDS) should accompany the victim to the hospital (MSDS available at <http://safety.rice.edu/msds.htm>).
- The procedure outlined above applies to all individuals receiving pay from Rice University who are injured or become ill while performing an activity that directly benefits Rice University. If transportation is unavailable within the injured's department, a request may be made to the Campus Police to provide such.*

**Undergraduate students** who are injured/become ill and who might require hospitalization should go to **Park Plaza Hospital's Emergency Room (713-527-5129, Rice ID required)** or the hospital of their choice.

### **Minor Medical Emergencies**

On-the-job, minor medical injuries/illness (i.e., falls, cuts, sprains and strains) involving employees should be reported immediately to the injured's supervisor. The supervisor should fill out a First Report of Injury Form (available from Human Resources or the Environmental Health & Safety Department). If medical attention is required, the injured should be taken to **Hermann Hospital's Emergency Room, 6411 Fannin (713-704-4060)** or their **physician of choice**.

**Undergraduate students** who incur a minor injury during normal class/working hours should be referred to the **Student Health Services at Brown College, x4966 or x2326**.

### **REPORTING ACCIDENTS**

To report an accident, "near miss" or hazardous situation on campus **not involving an injury**, contact the Environmental Health & Safety Department, x4444. Complete an Accident/Incident Report Form and submit it to your Department Head and the Environmental Health & Safety Department. Forms are available from EH&S.

Emergency procedures taken from <http://safety.rice.edu> .

# Standard Operating Procedures

## General Rules

1. Read this document and the full safety plan before you begin working in the lab. You will be asked to sign a verification that you've read these and agree to follow the relevant procedures annually. Familiarize yourself with the safety rules and procedures every six months. At this time period, walk around the lab and place your hand on the safety shower handle, the eyewash handle, the fire extinguisher, and the acid spill kit in order to make their location very familiar.
2. Hard to believe it's necessary to say this, but: No horseplay in the lab. No running except in an emergency.
3. Our number one reason for this document is to provide a safe environment for all laboratory workers. Therefore, compliance with this safety plan is not optional. It is mandatory. Failure to comply with the safety plan will result in a warning with a notice inserted in the HR files, and possible termination. A second violation could result in your termination.
4. If you notice unsafe practices by others, or inadequate safety equipment in the lab, you are obligated to inform Prof. Natelson or Rice EH&S. Efforts will be made to ensure that proper equipment is available and proper training is implemented.

## Chemical/fab safety and hazards

5. Avoid working alone in the chemical/fab portion of the laboratory. When you must, please take extra precautions to ensure your safety.
6. Where appropriate **eye protection** at all times in the chemical/fab portion of the laboratory.
7. Where appropriate eye protection and gloves when working with liquid cryogenics (LN<sub>2</sub>, LHe) anywhere in the lab.
8. Obviously, when working with laboratory chemicals, do so in the fume hood.
9. Never stick your head in the hood!
10. Keep the hoods uncluttered – many lab spills result from accidents in crowded/cluttered hoods.
11. For the lab chemicals that they are working with, all students and employees should know and constantly be aware of:
  - a. The chemical hazards as determined by materials safety data sheet (MSDS) and other appropriate references (e.g., shipping documents that came with the chemical). All MSDS information can be found online at <http://safety.rice.edu/msds.htm> .
  - b. Proper safeguards for using that chemical, including personal protective equipment.
  - c. Location and proper use of emergency equipment.
  - d. How and where to store the chemical when not in use.

- e. Proper personal lab hygiene practices.
  - f. Proper methods of transporting the chemicals. This includes the use of a plastic or rubber carrying jacket for transport outside the lab area, or a rimmed cart if multiple items are to be transported at once.
  - g. Proper procedures for emergencies, including evacuation routes, spill cleanup, and waste disposal.
12. When working with flammable solvents, make certain that there are no sources of ignition nearby that could cause a fire or explosion in the event of a spill or vapor release. (e.g., Do not place acetone bottles next to a turned-on soldering iron!)
13. Make sure that the “waste solvent” bottle in the fume hood is closed!
14. Never mix oxidizers with organic solvents.
15. For those working with strong acids ( $\text{pH} < 2$ ) and bases ( $\text{pH} > 10$ ), or strong oxidizers such as Piranha etch or 30% hydrogen peroxide it is required that you wear lab coat, rubber lab smock, safety glasses and face shield—we have all this equipment in the labs. No exceptions. Recall, be very careful with these acids and bases and oxidizers. One drop in your eye and you’re blind. A splash in your face and you will be DISFIGURED FOR LIFE! This is serious business; take it seriously. See the following links:

<http://www.ehs.utoronto.ca/Assets/ehs+Digital+Assets/ehs3/Chemical+Safety/Piranha+2010.pdf>

[http://www.lbl.gov/msd/msd\\_safety/assets/SOP\\_PIRANHA-ETCH12\\_3\\_08.pdf](http://www.lbl.gov/msd/msd_safety/assets/SOP_PIRANHA-ETCH12_3_08.pdf)

<http://dl.clackamas.cc.or.us/ch105-05/precauti.htm>

[http://www.cleanroom.byu.edu/acid\\_safety.phtml](http://www.cleanroom.byu.edu/acid_safety.phtml) (video)

<http://www.ohsu.edu/croetweb/links.cfm?subtopicID=480>

16. We sometimes work with hydrofluoric acid in the laboratory. Specific procedures for this are:
- a. Never use buffered oxide etch (BOE) or HF while alone in the lab. Avoid using BOE/HF outside of normal business hours (see (d) below).
  - b. Always wear the full personal protective equipment (lab coat, long pants, closed shoes, HF-safe gloves, safety glasses + face mask).
  - c. Only work with BOE/HF in the fume hood, and only use HF-safe containers and equipment. Check prior to use if you are uncertain.
  - d. In the event of skin exposure, wash exposed area immediately and thoroughly with water for several minutes. Then massage the affected area with calcium gluconate gel (located on top of the flammables cabinet) and seek medical attention. Do this by dialing x6000, and insist loudly that you need an ambulance, and that this is due to hydrofluoric acid contact, and that they do not need to double-check with a supervisor. This is especially important outside of normal business hours. Insist that the ambulance

take you to Memorial Hermann hospital, where they have an Occupational Safety desk where they know how to treat this issue.

- e. Dispose of any waste BOE/HF in the appropriate labeled container.
- 17. If you are ever on fire in any way, even if it is a small fire, get under the lab shower immediately. If you ever see someone on fire, get them under the shower immediately and pull the handle for them.
- 18. If you ever get laboratory chemicals in your eyes (which should never happen because you're wearing eye protection, right?), go to the eyewash station immediately.
- 19. If you ever get laboratory chemicals (nastier than isopropanol and acetone) on your skin in quantities warranting it, use the safety shower, stripping your clothing if necessary and covering up with a lab coat afterward. Call campus police (or have another person call for you) for medical assistance as directed. DO NOT GO HOME to shower.
- 20. If there is a small lab fire, attempt to extinguish it (using the extinguisher) while shouting "fire!". If the fire is out of control, shout "fire!", flee the lab, and pull the fire alarm on the way out of the building. If there is a fire raging in a fume hood, you should close the sash and pull the fire alarm on the way out, as well as call RUPD at x6000 and shout "fire!".
- 21. In the event of a building evacuation, we gather on the grassy area between Space Sciences and Herring Hall, closer to Space Sciences (the rectangular region in the grass marked off by concrete disks is the location where fire trucks and emergency vehicles would park).
- 22. When working with heat sources (hotplate, box oven, tube furnaces), **always** double-check the temperature of any surface that you are going to touch! Likewise, be sure that any surfaces that do get hot are not in contact with any flammable materials.

### **Other areas of the lab, electrical issues**

- 23. Where appropriate eye protection and observe laser safety precautions when working in the optics room. Do not put your head at table-height if you can avoid doing so. Always be careful about the status of the laser sources. Remember, the 785 nm and 1064 nm sources are not readily visible to the naked eye. Avoid looking directly (or indirectly if there are strong reflections) at UV light sources (in the optics room or the UV pen lamp), even when wearing eye protection.
- 24. When working with high voltage systems (e.g., the e-beam evaporator), if you have any reason to believe that there is a malfunction with the high voltage, do not touch the equipment. Use a heavy, insulating glove to turn off the wall main power if possible, but not if that would involve the risk of touching high voltage. Before servicing any high voltage system, make sure that the system is unplugged and any points to be touched are discharged.
- 25. Likewise, be smart about using liquid cryogenics. Do not touch exposed surfaces that are likely to be extremely cold.

26. In the event of a magnet quench (either the PPMS or the Attocube system), prop open all the lab doors to ensure adequate ventilation from boiling helium. Check the status of the relevant magnet power supply. Turn off the supply if it is still trying to drive current through the now-normal magnet.

### **Personal hygiene**

27. Wash promptly whenever a lab chemical has contacted the skin.
28. Avoid inhalation of chemicals; do not “sniff” to test chemicals.
29. Do not use mouth suction for any pipetting.
30. Wash well with soap and water before leaving the laboratory!
31. Do not eat, drink, smoke (!!), or apply skin products while in the chemical/fab portion of the laboratory.
32. Do not bring food, beverages, tobacco, or skin products into the chemical/fab portion of the lab.
33. Never store food in the lab chemical refrigerator, or chemicals in the entrance-area food fridge.

### **Personal protective equipment**

34. Eye protection worn when working with chemicals should meet the requirements of the American National Standards Institute (ANSI) Z87. Wear goggles such as type G, H, or I when working with lab chemicals, soldering, or using the machining equipment in the chem/fab area of the lab. When working with more than 30 mL of a corrosive liquid (see point 13 above), wear a face shield, type N, large enough to protect neck, chin, ears, and face.
35. When working with corrosive liquids or liquid lab chemicals in general, wear gloves made of materials known to be resistant to permeation by that lab chemical and tested by air inflation (use lab air, not your mouth!) for the absence of pinhole leaks.
36. When working with lab chemicals, shorts and short-sleeve shirts are only permitted if augmented by a high necked, calf- or ankle-length lab apron, or a long-sleeve, calf- or ankle-length lab coat.
37. Get in the habit of wearing a lab coat in general when working with lab chemicals.
38. When in the chem/fab portion of the lab, do not wear sandals or open-toed shoes, and wear low heels.
39. Inspect protective equipment before you use it. Don't use defective equipment, and report the need for new equipment to Prof. Natelson (or rectify the matter yourself, if it's as simple as going to the chem stock room and acquiring more safety glasses or gloves).

## Housekeeping

40. Access to emergency equipment, showers, eyewash, and exits should NEVER be blocked, even temporarily.
41. Don't leave dirty glassware in the sink in the hood or in the sink in the foyer.
42. Do not store lab liquids at heights above 5'6".
43. All chemical containers must be properly labeled in English, identifying contents and any particular hazards.
44. Keep work areas (benches, tables, hoods) free of clutter.
45. Never discard glass or needles in normal trash bins – use the approved “glass” or “sharps” boxes.
46. All lab chemicals should be returned to their storage areas at the end of the workday and when not in use.
47. Wastes should be properly labeled, stored in respective containers, and picked up for disposal rather than accumulated in quantity (call EH&S at x4444 for assistance).
48. Promptly clean up any minor spills. For major spills, call EH&S at x4444 for advice/assistance, and take any other necessary emergency care (see *Major Medical Emergencies*). Spills of toxic substances or accidents involving any hazardous chemical should be resolved immediately according to the Rice University laboratory safety plan, which can be found at <http://safety.rice.edu/chemical%20spills.htm>.
49. There will be periodic lab cleanups. All group members are expected to contribute and help out. During cleanups, hoods/benches/tables/desks must be cleaned; common areas must be cleaned; areas around particular experiments must be cleaned of clutter by the cognizant students/postdocs; all trash must be removed from the lab.

## Toxic chemicals

50. The MSDS for many chemicals used in the laboratory state limits or guidelines for exposure. At the time of this writing, adhering to the rules above (and common sense rules like not ingesting lab chemicals) should be adequate. If there is some new chemical in the lab, or you have some concern about exposure limits, DO NOT WORK with that chemical, and contact Prof. Natelson so that we can consult with EH&S about appropriate procedures.

## Flammable chemicals

51. Chemicals with a flash point below 200 F (93.3 C) will be considered “fire-hazard chemicals”. In the Natelson lab, these are typically organic solvents.
52. The OSHA and National Fire Protection Agency (NFPA) guidelines apply to the use of flammable chemicals in the lab. In all work with fire-hazard chemicals, follow the requirements of 29 CFR,



subparts H and L; NFPA Manual 30, "[Flammable and Combustible Liquids Code](#)"; and NFPA Manual 45, "[Fire Protection for Laboratories Using Chemicals](#)".

53. Fire-hazard chemicals should be stored in the flammables cabinet when not in use.
54. Fire-hazard chemicals should only be used in vented hoods and away from possible sources of ignition.
55. Store only compatible materials inside the cabinet.
56. Do not store papers or combustible packing materials in the cabinet.
57. Obey manufacturer's restrictions on total volume storage in the cabinet.

### **Reactive chemicals**

58. Reactive chemicals are described as such on the MSDS or in "[Handbook of Reactive Chemical Hazards](#)" by Bretherick. In the Natelson lab, these are likely to be oxidizers (hydrogen peroxide, furans, nitric acid). If you have a new lab chemical and its MSDS lists it as reactive, notify Prof. Natelson and DO NOT USE until further work has been done to determine safe modes of use.
59. Handle reactive chemicals with all proper safety precautions, including segregation in storage and prohibition on mixing even small quantities with other chemicals without prior approval and appropriate personal protection and precautions.

### **Corrosive chemicals**

60. Corrosive chemicals are again described as such on the manufacturer's MSDS. In the Natelson lab, these typically would be acids and bases.
61. As noted elsewhere here, handle corrosive substances with all proper safety precautions, including goggles and face shield, gloves tested for absence of pin holes and resistance to permeation, and a lab coat or apron.

### **Ventilation**

62. Always work in hoods with lab chemicals. Hoods should provide 70-90 linear feet per minute of airflow, and are attached to alarm monitors. If the hood alarm sounds, immediately stop all chemical work, close chemical containers, lower the sash, and contact Facilities at 713-348-2485.
63. Do not dispose of chemicals by deliberate evaporation in the hood.
64. Apparatus in the hood should be at least 6 inches away from the hood opening.
65. Close the sashes when not using the hoods.
66. The hood exhaust should be "on" all the time.

67. Hoods are not to be used for long-term storage of chemicals or apparatus.

### **Discipline and disability**

68. Everyone in the lab must make a conscious effort to adhere to the safety guidelines. As mentioned in (3), disciplinary action will be brought if guidelines are consciously or repeatedly violated.
69. If a student or postdoc consistently and willfully fails to follow the guidelines in this document, as determined by the Principal Investigator or lab safety officer, the following actions will be taken:
- a. A letter of reprimand will be filed with the PI and Rice EH&S indicating refusal to follow lab protocol.
  - b. The student will be notified of this action in hopes of discouraging future violations.
  - c. Further violations of this nature could result in termination from the group.
70. In the event that you are unable to conform to the safety guidelines established herein due to a medical or psychological reason, a physician's note on official letterhead must be filed with the PI before beginning work.

# 2016 SAFETY MANUAL & LABORATORY CHEMICAL HYGIENE PLAN, *Natelson lab version*

## EMERGENCY PHONE NUMBERS

AMBULANCE / FIRE / POLICE	713-348-6000
MEMORIAL HERMANN HOSPITAL EMERGENCY ROOM	713-704-4060
DEPARTMENT OF ENVIRONMENTAL HEALTH AND SAFETY	713-348-4444
SAFETY OFFICE in the BioScience Research Collaborative (BRC)	713-348-8800
STUDENT HEALTH SERVICES	713-348-4966
POISON INFORMATION CENTER	1-800-222-1222
OTHER IMPORTANT NUMBERS: Physics Departmental Office Purchasing Coordinator; Angela McFarland Deputy Chair of P&A; Prof. Stan Dodds Chemistry Storeroom in Space Science	713-348-4938 713-348-3639 713-348-2510 713-348-3275

**Note: If you are planning to work in a lab and you are a student, postdoctoral researcher or research scientist, the Office of Sponsored Research may require you to also take the**

### **[Responsible Conduct of Research \(RCR\) Training](#)**

If you are not sure whether you are required to take the RCR training, e-mail [graduate@rice.edu](mailto:graduate@rice.edu) or contact the Office of Sponsored Research.

(Electronic Version Available on the Natelson group website)

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# PREFACE

## Acknowledgement

The chemical safety portions of this manual are based on those in the 2012 version of the Rice University Department of Chemistry chemical hygiene and safety plan, obtained via email from Rice University EH&S in May, 2013.

The cryogen safety portions of this manual were written by Prof. Natelson in September, 2013.

For the latest in Rice University lab safety information, please check out the official EH&S website here: <http://safety.rice.edu/>

All laboratory personnel are required to read the Safety Manual prior to working in the Natelson laboratory. Acknowledgment of having read the current version of the manual is required. The Principal Investigator is responsible for ensuring all laboratory personnel in their laboratory read and understand this Safety Manual. **An acknowledgement form is found at the end of this manual and shall serve as record of receipt and understanding by laboratory personnel. A new acknowledgment form is required every year, at the beginning of the fall semester.**

## Other requirements

In addition to the guidelines set forth in this manual, the University may require additional procedures or processes. For example, the Office of Sponsored Research may require you to also take the

### [Responsible Conduct of Research \(RCR\) Training](#)

If you are not sure whether you are required to take the RCR training, e-mail [graduate@rice.edu](mailto:graduate@rice.edu) or contact the Office of Sponsored Research ([osrrice@rice.edu](mailto:osrrice@rice.edu)).

Details about registering Class3b and 4 lasers can be found in Section 6 of this manual.

**NOTE:** This manual DOES NOT cover biological safety practices, other than describing biological safety cabinets and disposal of biohazards. You are asked to contact EHS if you are working with biological hazards of any type to ensure compliance.



# 1 CHEMICAL HYGIENE PLAN

As outlined in the Occupational Safety and Health Administration's (OSHA's) Code of Federal Regulations 29CFR 1910.1450, a Chemical Hygiene Plan must be developed for all laboratories that use hazardous chemicals. The purpose of this plan is to define work practices and procedures to ensure that all laboratory occupants are protected from any health hazards associated with the use of hazardous chemicals.

“Hazardous chemical” means a chemical for which there is statistically significant evidence, based on at least one study conducted in accordance with established scientific principles, that acute or chronic health effects may occur in exposed employees. The term “health hazard” includes chemicals that are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Each laboratory/principal investigator must develop a Chemical Hygiene Plan. It is acceptable for a laboratory to use the Chemical Hygiene Plan Outline (Section 1.1) presented in this manual as a template. Rice University's Safety Policies and Procedures manual may be included as part of the plan, but may not be used in place of the Chemical Hygiene Plan.

The following outline is intended to assist the laboratory, principal investigator, or department in plan development.

NOTE: You must also note the “physical” hazards that exist in laboratories, such as ability burn, cut, etc. through contact, possible explosion, laser exposure, etc.)

## 1.1 CHEMICAL HYGIENE PLAN OUTLINE

*(Please print or type)*

Date of Plan: April 30, 2015

Department: Physics and Astronomy

Building: Brockman Hall Room Number: B11

Prepared by: Douglas Natelson

Professor: Douglas Natelson

Professor's Name/Home Phone/Pager/Cellular Numbers:

Douglas Natelson/713-663-6628 (home)/832-338-7268 (cell)

Emergency Contacts: Names/Home Phone/Pager/Cellular Numbers;

\_\_\_\_\_  
\_\_\_\_\_

Reviewer: \_\_\_\_\_

Type of Laboratory (check all that apply):

Research X

Teaching \_\_\_\_\_

Prep. \_\_\_\_\_

Storage \_\_\_\_\_

Other Specify \_\_\_\_\_

Descriptive Titles of Current laboratory Projects:

Noise and coherence in nanoscale junctions; Nanostructure studies of strongly correlated materials; Novel single-molecule vibrational spectroscopies. [All of these projects involve nanofabrication (some amount of chemical processing of metals and semiconductors), vacuum equipment, and cryogen handling. The last project also involves the use of semiconductor lasers.

All plans must contain the following information. This outline has been developed to assist you in developing the plan for the laboratory.

1. Provide a copy of the Standard Operating Guidelines (SOG's) for each hazardous procedure in the laboratory. Chemical storage methods, waste disposal procedures, and special personal protective equipment should be included in the plan. Also, describe any necessary control measures, including the use of fume hoods, localized exhaust, personnel protective equipment, laboratory safe refrigerators and good hygiene practices for the use of hazardous materials.

2. Fume hood exhausts are monitored by:

  X   electronic controls and or        visual aids  
to ensure the equipment is functioning properly.

Checklist:

Fume hoods tested within the last 3 years Yes   X   No       

(If not, call Facilities and Engineering to schedule a recertification.)

3. Prior to working in the laboratory, employees are trained on the proper handling and use of hazardous chemicals.   Prof. Natelson   is  
*Name and/or position*

responsible for documenting and conducting laboratory training.

Training will be conducted at least   annually  .

*Time frame*

A list of particular operations or procedures that are hazardous enough that prior approval will be required before employees carry them out will be maintained within the laboratory and used to determine additional lab-specific training.

All lab-specific personnel training is to be documented and maintained by the person designated above (the laboratory Chemical Hygiene Officer).

In addition to specific laboratory safety training, all students and employees have attended a laboratory safety training class provided annually by Rice's Environmental Health and Safety Department.

4. Labels are to remain on all containers at all times. If the original label is no longer affixed, the chemical hazards information is provided on

the container. All chemical information is in the English language  
\_\_\_\_\_ is responsible for ensuring the labels

*Name and/or position*

remain on the containers.

Checklist: All containers are clearly labeled, including hazard  
identification? Yes \_\_\_ No \_\_\_

5. All incoming containers are dated upon receipt and re-dated when  
opened. Peroxide forming compounds are not kept in the laboratory for  
a period longer than six months.

\_\_\_\_\_ is responsible for ensuring that all

*Name and/or position*

containers are dated.

Checklist:

Peroxides, peroxide-forming compounds and shock sensitive  
compounds are properly stored and labeled with last date opened?

Yes \_\_\_ No \_\_\_

6. When a chemical is no longer needed in the laboratory, the  
Environmental Health and Safety Department is contacted to remove  
the chemical from the laboratory. All spent chemical containers located  
in the laboratory are properly labeled. Only compatible materials are  
placed in like containers. Every effort is made to order and keep the  
minimum amount of materials necessary for use during research.

\_\_\_\_\_ is responsible for chemical disposal in the

*Name and/or position*

laboratory.

Checklist:

Waste is properly labeled and prepared for transport? Yes \_\_\_ No \_\_\_

7. Secondary containers are used for the transportation of chemicals when  
being hand-carried.

Approved secondary containers available are;

\_\_\_\_\_ bottle carriers and PTFE trays

\_\_\_\_\_ and are located in:

\_\_\_\_\_ the fabrication room , next to the fume hoods.

---

Prof. Natelson  
*Name and/or position*

is responsible for maintaining the  
availability of secondary containers.

8. Eye wash stations are tested at least quarterly. A record of this testing is maintained in the lab, on a hang tag on the station.  
*Location*

9. Spill kits are available in the laboratory. The kits are appropriate for each type of spill that may occur. Chemical spill kits are located \_\_\_\_\_ and are maintained by \_\_\_\_\_  
*Location*  
*Name and/or position*

10. An Emergency Contact List is posted on **each** exit door of the laboratory. Sign Generator is found on EHS website (<http://safety.rice.edu/>). You will need your NetID to access the lab groups. Several questions will be asked about whom the lab contacts should be, their contact information and the types of hazards that are present in the laboratory. You can then print out a sign directly from the website upon completion.

11. Radioactive Material(s) Used:   **NONE**  

Location of Radioactive Material(s):  
\_\_\_\_\_

Radioactive License Number:  
\_\_\_\_\_

License Holder:  
\_\_\_\_\_

Radiation Safety Officer:  
\_\_\_\_\_

12. DEA Material(s) Used:

\_\_\_\_\_ **NONE** \_\_\_\_\_

DEA License Number:

\_\_\_\_\_

DEA License Holder:

\_\_\_\_\_

13. Animal experiments are conducted in our lab. \_\_\_\_\_ Yes  No
14. Select Agents (Refer to **Section 1.3** of the Chemistry Safety Manual) are in use or planned to be used in the near future? \_\_\_\_\_ Yes  No . If yes please contact the Environmental Safety Department to register the chemicals.
15. Lasers are in use or planned to be in use.  Yes \_\_\_\_\_ No

If yes, what Class of lasers will be used? II

Are proper warning signs posted near laser and on entry door? yes

If Class IIIb or IV lasers are in use please contact the Department Safety Coordinator to confirm the lasers are registered with the state of TX.

**(Refer to the Laser Safety Section of this Safety Manual about registering your Class III or IV laser.)**

Responsibility:

The Chemical Hygiene Officer is responsible for implementing the Overall Chemical Hygiene Plan. Each Individual laboratory supervisor is responsible to assure that the plan is effectively implemented on a continual basis.

## 1.2 DEFINITIONS

### 1.2.1 LABORATORY DEFINITION

For the purposes of this OSHA standard a laboratory is defined as a facility in which hazardous chemicals (defined below) are handled or manipulated in reactions, transfers, etc. in small quantities (containers that are easily manipulated by one person) on a non-production basis. Typically multiple chemical procedures are used.

### 1.2.2 HAZARDOUS CHEMICAL DEFINITION

The OSHA Laboratory Health Standard defines a hazardous chemical as any element, chemical compound, or mixture of elements and/or compounds which is a physical hazard or a health hazard. The standard applies to all hazardous chemicals regardless of the quantity.

A chemical is a physical hazard if there is scientifically valid evidence that it is a combustible liquid, a compressed gas, an explosive, an organic peroxide, an oxidizer or pyrophoric, flammable, or reactive.

A chemical is a health hazard if there is statistically significant evidence, based on at least one study conducted in accordance with established scientific principles, that acute or chronic health effects may occur in exposed employees. Classes of health hazards include:

- |  |                         |
|--|-------------------------|
| * carcinogens  | * irritants             |
| * reproductive toxins  | * corrosives            |
| * sensitizers  | * neurotoxins (nerve)   |
| * hepatotoxins (liver)   | * nephrotoxins (kidney) |
| * agents that act on the hematopoietic system (blood)          |                         |
| * agents that damage the lungs, skin, eyes, or mucus membranes |                         |

A chemical is considered a **carcinogen** or **potential carcinogen** if it is listed in any of the following publications (OSHA uses the term "select" carcinogen):

- National Toxicology Program, Annual Report on Carcinogens (latest edition) (<http://ntp.niehs.nih.gov/?objectid=72016262-BDB7-CEBA-FA60E922B18C2540>)
- International Agency for Research on Cancer, Monographs (latest edition) (<http://monographs.iarc.fr/>)
- OSHA, 29 CFR 1910.1001 to 1910.1101, Toxic and Hazardous Substances

A chemical is considered **hazardous** according to the OSHA standard, if it is listed in any of the following:

- OSHA, 29 CFR 1910.1000 Table Z-1 through Z-3

[http://www.osha.gov/pls/oshaweb/owastand.display\\_standard\\_group?p\\_toc\\_level=1&p\\_part\\_number=1910](http://www.osha.gov/pls/oshaweb/owastand.display_standard_group?p_toc_level=1&p_part_number=1910)

- [Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment, ACGIH \(latest edition\)](#)
- [The Registry of Toxic Effects of Chemical Substances](#), NIOSH (latest edition)

Over 600,000 chemicals are considered hazardous by the OSHA definition.

In most cases, the chemical container's original label will indicate if the chemical is hazardous. Look for key words like **caution, hazardous, toxic, dangerous, corrosive, irritant, carcinogen**, etc. Containers of hazardous chemicals acquired or manufactured before 1985 may not contain appropriate hazard warnings.

If you are not sure a chemical you are using is hazardous, review the **Material Safety Data Sheet** (See **Section 1.5**) for the substance or contact your supervisor.

## 1.3 HAZARD IDENTIFICATION

### 1.3.1 CHEMICAL HAZARD IDENTIFICATION

The NFPA 704 Diamond ("NFPA Diamond" or "fire diamond") is a standard placard that identifies the level of chemical hazard at fixed locations, such as production facilities, warehouses, storage tanks, and storage sheds. It also is used on some transported containers.

The NFPA 704 diamond (shown at right) is divided into four colored quadrants. Each quadrant provides information about the materials inside:

- Blue represents health hazard.
- Red represents flammability.
- Yellow represents reactivity.
- White provides information about special precautions.



Within each quadrant is a number from 0 to 4 indicating the degree of risk associated with the material. The higher the number, the higher the risk. For some materials, the white quadrant contains symbols indicating special hazards. The meaning of each code number and symbol is shown in the table below.

If more than one chemical is present at a facility, the NFPA diamond indicates overall hazard at that location, *not* the hazard posed by a particular chemical. It shows the highest of each of the four hazards present. For example, it may be that one chemical poses the highest health hazard while another poses the highest fire hazard.



If there's no NFPA diamond at a facility, *don't* assume that there are no dangerous chemicals present. Sometimes, a diamond may be missing or displayed in a location where it isn't visible to responders.

<b>Interpreting NFPA 704 numbers and symbols</b>	
<b>Number</b>	<b>Meaning</b>
<b>Health hazard (blue quadrant):</b>	
<b>4</b>	Too dangerous to enter - vapor or liquid
<b>3</b>	Extremely hazardous - use full protection
<b>2</b>	Hazardous - use breathing apparatus
<b>1</b>	Slightly hazardous
<b>0</b>	Like ordinary material
<b>Flammability (red quadrant):</b>	
<b>4</b>	Extremely flammable
<b>3</b>	Ignites at normal temperatures
<b>2</b>	Ignites when moderately heated
<b>1</b>	Must be preheated to burn
<b>0</b>	Will not burn
<b>Reactivity (yellow quadrant):</b>	
<b>4</b>	May detonate - evacuate area if materials are exposed
<b>3</b>	Strong shock or heat may detonate - use monitors
<b>2</b>	Violent chemical change possible
<b>1</b>	Unstable if heated - use normal precautions
<b>0</b>	Normally stable
<b>Special hazards (white quadrant)</b>	
<b>W or "No water"</b>	Indicates a material that is unusually reactive with water (e.g., sodium).
<b>OX or "Oxidizer"</b>	Indicates a material that is an <b>oxidizer</b> (e.g., ammonium nitrate).

Some laboratories may synthesize or develop new chemical substances on occasion. If the composition of the substance is known and will be used exclusively in the laboratory, the laboratory worker must label the substance (structure may be used if name is not known) and determine, to the best of his/her abilities, the hazardous properties (e.g. corrosive, flammable, reactive, toxic, etc.) of the substance. If the chemical produced is of unknown composition, it must be assumed to be hazardous and appropriate precautions taken.

If a chemical substance is produced for another user outside this facility, the laboratory producing the substance is required to provide as much information as possible regarding the identify and known hazardous properties of the substance to the receiver of the material.

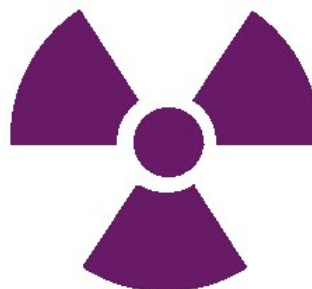
### 1.3.2 BIOHAZARD IDENTIFICATION

All areas, equipment and materials, including wastes, which might be contaminated with infectious agents must be clearly identified by an appropriate label or sign. Such identification must include the signal work BIOHAZARD or the biohazard symbol clearly visible from a distance of five feet. In addition to the signal word or symbol, signage must also include a major message (words or pictographs) that describes the specific hazard or hazards.



### 1.3.3 RADIOACTIVE MATERIALS IDENTIFICATION

All radioactive materials and radiation-producing devices must be labeled with this universal symbol for radiation. Additionally, the doors to rooms that use radioactive materials and equipment that may contain radioactive materials (e.g. refrigerators, centrifuges, radioactive waste containers, etc.) will bear the words "CAUTION RADIOACTIVE MATERIALS" on this sign. On radiation producing machines, the sign will be accompanied by the words "CAUTION THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED".



### 1.3.4 SELECT AGENTS

Laboratories are not allowed to work with [“Select Agents”](#) as defined by the Center for Disease Control until all material have been approved by the appropriate governmental agency, Environmental Health & Safety, the Provost and Departmental Chair.

<http://www.cdc.gov/od/sap/>

## 1.4 TRAINING & INFORMATION

### 1.4.1 CHEMICAL SAFETY TRAINING

**All employees exposed, or potentially exposed, to hazardous chemicals while performing their laboratory duties must receive information and training regarding the standard, the chemical hygiene plan and laboratory safety.**

Our training program for laboratory workers consists of two parts:

1) Introduction to the standard and to information not specific to the individual worksite to be conducted by the Office of Environmental Health and Safety. This mandatory training is offered two to three times a year (once the week before classes start in the fall and then again in the spring and summer semesters). It is recommended that lab personnel attend a refresher course every 5 years.

2) **Site specific elements of training to be conducted by the Principal Investigator or department chemical hygiene officer/laboratory supervisor.** The training and information will be provided when an employee is initially assigned to a laboratory where hazardous chemicals are present, and also prior to assignments involving new hazardous chemicals and/or new laboratory work procedures.

The training and information program will describe the:

- Physical and health hazards of various classes of laboratory chemicals handled;
- Methods/procedures for safely handling and detecting the presence or release of hazardous chemicals present in the laboratory;
- Appropriate response in the event of a chemical emergency (spill, overexposure, etc.);
- Chemical safety policies; and
- Applicable details of the Chemical Hygiene Plan (such as the standard operating procedures for using chemicals).

**When an employee is to perform a non-routine task presenting hazards for which he or she has not been trained, the employee's supervisor will be responsible for discussing with the employee the hazards of the task and any special measures (e.g. personal protective equipment or engineering controls) that should be used to protect the employee.**

Every laboratory worker should know the location and proper use of available protective clothing and equipment, and emergency equipment/procedures. Information on protective clothing and equipment is contained in Section 2.3 of this manual.

Students, visitors and other authorized personnel over the age of 16 must receive appropriate training **prior** to working in any laboratory where hazardous chemicals are stored or used. Any person under the age of 16 will generally not be allowed to be present or work in a laboratory where hazardous chemicals are stored or used. Any exceptions to this requirement must be approved by the Department Chair or the Director of Environmental Health and Safety. All lab personnel under the age of 18 will not be allowed to work with radioactive materials and must have a parental release form (**Release and Hold Harmless Agreement**) signed and submitted to the Department Chair, the Rice University Risk Manager and Laboratory Supervisor.

The Release and Hold Harmless Agreement form can be found in the Appendix of this manual.

## **1.4.2 CHEMICAL SAFETY INFORMATION SOURCES**

There are numerous sources of chemical safety information. These sources include:

1. special health and safety reference literature available on the internet and in the Office of Environmental Health and Safety;
2. the labels found on containers of hazardous chemicals;
3. the substance's Material Safety Data Sheet (Section 1.5);

In addition, your supervisor is available to provide safety information. Each of these sources is now discussed in greater detail.

### **1.4.2.1 Safety Reference Literature**

The Office of Environmental Health and Safety maintains a library of reference materials addressing chemical health and safety issues. One of the references contains all applicable chemical workplace exposure standards and recommended exposure levels. Another reference contains a copy of OSHA's laboratory safety standard and its appendices.

## **1.5 CHEMICAL LABELING AND MATERIAL SAFETY DATA SHEETS**

### **1.5.1 CONTAINER LABELING**

All containers of hazardous chemicals, which could pose a physical, or health hazard to an exposed employee, must have a label attached. Labels on purchased hazardous chemicals must include:

1. The common name of the chemical;
2. The name, address and emergency phone number of the company responsible for the product; and

3. An appropriate hazard warning (Section 1.3).
4. The date the chemical was received AND opened

The warning may be a single word - "danger", "warning" or "caution" - or may identify the primary hazard, both physical (i.e., water reactive, flammable or explosive) and health (i.e., carcinogen, corrosive, or irritant).

Most labels will provide you with additional safety information to help you protect yourself while working with this substance. This includes protective measures to be used when handling the material, clothing that should be worn, first aid instructions, storage information and procedures to follow in the event of a fire, leak or spill.

If you find a container with no label, report it to your supervisor. You should also report labels that are torn or illegible so that the label can be replaced immediately. Existing labels on new containers of hazardous chemicals should never be removed or defaced, *except when empty!* If you use secondary working containers that will take more than one work shift to empty, or if there is a chance that someone else will handle the container before you finish it, you must label the container. This is part of your responsibility to help protect co-workers.

Read the label each time you use a newly purchased chemical. It is possible the manufacturer may have added new hazard information or reformulated the product since your last purchase, and thus altered the potential hazards you face while working with the product.

All employees involved in unpacking chemicals are responsible for inspecting each incoming container to insure that it is labeled with the information outlined above. The principal investigators or department chemical hygiene officer/laboratory supervisors should be notified if containers do not have proper labels.

### **1.5.2 MATERIAL SAFETY DATA SHEETS**

A Material Safety Data Sheet, often referred to by its acronym MSDS, is a detailed informational document prepared by the manufacturer or importer of a hazardous chemical which describes the physical and chemical properties of the product. Information included in a Material Safety Data Sheet aids in the selection of safe products, helps employers and employees understand the potential health and physical hazards of a chemical and describes how to respond effectively to exposure situations. Material Safety Data Sheets (<http://safety.rice.edu/msds.htm>) can be accessed through the Office of Environmental Health and Safety Web Site. All laboratory personnel within a research group must be able to access this site or they will be required to keep hard copies of MSDS's for each chemical they use or store in the laboratory.

The format of a Material Safety Data Sheet may vary but there is specific information that must be included in each sheet. It is useful to review this information to increase your ability to use a Material Safety Data Sheet.

All Material Safety Data Sheets should include the following information:

**Section I** of the MSDS lists information identifying the manufacturer and the product.

- Manufacturer's name, address and telephone number
- Number to call in case of emergency involving product
- Chemical name and synonyms
- Trade name and synonyms
- Chemical family and formula
- CAS# (Chemical Abstract Service) for pure materials

**Section II** describes the various hazardous ingredients contained in the product, the percentages, and exposure limits when appropriate. All hazardous chemicals which comprise 1% or greater of the mixture will be identified. Carcinogens will be listed if their concentrations are 0.1% or greater. If a component is not listed, it has been judged to be non-hazardous or is considered proprietary information by the manufacturer. The types of components that might be listed include:

- Pigments, catalysts, vehicles, solvents, additives, others
- Base metals, alloys, metallic coatings, fillers, hazardous mixtures of other liquids, solids or gases

**Section III** describes the physical properties of the material.

- Boiling point
- Vapor pressure
- Vapor density
- Solubility in water
- Specific gravity
- Percent volatile
- Evaporation rate
- Appearance and odor

**Section IV** describes the fire and explosion hazard data for the material. Based on the flash point and other fire and explosion data, the appropriate extinguishing agent for fires involving the material will be listed. Special procedures may also be listed.

- Flash point
- Lower and upper explosive limits (**LEL/UEL**)
- Extinguishing agent - water, dry chemical, foam, halon, etc.
- Unusual fire and explosion hazards, toxic fumes

**Section V** describes the known health hazards associated with the material, applicable exposure limits and symptoms/health effects associated with overexposure. This information will help the user and medical personnel recognize if an overexposure has occurred.

- Threshold Limit Value
- Effects of overexposure: headache, nausea, narcosis, irritation, weakness, etc.
- Primary routes of exposure: inhalation, skin, ingestion
- Cancer or other special health hazards
- Emergency and first aid procedures for ingestion, inhalation and skin or eye contact

**Section VI** describes reactivity data; that is, the material's ability to react and release energy or heat under certain conditions or when it comes in contact with certain substances.

- Stability: stable; unstable; conditions to avoid
- Incompatibility: materials to avoid
- Hazardous decomposition products
- Hazardous polymerizations: conditions to avoid

**Section VII** gives instructions for the steps to be taken in case of an accidental release or spill. The steps normally include information on containment, evacuation procedures and waste disposal as appropriate. The statements on the Material Safety Data Sheet are very general; more specific information is available from your supervisor or the department chemical hygiene officer/laboratory supervisor.

- Steps to be taken in case material is released or spilled
- Waste disposal methods

**Section VIII** describes the protective equipment for the individual who will work with the substance. This section normally describes worst case conditions; therefore, the extent to which personal protective equipment is required is task dependent. Contact your supervisor or department Chemical Hygiene Officer/Laboratory Supervisor for specific instructions if you are unsure.

- Respiratory equipment: dust mask; chemical cartridge respirator; self-contained breathing apparatus
- Ventilation: local; general; special
- Protective gloves: type; fabrication material
- Eye protection: goggles; face shield
- Other protective equipment

**Section IX** describes handling and storage procedures to be taken with the material. Information may include statements, such as: keep container closed; store in a cool, dry, well ventilated area; keep refrigerated (caution: flammable solvents require a "flammable storage refrigerator"); avoid exposure to sunlight; etc.

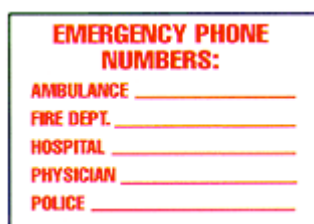
**Section X** describes any special precautions or miscellaneous information regarding the material.

Manufacturers may withhold certain information as proprietary (such as hazardous ingredients) on a Material Safety Data Sheet if the information is considered a trade secret. The Chemical Hygiene Officer has a legal right to obtain this information from the manufacturer to evaluate the potential health risk if potential overexposure or adverse health effects are suspected.

### 1.5.3 LABORATORY SIGNS

Prominent signs of the following types should be posted in each laboratory:

- Telephone numbers of emergency personnel/facilities



- Telephone numbers of supervisors, and laboratory workers should also appear on the outside of the lab door. A Sign Generator is found on EHS website (<http://safety.rice.edu/>). You will need your NetID to access the lab groups. Several questions will be asked about whom the lab contacts should be, their contact information and the types of hazards that are present in the laboratory. You can then print out a sign directly from the website upon completion. such as in the following example:

Personnel	Office	Cell	Home
Prof. I.M. Chemist (Advisor)	x 4185	832-555-1212	832-555-1213
Dr. Safe T. King (postdoc)	x 1345	832-555-1212	832-555-1212
Got A. Study (grad student)	x 1234	832-555-1212	832-555-1212

- Signs identifying locations for safety showers, eyewash stations, other safety and first aid equipment, and exits;



**FIRST AID KIT**





- Warnings in areas or on equipment where special or unusual hazards exist (also see Section 1.3).



## 1.6 CHEMICAL EXPOSURE ASSESSMENT

Regular environmental or employee exposure monitoring of airborne concentrations is not usually warranted or practical in laboratories because chemicals are typically used for relatively short time periods and in small quantities. However, sampling may be appropriate when a highly toxic substance is either used regularly (3 or more separate handling sessions per week), used for an extended period of time (greater than 3 to 4 hours at a time), or used in especially large quantities. Notify the Director, Environmental Health and Safety if you are using a highly toxic substance in this manner.

The exposures to laboratory employees who suspect and report that they have been overexposed to a toxic chemical in the laboratory, or are displaying symptoms of overexposure to toxic chemicals, will also be assessed. The assessment will initially be qualitative and, based upon the professional judgment of the Director, Environmental Health and Safety or an independent occupational physician and, may be followed up by specific quantitative monitoring. Individual concerns about excessive exposures occurring in the laboratory should be brought to the attention of your supervisor or the Director, Environmental Health and Safety immediately.

## 1.7 MEDICAL CONSULTATION & EXAMINATION

Rice University, through the Department of Chemistry, will provide 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, whenever an employee:

- Develops signs or symptoms associated with excessive exposure to a hazardous chemical used in their laboratory;
- Is exposed routinely above the action level (or in the absence of an action level, the applicable OSHA work place exposure limit) for an OSHA regulated substance;
- May have been exposed to a hazardous chemical during a chemical incident such as a spill, leak, explosion or fire; and
- Is referred for medical follow up by the Director, Environmental Health and Safety.

**Non-emergency contact:** Rice University Risk Manager Renee Block (x4751) or the Department Administrator to get information about scheduling an appointment to see Doctor under contract.

**Emergency Contact:** Rice University Police (x6000) who will arrange transport to Emergency Room.

**NOTE:** Non-Rice employees typically are not covered by workers compensation and may be required to pay for their own medical expenses. Such non-Rice employees may include Visiting Scholars, Complimentary Scientists, etc. Please contact the Rice University Risk Manager Renee Block (x4751) to determine eligibility of coverage.

## 1.7.1 MEDICAL EMERGENCIES

### 1.7.1.1 Major Medical Emergencies

- **If it is not practical to move the ill or injured individual**, call the Rice University Police (x6000) and they will obtain an ambulance and escort it to the location of the emergency.
- **DO NOT PLACE A 911 CALL - THE RICE UNIVERSITY POLICE WILL DO THIS.**
- For job sustained injury/illness, all patients should be taken to **Hermann Hospital's Emergency Room**, 6411 Fannin (713-704-4060) or their own hospital of choice. Hospital personnel should be told it is an on-the-job injury for Rice University, if applicable. Proof of Rice employment, such as a campus ID card, will be required. A **First Report of Injury Form** (Appendix E) must also be filed with the Risk Manager, VP for Investments/Treasurer. (Copies of all forms should also be sent to the Chemistry Departments Purchasing Coordinator in SS 216)
- When the injury or illness involves a chemical, a Material Safety Data Sheet (MSDS) should accompany the victim to the hospital.
- *The procedure outlined above applies to all individuals receiving pay from Rice University (which includes graduate students who receive a stipend) who are injured or become ill while performing an activity that directly benefits Rice University. If transportation is unavailable within the injured persons department, a request may be made to the Campus Police to provide such.*
- **Undergraduate Students** who are injured/become ill and who might require hospitalization should go to to **Hermann Hospital's Emergency Room**, 6411 Fannin (713-704-4060) or the hospital of their choice.

### 1.7.1.2 Minor Medical Emergencies

- On-the-job, minor medical injuries/illness (i.e., falls, cuts, sprains and strains) involving employees should be reported immediately to the injured persons supervisor. The supervisor should fill out a [First Report of Injury Form](#) and an [Accident Report Form](#) (See **Appendices D & E** or obtain from the University Risk Manager or the Environmental Health & Safety Department) and provide copies to the department (Purchasing Coordinator in SS 216). If medical attention is required, the injured person should be taken to [Hermann Hospital's Emergency Room, 6411 Fannin \(713-704-4060\)](#) or their **physician of choice**. [Nova Medical Centers](#) is another alternative for on-the-job injuries that are non-emergencies.
- **Undergraduate Students** who incur a minor injury during normal class/working hours should be referred to the [Student Health Services at Brown College, x4966 or x2326](#).

## 1.8 CHEMICAL FUME HOOD EVALUATION

Every laboratory ventilation hood used for the control of air contaminants shall be monitored to assure that adequate airflow is being maintained in order to provide continued protection against employee over-exposure. Laboratory hood airflow shall be considered adequate when the average face velocity equals a minimum of a 60-80 feet/minute with the hood sash at a working height (14 to 20 inches). Other local exhaust ventilation, such as instrument vents, will also be tested. The criteria for minimal acceptable flow shall be determined by the Office of Environmental Health and Safety. **All hoods should be inspected and tested at a minimum of every three years.** Check date of last inspection (sticker placed on front of hood) and call Facilities and Engineering (x2485) or the Office of Environmental Health and Safety at (x4444) to schedule a hood inspection.

If fume hood is malfunctioning call Facilities and Engineering (x2485) or place a work order through FAMIS (<https://famisweb.rice.edu>).

## 1.9 RESPIRATORY PROTECTION PROGRAM

Rice University attempts to minimize employee respiratory exposure to potentially hazardous chemical substances through engineering methods (such as local exhaust ventilation) or administrative control. It is recognized, however, that for certain situations or operations, the use of these controls may not be feasible or practical. Under these circumstances, or while such controls are being instituted, or in emergency situations, the use of personal respiratory protective equipment may be necessary. A sound and effective program is essential to assure that the personnel using such equipment are adequately protected.

If you are using a respirator or have questions concerning the use of respirators or any of the program components, contact your supervisor or the Director, Environmental Health and Safety.

## **1.10 RECORDKEEPING**

All exposure assessments and occupational medical consultation/examination reports will be maintained in a secure area in accordance with OSHA's medical records rule (29 CFR 1910.20).

## **1.11 RESEARCH PROTOCOL CHEMICAL SAFETY REVIEW**

Under some circumstances a particular chemical substance and associated laboratory operation, procedure or activity may be considered sufficiently hazardous and requires prior approval from the department chemical hygiene officer/laboratory supervisor and possibly the Office of Environmental Health and Safety, before research begins. The operations, procedures, and chemical substances listed in Appendix A require prior approval before beginning work. Please check with your supervisor before using any of these chemicals and review the safe handling procedures. In some cases the Office of Environmental Health and Safety may need to approve a protocol before working with extremely hazardous or toxic chemicals. Please call EH&S (x4444) if you have questions about the specifics of these situations.

This approval process will ensure that safeguards are properly set up and that personnel are adequately trained in the procedure.

## **2 STANDARD OPERATING PROCEDURES FOR WORKING WITH CHEMICALS**

### **2.1 GOOD WORK PRACTICES/PROCEDURES FOR HANDLING LABORATORY CHEMICALS**

#### **2.1.1 GENERAL GUIDELINES**

Carefully read the label before using a chemical. The manufacturer's or supplier's Material Safety Data Sheet (MSDS) will provide special handling information. Be aware of the potential hazards existing in the laboratory and the appropriate safety precautions. Know the location and proper use of emergency equipment, the appropriate procedures for responding to emergencies, and the proper methods for storage, transport and disposal of chemicals within the facility.

Do not work alone in the laboratory. If you must work alone, let someone else know and have them periodically check on you.

Label all chemical containers with appropriate identification and hazard information (see Section I, Container Labeling).

Use only those chemicals for which you have the appropriate exposure controls (such as a chemical fume hood) and administrative programs/procedures (training, restricted access, etc.). Always use adequate ventilation with chemicals. Operations using large quantities (500 milliliters) of volatile substances with workplace standards at or below 50 ppm should be performed in a chemical fume hood.

Use hazardous chemicals and all laboratory equipment only as directed or for their intended purpose.

Inspect equipment and apparatus for damage before adding a hazardous chemical. Do not use damaged equipment.

Inspect personal protective apparel and equipment for integrity and proper functioning before use.

Malfunctioning laboratory equipment (hood) should be labeled or tagged "out of service" so that others will not inadvertently use it before repairs are made. Contact Facilities & Engineering (x2485) to schedule repair.

Handle and store laboratory glassware with care. Do not use damaged glassware. Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals or fragments should implosion occur.

Do not dispense more of a hazardous chemical than is needed for immediate use.

### **2.1.2 PERSONAL HYGIENE**

Remove contaminated clothing and gloves before leaving laboratory. Gloves that are even slightly used must be removed before leaving the laboratory. Avoid contamination of common surface areas by not using gloves to answer telephones, open room doors, etc.

Avoid direct contact with any chemical. Keep chemicals off your hands, face and clothing, including shoes. Never smell, inhale, or taste a hazardous chemical. Wash thoroughly with soap and water after handling any chemical.

Smoking, drinking, eating and the application of cosmetics is forbidden in laboratories.

Never pipet by mouth. Use a pipet bulb or other mechanical pipet filling device.

### **2.1.3 HOUSEKEEPING**

Keep floors clean and dry.

Keep all aisles, hallways, and stairs clear of all chemicals. Stairways and hallways should not be used as storage areas.

Keep all work areas, and especially work benches, clear of clutter and obstructions.

All working surfaces should be cleaned regularly.

Access to emergency equipment, utility controls, showers, eyewashes and exits should never be blocked.

Wastes should be kept in the appropriate containers and labeled properly.

Any unlabeled containers are considered wastes at the end of each working day.

## **2.2 WHEN TO REVIEW SAFETY PROCEDURES BEFORE PROCEEDING**

Sometimes laboratory workers should not proceed with what seems to be a familiar task. Hazards may exist that are not fully recognized. Certain indicators (procedural changes) should cause the employee to stop and review the safety aspects of their procedure. These indicators include:

- A new procedure, process or test, even if it is very similar to older practices.
- A change or substitution of any of the ingredient chemicals in a procedure.
- A substantial change in the amount of chemicals used (scale up of experimental procedures); usually one should review safety practices if the volume of chemicals used increases by 200%.
- A failure of any of the equipment used in the process, especially safeguards such as chemical fume hoods.

- Unexpected experimental results (such as a pressure increase, increased reaction rates, unanticipated byproducts). When an experimental result is different from the predicted, a review of how the new result impacts safety practices should be made.
- Chemical odors, illness in the laboratory staff that may be related to chemical exposure or other indicators of a failure in engineered safeguards.

The occurrence of any of these conditions should cause the laboratory employee to pause, evaluate the safety implications of these changes or results, make changes as necessary and proceed cautiously.

## **2.3 PROTECTIVE CLOTHING AND LABORATORY SAFETY EQUIPMENT**

### **2.3.1 GENERAL CONSIDERATION - PERSONAL PROTECTIVE CLOTHING/EQUIPMENT**

[\(http://www.cdc.gov/niosh/npptl/topics/protclothing/\)](http://www.cdc.gov/niosh/npptl/topics/protclothing/)

Personal protective clothing and equipment should be selected carefully and used in situations where engineering and administrative controls cannot be used or while such controls are being established. These devices are viewed as less protective than other controls because they rely heavily on each employee's work practices and training to be effective. The engineering and administrative controls which should always be considered first when reducing or eliminating exposures to hazardous chemicals include:

- **Substitution** of a less hazardous substance
- **Scaling down size of experiment**
- **Substitution** of less hazardous equipment or process (e.g., safety cans for glass bottles)
- **Isolation** of the operator or the process
- **Local and general ventilation** (e.g., use of fume hoods)

The Material Safety Data Sheet (MSDS) will list the personal protective equipment recommended for use with the chemical. The MSDS addresses worst case conditions. Therefore, all the equipment shown may not be necessary for a specific laboratory scale task.

Your supervisor, other sections of this manual or the Environmental Health and Safety Department can assist you in determining which personal protective devices are required for each task. Remember, there is no harm in being overprotected. Appropriate personal protective equipment will be provided to employees.

## 2.3.2 PROTECTION OF SKIN AND BODY

Skin and body protection involves wearing protective clothing over all parts of the body which could become contaminated with hazardous chemicals. Personal protective equipment (PPE) should be selected on a task basis, and checked to ensure it is in good condition prior to use (e.g. no pinholes in gloves).

### 2.3.2.1 Normal clothing worn in the laboratory

When there is no immediate danger to the skin from contact with a hazardous chemical it is still prudent to select clothing to minimize exposed skin surfaces. Employees should wear long sleeved/long legged clothing and avoid short sleeved shirts, short trousers or skirts. A laboratory coat should be worn over street clothes and be laundered regularly. Laboratory coats are intended to prevent contact with dirt, chemical dusts and minor chemical splashes or spills. If it becomes contaminated, it should be removed immediately and affected skin surface washed thoroughly. Shoes should be worn in the laboratory at all times. **Sandals and perforated shoes are not allowed.** In addition, long hair and loose clothing should be confined.

### 2.3.2.2 Protective clothing

Additional protective clothing may be required for some types of procedures or with specific substances (such as when carcinogens or large quantities of corrosives, oxidizing agents or organic solvents are handled). This clothing may include impermeable aprons and gloves as well as plastic coated coveralls, shoe covers, and arm sleeves. Protective sleeves should always be considered when wearing an apron. These garments can either be washable or disposable in nature. Flame resistant lab coats should be worn for [handling pyrophoric reagents](#). They should not be worn outside the laboratory. The choice of garment depends on the degree of protection required and the areas of the body which may become contaminated. Rubberized aprons, plastic coated coveralls, shoe covers, and arm sleeves offer much greater resistance to permeation by chemicals than laboratory coats and, therefore, provide additional time to react (remove the garment and wash affected area) if contaminated.

For work where contamination is possible, special attention must be given to sealing all openings in the clothing. Tape can be utilized for this purpose. In these instances caps should be worn to protect hair and scalp from contamination.

Chemical resistant gloves should be worn whenever the potential for contact with corrosive or toxic substances and substances of unknown toxicity exists. Gloves should be selected on the basis of the materials being handled, the particular hazard involved, and their suitability for the operation being conducted. Before each use, gloves should be checked for integrity. Gloves should be washed prior to removal whenever possible to prevent skin contamination. Non-disposable gloves should be replaced periodically, depending on frequency of use and their resistance to the substances handled.



Remove contaminated clothing and gloves before leaving laboratory. Gloves that are even slightly used must be removed before leaving the laboratory. Avoid contamination of common surface areas by not using gloves to answer telephones, open room doors, etc.

Protective garments are not equally effective for every hazardous chemical. Some chemicals will "break through" the garment in a very short time. Therefore, garment and glove selection is based on the specific chemical utilized. General selection criteria are as follows:

<b>GLOVE TYPE SELECTION GUIDE</b>					
<b>CHEMICAL FAMILY</b>	<b>BUTYL RUBBER</b>	<b>NEOPRENE</b>	<b>PVC (VINYL)</b>	<b>NITRILE</b>	<b>NATURAL LATEX</b>
Acetates	G	NR	NR	NR	NR
Acids, inorganic	G	E	E	E	E
Acids, organic	E	E	E	E	E
Acetonitrile, Acrylonitrile	G	E	G	S	E
Alcohols	E	E	NR	E	E
Aldehydes	E	G	NR	S*	NR
Amines	S	NR	NR	F	NR
Bases, inorganic	E	E	E	E	E
Ethers	G	F	NR	E	NR
Halogens (liquids)	G	NR	F	E	NR
Inks	G	E	E	S	F
Ketones	E	G	NR	NR	G
Nitro compounds (Nitrobenzene, Nitromethane)	G	NR	NR	NR	NR
Oleic Acid	E	E	F	E	NR
Phenols	E	E	NR	NR	G
Quinones	NR	E	G	E	E
Solvents, Aliphatic	NR	NR	F	G	NR
Solvents, Aromatic	NR	NR	F	F	NR

\*Not recommended for Acetaldehyde, use Butyl Rubber

S – Superior, E – Excellent, G – Good, F – Fair, NR - Not Recommended

Double gloves are recommended for working with nanoparticles. Contact the Chemical Hygiene Officer for personal protection equipment selection assistance or information.

### 2.3.3 PROTECTION OF THE EYES

**Eye protection is required for all personnel and any visitors present in locations where chemicals are handled and a chemical splash hazard exists.** Safety glasses, goggles and goggles with face shield should be worn in the laboratory based upon the physical state, the operation or the level of toxicity of the chemical used. Safety glasses effectively protect the eye from solid materials (dusts and flying objects) but are less effective at protecting the eyes from chemical splash to the face. Goggles should be worn in situations where bulk quantities of chemicals are handled and chemical splashes to the face are possible. Goggles form a liquid proof seal around the eyes, protecting them from a splash. When handling highly reactive substances or large quantities of hazardous chemicals, corrosives, poisons, and hot chemicals, goggles with face shield should be worn.

Prescription glasses are not always impact resistant so safety glasses are required to be worn over these glasses.

Contact lenses can increase the risk of eye injury if worn in the laboratory - particularly if they are of the gas permeable variety. Gases and vapors can be concentrated under such lenses and cause permanent eye damage. Chemical splashes to the eye can get behind all types of lenses. Once behind a lens the chemical is difficult to remove with a typical eye wash. For these reasons it is recommended that contact lenses not be worn in laboratories.

Eye and face injuries are prevented by the use of the following:

COMPARISON CHART -- EYE PROTECTION DEVICES									
TYPE	FRONT SPLASH Protection	SIDE SPLASH Protection	FRONT FLYING OBJECT IMPACT Protection	SIDE IMPACT Protection	NECK, FACE Protection	COMFORT TO WEARER	USER ACCEPTANCE	USE LIFETIME	COST
Goggles	Excellent	Excellent	Excellent	Excellent	Poor	Fair	Poor	Fair	Moderate
Glasses (no shields)	Good	Poor	Excellent	Poor	Poor	Good to very good	Very good	Very good	Moderate
Glasses (shields)	Good	Good	Good	Fair	Poor	Good	Good	Very good	Moderate
Face shield (various sizes)	Excellent	Good to excellent	Excellent (if adequate thickness)	Good to excellent	Depends on type and length	Fair	Good for short periods	Fair	Moderate (depending on type)

**SOURCE:** ANSI Z87.1 Occupational and Educational Eye and Face Protection, available from American National Standards Institute, Inc., 1430 Broadway, New York, N.Y. 10018

### 2.3.4 PROTECTION OF THE RESPIRATORY SYSTEM

Inhalation hazards can be controlled using ventilation or respiratory protection. Check the label and MSDS for information on a substance's inhalation hazard and special ventilation requirements. When a potential inhalation hazard exists, a substance's label or MSDS contains warnings such as:

- Use with adequate ventilation
- Avoid inhalation of vapors
- Use in a fume hood
- Provide local ventilation

Take appropriate precautions before using these substances. Controlling inhalation exposures via engineering controls (ventilation) is always the preferred method (See Section 2.3.5.1). As with other personal protective equipment, respiratory protection relies heavily on employee work practices and training to be effective.

#### Use of Respirators

Respirators are designed to protect against specific types of substances in limited concentration ranges. Respirators must be selected based on the specific type of hazard (toxic chemical, oxygen deficiency, etc.), the contaminant's anticipated airborne concentration, and required protection factors.

Types of respiratory protective equipment include:

- Particle-removing air purifying respirators
- Gas and vapor-removing air purifying respirators
- Atmosphere supplying respirators

Respirators are not to be used except in conjunction with a complete respiratory protection program as required by OSHA. If your work requires the use of a respirator, contact your supervisor and the Environmental Health and Safety Department. See Section 1.9 for additional information.

### 2.3.5 LABORATORY SAFETY EQUIPMENT

#### 2.3.5.1 Chemical Fume Hoods

In the laboratory the chemical fume hood is the primary means of controlling inhalation exposures. Hoods are designed to retain vapors and gases released within them, protecting the laboratory employee's breathing zone from the contaminant. This protection is accomplished by having a curtain of air (approximately 60-80 linear feet per minute) move constantly through the face (open sash) of the hood. Chemical fume hoods can also be used to isolate apparatus or chemicals that may present physical hazards to employees. The closed sash on a hood serves as an effective barrier to fires, flying objects, chemical splashes or spattering and small implosions and explosions. Hoods can also effectively contain spills which might occur during dispensing procedures particularly if trays are placed in the bottom of the hoods. Hoods are not to be used to dispose of volatile substances. Volatile substances designated as waste should be placed in an appropriate waste container, labeled and picked up for disposal (**See Section 2.8**).

When using a chemical fume hood keep the following principles of safe operation in mind:

- Keep all chemicals and apparatus at least six inches inside the hood (behind sash).
- Hoods are not intended for storage of chemicals. Materials stored in them should be kept to a minimum. Stored chemicals should not block vents or alter air flow patterns.
- Keep the hood sash at a minimum height (4 to 6 inches) when not manipulating chemicals or adjusting apparatus within the hood.
- When working in front of a fume hood, make sure the sash opening is appropriate. This can be achieved by lining up to arrows placed on the sash door and hood frame. This sash opening will ensure an adequate air velocity through the face of the hood.
- Do not allow objects such as paper to enter the exhaust ducts. This can clog ducts and adversely affect their operation.

Follow the chemical manufacturer's or supplier's specific instructions for controlling inhalation exposures with ventilation (chemical fume hood) when using their products. These instructions are located on the products MSDS and/or label. However, it should be noted that these ventilation recommendations are often intended for non-laboratory work environments and must be adapted to suit the laboratory environment as well as the specific procedure or process.

If specific guidance is not available from the chemical manufacturer or supplier, or if the guidance is inappropriate for the laboratory environment, contact the Director of Environmental Health and Safety and/or review the hood use guidelines in the table below. These guidelines are based on information readily available on a chemical's MSDS:

1. Applicable workplace exposure standards [Threshold Limit Values (TLV) or Permissible Exposure Limits (PEL)];
2. Acute and chronic toxicity data (LD<sub>50</sub> and specific organ toxicity); and
3. Potential for generating airborne concentrations (vapor pressure).

These terms are defined in the glossary at the back of this manual. The guidelines outlined in the table below should not be considered as necessary or appropriate in every case, but as reasonable “rules of thumb.”

<b>Guidelines For Chemical Fume Hood Use</b>	
<b>It may be appropriate to use a hood when handling the type of substance listed in column 1 if the exposure standard or toxicological criteria in column 2 applies.</b>	
Column 1 Type Substance & Handling Procedure	Column 2 Exposure Standard or Toxicity of Substance
Substance handled is solid, liquid or gaseous and When other effective controls are not being used.	TLV or PEL < 5 ppm (vapor) or < 0.2 mg/m <sup>3</sup> (particulate) or Oral LD <sub>50</sub> < 10 mg/kg (Rat or Mouse) <sup>(See Note 1 Below)</sup> or Chemicals handled are respiratory sensitizers.
Substance handled is liquid or gaseous and It is handled in large quantities (greater than 500 milliliters) or the procedure used could release the substance to the laboratory atmosphere (heating). Or You may be exposed to the substance (handling it in open containers) for an extended period of time (greater than 2 hrs. per day).	TLV or PEL >5 ppm, but < 50 ppm or Substances handled are toxic to specific organ systems, carcinogens or reproductive toxins with a vapor pressure exceeding 25 mm Hg at 25°C. or Oral LD <sub>50</sub> >10 but < 500 mg/kg (Rat or Mouse) <sup>(See Note 1 Below)</sup>
Substance handled is a solid and The particle size of the material is small (respirable) or consistency of the material is "light and fluffy" and the procedure used may generate airborne particulates.	TLV or PEL >0.2 mg/m <sup>3</sup> , but < 2 mg/m <sup>3</sup> or Oral LD <sub>50</sub> >10 but < 50 mg/kg (Rat or Mouse) <sup>(See Note 1 Below)</sup>

Note 1: The oral LD<sub>50</sub> hood use criteria has been included because it is often the only toxicological data available on a material safety data sheet. The species of animals most often used in these acute toxicity tests are the rat and/or the mouse. The LD<sub>50</sub> criteria outlined in the table is a reasonable "rule of thumb" for materials that require control due to their acute toxicity characteristics. LD<sub>50</sub> data should only be used if other criteria are unavailable.

### 2.3.5.3 Eyewashes and Safety Showers

Whenever chemicals have the possibility of damaging the skin or eyes, an emergency supply of water must be available. All laboratories in which bulk quantities of hazardous chemicals are handled and could contact the eyes or skin resulting in injury should have access to eyewash stations and safety showers. As with any safety equipment, these can only be useful if they are accessible, therefore:

#### **IMPORTANT**

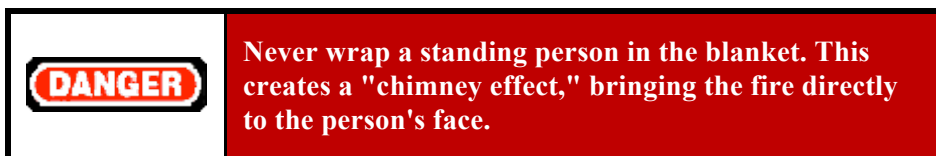
- Keep all passageways to the eyewash and shower clear of any obstacle (even a temporarily parked chemical cart or nearby wash bottle could prevent someone from reaching the area). Keep an area of at least 30 inches around eyewash station free from obstacles.
- Eyewashes should be checked quarterly by the lab safety representative to be certain that water flows through it.
  - The station should only be used if chemicals come in contact with the eyes.
  - Eyelids have to be forcibly kept open to ensure effective washing.
  - Be sure to wash from the nose out to the ear. This will avoid washing chemicals back into the eye or into an unaffected eye.
  - Flood eyes and eyelids with water for a minimum of 15 minutes.
  - Contacts should not be worn during labs. If you are wearing them when involved with an accident, remove them as soon as possible to rinse eyes of any harmful chemicals.
  - Contact the Campus Police at (x6000) for medical attention.
- Safety showers should be checked routinely to assure that access is not restricted and that the start chain is within reach.
  - The flow through the safety showers should be tested periodically to ensure sufficient flow (approximately 60 gallons per minute).
  - The shower provides an effective means of treatment in the event that large amounts of chemicals are spilled or splashed onto the skin or clothing.
  - As long as the hanging handle is pulled down, the safety shower will supply a continuous stream of water to cover the entire body.
  - Individuals should remove clothing, including shoes and jewelry, while under an operating shower.
  - Contact the Campus Police at (x6000) for medical attention.

### 2.3.5.4 Fire Safety Equipment

Fire safety equipment easily accessible to the laboratory must include a fire extinguisher and may include fire hoses, fire blankets, and automatic extinguishing systems. Familiarize yourself with all the fire extinguishers in your area and know what types you may need to use in your research.

#### A. Fire Safety Blanket:

- Fire blankets are not the best means to extinguish a fire. They may be used to extinguish clothing that is burning, but should never be used on any other type of fire.



- Fire extinguishers may be used on a fire involving personal clothing. Fire blankets are a good means to keep shock victims warm.

#### B. Fire Extinguisher:

- Fire extinguishers are classified according to a particular fire type and are given the same letter and symbol classification as that of the fire.

### Fire Extinguisher Ratings



**Class A Extinguishers** will put out fires in ordinary combustibles, such as wood and paper. The numerical rating for this class of fire extinguisher refers to the amount of water the fire extinguisher holds and the amount of fire it will extinguish.



**Class B Extinguishers** should be used on fires involving flammable liquids, such as grease, gasoline, oil, etc. The numerical rating for this class of fire extinguisher states the approximate number of square feet of a flammable liquid fire that a non-expert person can expect to extinguish.



**Class C Extinguishers** are suitable for use on electrically energized fires. This class of fire extinguishers does not have a numerical rating. The presence of the letter “C” indicates that the extinguishing agent is non-conductive.



**Class D Extinguishers** are designed for use on flammable metals and are often specific for the type of metal in question. There is no picture designator for Class D extinguishers. These extinguishers generally have no rating nor are they given a multi-purpose rating for use on other types of fires.



## Types of Fire Extinguishers

**Dry Chemical** extinguishers are usually rated for multiple purpose use. They contain an extinguishing agent and use a compressed, non-flammable gas as a propellant.

**Halon** extinguishers contain a gas that interrupts the chemical reaction that takes place when fuels burn. These types of extinguishers are often used to protect valuable electrical equipment since they leave no residue to clean up. Halon extinguishers have a limited range, usually 4 to 6 feet. The initial application of Halon should be made at the base of the fire, even after the flames have been extinguished.

**Carbon Dioxide** (CO<sub>2</sub>) extinguishers are most effective on Class B and C (liquids and electrical) fires. Since the gas disperses quickly, these extinguishers are only effective from 3 to 8 feet. The carbon dioxide is stored as a compressed liquid in the extinguisher; as it expands, it cools the surrounding air. The cooling will often cause ice to form around the “horn” where the gas is expelled from the extinguisher. Since the fire could re-ignite, continue to apply the agent even after the fire appears to be out.

**Water** These extinguishers contain water and compressed gas and should only be used on Class A (ordinary combustibles) fires.

**The average fire extinguisher only operates about 10 seconds. Don't waste it!**

You must get close to the fire in order to extinguish the flames - as close as 5 or 6 feet!  
(Position yourself between the fire and the nearest exit)

To effectively operate an extinguisher, think **P-A-S-S**.

- P** -- pull the pin
- A** -- aim the hose at the base of the fire
- S** -- squeeze the handle
- S** -- sweep the hose back and forth at the base of the fire



**Contact the Environmental Health and Safety Office for fire extinguisher training and for replacement of used fire extinguishers (x4444).**

### C. Sprinkler System:

**Sprinklers located throughout the lab area are automatically activated.**

- No one should attempt to alter the system in any way.
- Items in the lab should be stored at least 18 inches away from the sprinkler heads.



## 2.4 CHEMICAL PROCUREMENT, DISTRIBUTION, AND STORAGE

### 2.4.1 PROCUREMENT

The University Purchasing Policy must be followed when purchasing all materials. Before a new substance that is known or suspected to be hazardous is received, information on proper handling, storage, and disposal should be known to those who will handle it. It is the responsibility of the supervisor to ensure that the laboratory facilities in which the substance will be handled are adequate and that those who will handle the substance have received the proper training. The necessary information on proper handling of hazardous substances can be obtained from the Material Safety Data Sheets which are provided by the vendor. Because storage in laboratories is restricted to small containers, order small-container lots to avoid hazards associated with repackaging. No container should be accepted without an adequate identifying label as outlined in Section 1.5 of this manual.

### 2.4.2 DISTRIBUTION AND TRANSPORTATION OF CHEMICALS

#### **IMPORTANT:**

When hand-carrying containers of hazardous chemicals or unopened containers with corrosive or highly acutely or chronically toxic chemicals, place the container in a secondary container or bucket.

- Rubberized buckets are commercially available and provide both secondary containment as well as "bump" protection.
- If several bottles must be moved at once, the bottles should be transported on a small cart with a substantial rim to prevent spillage from the cart. If you are using a utility cart to carry more than one chemical, a simple polypropylene tray on the cart will work. Be sure that the size of the tray will contain all of the chemicals you are transporting. Also, make sure that the chemicals placed into the tray are compatible; if the bottles were to break you would not want a chemical reaction to occur while you were in a hallway.



- When transporting dry ice, place a cover over the container to minimize escaping carbon dioxide.

Wear appropriate PPE when transporting chemicals (lab coat, safety glasses, glove on carrying hand, etc.)

Wherever available, a freight elevator should be used to transport chemicals from one floor to another. (*Freight elevators at Rice have special tags denoting them as freight elevators.*)

**Hazardous materials cannot be transported in a personal vehicle. Under no circumstances should one transport hazardous materials to and from the Bioscience Research Collaborative (BRC) from other areas of campus. Only vehicles/vendors with appropriate DOT licensing are allowed to transport hazardous materials to and from the BRC.**

### 2.4.3 CHEMICAL STORAGE IN THE LABORATORY

Carefully read the label before storing a hazardous chemical. The MSDS will provide any special storage information as well as information on incompatibilities. *Do not store unsegregated chemicals in alphabetical order. Do not store incompatible chemicals in close proximity to each other.*

Separate hazardous chemicals in storage as follows:

- Solids:
  1. oxidizers
  2. flammable solids (red phosphorus, magnesium, lithium)
  3. water reactives
  4. others
- Liquids:
  1. acids
  2. oxidizers
  3. flammable/combustible
  4. caustics
  5. perchloric acid
- Gases:
  1. toxic
  2. oxidizers and inert
  3. flammable

Once separated into the above hazard classes, chemicals may be stored alphabetically.

Use approved storage containers and safety cans for flammable liquids. It is preferable to store flammable chemicals in flammable storage cabinets. *Flammable chemicals requiring refrigeration should be stored only in the refrigerators and freezers specifically designed for flammable storage.*

A good place to store hazardous chemicals is a vented cabinet under the hood. Chemicals of different chemical classes can be segregated by placing them in trays. Do not store

chemicals on bench tops or in hoods. **Liquids (particularly corrosives or solvents) should not be stored above eye level (5 feet).**

Use secondary containers (one inside the other) for especially hazardous chemicals (carcinogens, etc.).

Avoid exposure of chemicals while in storage to heat sources (especially open flames) and direct sunlight.

Conduct periodic inventories of chemicals stored in the laboratory (annually) and dispose of old or unwanted chemicals promptly in accordance with the facilities hazardous chemical waste program.

Assure all containers are properly labeled.

Do not store water reactive or sensitive materials under a sink (strong acids, metal hydrides, etc.).

#### **2.4.3.1 Chemical Storage - Chemical Stability**

Stability refers to the susceptibility of a chemical to dangerous decomposition. The label and MSDS will indicate if a chemical is unstable.

**Special note: peroxide formers-** Ethers, liquid paraffins, and olefins form peroxides on exposure to air and light. Peroxides are extremely sensitive to shock, sparks, or other forms of accidental ignition (even more sensitive than primary explosives such as TNT). Since these chemicals are packaged in an air atmosphere, peroxides can form even though the containers have not been opened. Unless an inhibitor was added by the manufacturer, sealed containers of ethers should be discarded after one (1) year. Opened containers of ethers should also be discarded within one (1) year of opening. All such containers should be dated upon receipt and upon opening.

See **Section 3.2, Highly Reactive Chemicals and High energy Oxidizers** for additional information and examples of materials which may form explosive peroxides.

For additional information on chemical stability, contact your supervisor or the Director, Environmental Health and Safety

#### **2.4.3.2 Chemical Storage - Incompatible Chemicals**

Chemical storage guidelines are presented below. Use these to segregate and store chemicals according to their hazard class. This prevents an undesirable chemical reaction from occurring should two or more chemicals accidentally mix. Consult sources such as the substance's Material Safety Data Sheet for specific storage guidelines.

#### **Chemical Incompatibility Matrix**

The chemical incompatibilities shown below are not exhaustive. As a result, it is important for Laboratory personnel to research the properties of the chemicals they are using. Use sources such as [Material Safety Data Sheets](#) (MSDSs) for guidance on chemical

incompatibility. Also ensure you read the container's label – it should also have storage guidelines.

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

X = Not compatible—do not store together

### ***Segregation and Storage With Respect To Hazard Class***

#### **Acids**

- Segregate acids from reactive metals such as sodium, potassium, and magnesium.
- Segregate oxidizing acids from organic acid and flammable and combustible materials.
- Nitric acid and hydrochloric acid may be stored in the same corrosive storage cabinet, but they must be kept in separate drip trays. These can combine to form chlorine and nitrosyl chloride gases—both are toxic.

- Segregate acids from chemicals that could generate toxic or flammable gases upon contact, such as sodium cyanide, iron sulfide and calcium carbide.
- Segregate acids from bases.

#### **Bases**

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

#### **Solvents (Flammable and combustible liquids)**

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

#### **Oxidizers**

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

#### **Cyanides**

- Segregate from aqueous solutions, acids and oxidizers.

#### **Water-Reactive Chemicals**

- Store in a cool, dry place, away from any water source.
- Make certain that a Class D fire extinguisher is available in case of fire.

#### **Pyrophoric Substances**

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

#### **Light-Sensitive Chemicals**

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

#### **Peroxide-Forming Chemicals**

- Most peroxide forming chemicals are also flammable liquids. Therefore, store in airtight containers in a flammable storage locker.

- Segregate from oxidizers and acids.

### **Toxic Chemicals**

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

## Chemical Incompatibility Table

The following table is another resource for determining chemical incompatibilities. Like the preceding matrix, this is not exhaustive. Therefore, use sources such as MSDSs to determine chemical incompatibility. The container's label should also provide storage guidelines.

<b>CHEMICAL</b>	<b>KEEP OUT OF CONTACT WITH</b>
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates and other oxidizers
Acetone	Concentrated nitric and sulfuric acid mixtures, and strong bases
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Alkali metals	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, the halogens
Ammonia, anhydrous	Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenic materials	Any reducing agent
Azides	Acids
Bromine	Same as chlorine
Calcium oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organic or combustible materials
Chromic acid and chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, glycerin, turpentine, alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other

	petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids, organic or inorganic
Cyanides	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Hydrocarbons	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkali
Hydrofluoric acid	Ammonia, aqueous or anhydrous, bases and silica
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, flammable liquids
Hydrogen sulfide	Fuming nitric acid, other acids, oxidizing gases, acetylene, ammonia (aqueous or anhydrous), hydrogen
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Sulfuric acid
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, any heavy metals
Nitrites	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver, mercury
Oxygen	Oils, grease, hydrogen; flammable liquids, solids, or gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease,



	and oils
Peroxides, organic	Acids (organic or mineral), avoid friction, store cold
Phosphorus (white)	Air, oxygen, alkalis, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate and perchlorate	Sulfuric and other acids
Potassium permanganate	Glycerin, ethylene glycol, benzaldehyde, sulfuric acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric Acid	Potassium chlorate, potassium perchlorate, potassium permanganate (or compounds with similar light metals, such as sodium, lithium, etc.)
Tellurides	Reducing agents

(From Manufacturing Chemists' Association, *Guide for Safety in the Chemical Laboratory*, pp. 215–217, Van Nostrand Reinhold, 2nd Edition.)

## 2.5 CHEMICAL SPILLS & ACCIDENTS

### 2.5.1 GENERAL INFORMATION

Try to anticipate the types of chemical spills that can occur in your laboratory and obtain the necessary equipment (spill kits and personal protective equipment) to respond to a minor spill. Learn how to safely clean up minor spills of the chemicals you use regularly. A

MSDS contains special spill clean-up information and should also be consulted. *Chemical spills should only be cleaned up by knowledgeable and experienced personnel.*

**If the spill is too large for you to handle**, is a threat to health safety or the environment, or involves a highly toxic or reactive chemical, **call the Campus Police (x6000)** or the Department of Environmental Safety (x4444).

### **2.5.2 CLEANING UP CHEMICAL SPILLS**

If you are cleaning up a small spill yourself, make sure that you are aware of the hazards associated with the materials spilled, have adequate ventilation (chemical fume hood on) and proper personal protective equipment (minimum - gloves, goggles, and lab coat). Consider all residual chemical and cleanup materials (adsorbent, gloves, etc.) as hazardous waste. Place these materials in a sealed container (plastic bags) and store in a chemical fume hood. Contact the Office of Environmental Health and Safety for disposal instructions.

**Spill kits are available from the Office of Environmental Health and Safety free of charge.** Store the spill kit in an easily accessible area that is clearly labeled.

### **2.5.3 MINOR CHEMICAL SPILL**

- Alert people in immediate area of spill.
- Increase ventilation in area of spill.
- Wear protective equipment, including safety goggles, gloves, and long-sleeve lab coat.
- Avoid breathing vapors from spill.
- Use appropriate kit to neutralize and absorb inorganic acids and bases. Collect residue, place in container, and dispose as hazardous chemical waste.
- For other chemicals, use appropriate kit (mercury spill kit available from EH&S see **Section 2.5.5**) or absorb spill with vermiculite, dry sand, diatomaceous earth or paper towels. Collect residue, place in container, and dispose as chemical waste.
- Clean spill area with water.

### **2.5.4 MAJOR CHEMICAL SPILL**

- Attend to injured or contaminated persons and remove them from exposure.
- Alert people in the laboratory to evacuate.
- If spilled material is flammable, turn off ignition and heat sources. Place other device (plastic bag) over spilled material to keep substance from volatilizing.

- An emergency exhaust purge can be activated in the case of a large chemical spill (liquid or gas) to purge the lab while personnel clean the spill or evacuate.
- Contact the Environmental Health and Safety Department (x4444) and the Campus Police (x6000).
- Close doors to affected area.
- Have a person with knowledge of the incident and laboratory available to answer questions from responding emergency personnel.

### **2.5.5 MERCURY SPILLS**

- Mercury spill kits are available at no cost from the Environmental Health and Safety Department. *Do not use a domestic or commercial vacuum cleaner.*
- Cover small droplets in inaccessible areas with one of the following:
  - Powdered sulfur
  - Powdered zinc

Place residue in a labeled container and dispose of as hazardous chemical waste and call the Environmental Health and Safety Department for pick-up.

### **2.5.6 ALKALI METAL SPILLS**

- Smother with powdered graphite, sodium carbonate, calcium carbonate or "Met-L-X" and call the Environmental Health and Safety Department for an appropriate spill kit.

### **2.5.7 WHITE PHOSPHORUS**

- Smother with wet sand or wet "noncombustible" absorbent and call the Environmental Health and Safety Department for pick-up.

## **2.6 PERSONAL CONTAMINATION AND INJURY**

### **2.6.1 GENERAL INFORMATION**

- Know the locations of the nearest safety shower and eye wash station.
- Report all incidents and injuries to your supervisor. Fill out accident/injury report and Employer's First report of Injury from EHS website, <http://safety.rice.edu/forms.htm>
- If an individual is contaminated or exposed to a hazardous material in your laboratory, do what is necessary to protect their life and health as well as your own. Determine what the individual was exposed to and consult the MSDS which will contain special first aid information.

- Do not move an injured person unless they are in further danger (from inhalation or skin exposure).
- A blanket should be used immediately to protect the victim from shock and exposure.
- Get medical attention promptly by dialing the Campus Police (x6000).

### 2.6.2 CHEMICALS SPILLS ON THE BODY

- Quickly remove all contaminated clothing and footwear.
- Immediately flood the affected body area in cold water for at least 15 minutes. Remove jewelry to facilitate removal of any residual material.
- Wash off chemical with water only. *Do not use neutralizing chemicals, ointments, creams, lotions or salves.*
- Get medical attention promptly.

It should be noted that some chemicals (phenol, aniline,) are rapidly adsorbed through the skin. If a large enough area of skin is contaminated, an adverse health effect (systemic toxicological reaction) may occur immediately to several hours after initial exposure depending on the chemical. Seek medical attention after washing the material off the skin.

### **IMPORTANT: Hydrofluoric Acid**

If the incident involves **hydrofluoric acid (HF)**, immediately wash the affected area of skin at sink or under safety shower. If calcium gluconate gel (available in Chemistry Storeroom) is readily available, limit rinsing to 5 minutes so that application can be quickly initiated to limit the migration of the fluoride ion. Reapply and massage calcium gluconate gel into affected area of skin every 15 minutes. Seek medical attention immediately. Provide the physician with the chemical name and MSDS. Because of the ability of HF to produce severe delayed 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.

### 2.6.3 CHEMICAL SPLASH IN THE EYE

- Irrigate the eyeball and inner surface of eyelid with plenty of cool water for at least 15 minutes. Use eyewash or other water source. Forcibly hold eyelids open to ensure effective wash.
- Get medical attention promptly by contacting the Campus Police (x6000).

### 2.6.4 INGESTION OF HAZARDOUS CHEMICALS

Identify the chemical ingested.

- Get medical attention promptly by contacting the Campus Police (x6000).

- Call the Poison Information Center at Hermann Hospital by calling 713-704-4060.
- Cover the injured person to prevent shock.
- Provide the ambulance crew and physician with the chemical name and any other relevant information. If possible, send the container, MSDS or the label with the victim.

### **2.6.5 INHALATION OF SMOKE, VAPORS AND FUMES**

- Anyone overcome with smoke or chemical vapors or fumes should be removed to uncontaminated air and treated for shock.
- Do not enter the area if you expect that a life threatening condition still exists - oxygen depletion, explosive vapors or highly toxic gases (cyanide gas, hydrogen sulfide, nitrogen oxides, carbon monoxide)
- If CPR certified, follow standard CPR protocols.
- Get medical attention promptly by calling the Campus Police (x6000).

### **2.6.6 BURNS**

#### **2.6.6.1 Burn Definition**

A burn is damage to the skin and sometimes to the underlying tissues. Burns are categorized according to the depth and extent of the damage to the skin:

Superficial burn (also called first-degree burn)

Mildest type of burn

Often caused by ultraviolet light, or very short ("flash") flame exposure

Affects only the outer layer of the skin (epidermis)

Normally does not cause scarring

Takes about three to six days to heal

Superficial partial-thickness burn (also called second-degree burn)

Often caused by a scald (spill or splash) or short ("flash") flame exposure

Affects the outer layer of the skin more deeply, usually causing blistering

May or may not cause scarring, but often does cause long-term skin color changes

Takes about one to three weeks to heal

Deep partial-thickness burn (also called second-degree burn)

Often caused by a scald (spill), may involve flame, oil, or grease

Affects the outer and underlying layer of skin (dermis), causing blistering

Usually causes scarring

Usually takes more than three weeks to heal

Full-thickness burn (also called third-degree burn)

Very serious

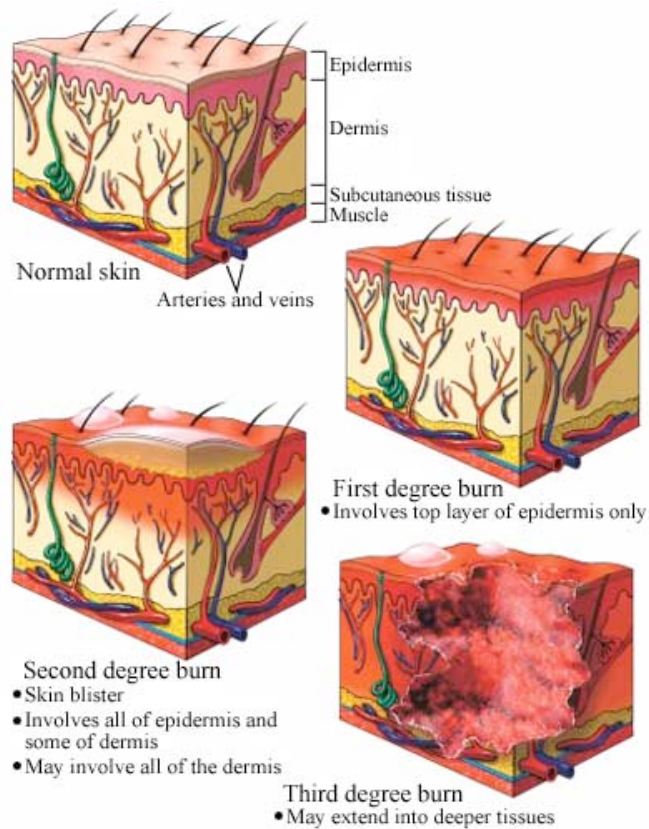
Often caused by scald (immersion), may involve flame, steam, oil, grease, chemicals, or high-voltage electricity

Damages all layers of the skin, and may involve the tissues underneath (muscle and bone)

Causes scarring

Will heal only at the wound edges by scarring, unless skin grafting is done.

### 2.6.6.2 Burn Classification



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### **2.6.6.3 Burn Symptoms**

Burn symptoms and signs vary depending on the type of burn.

#### **Superficial Burn**

Symptoms include:

- Burned area turns red and is painful

- The area blanches (turns white) when you press on it

- The area may swell, but it is dry and there is no blistering

#### **Superficial Partial-thickness Burn**

Symptoms include:

- Blisters

- The area is moist, red, and weeping

- The area blanches (turns white) when you press on it

- Painful to air and temperature

#### **Deep Partial-thickness Burn**

Symptoms include:

- Blisters, usually loose and easily unroofed

- The area can be wet or waxy dry

- The skin color can vary from pale, to yellow-white, to red

- The area does not blanch (turn white) with pressure

- May or may not be painful, can perceive pressure

#### **Full-thickness Burn**

Symptoms include:

- Skin can appear waxy white, leathery gray, or charred and blackened

- May not be painful if nerves have been damaged, the only sensation may be to deep pressure

#### **2.6.6.4 Treatment of Burns**

Treatment for a burn depends on the cause. Quick treatment is important and can lessen the damage to the tissues.

##### **General Guidelines for Self Care of Burns:**

You can treat a superficial burn as minor, *unless* it involves large areas of the hands, feet, face, eyes, groin, buttocks, or a major joint. For these areas, or severe and extensive sunburn, see your doctor immediately.

You can treat a superficial partial-thickness burn as minor if it is no bigger than 2 to 3 inches in diameter. However, if the burned area is larger, or if the burn is on the hands, feet, face, eyes, groin, buttocks, or a major joint, seek medical attention immediately.

For more serious burns, like deep partial-thickness or full-thickness burns, seek medical attention immediately or call the Campus Police at x6000.

For more serious burns, until an emergency unit arrives:

Do not take off any clothing that is stuck to the burn

Make sure the victim is not near or in contact with any smoldering materials, or exposed to further smoke or heat

Do not soak the burn in water, but you can cover the area with a cool moist sterile bandage or clean cloth

As with any severe injury, make sure the person is breathing and administer CPR if necessary

##### **First Aid for Minor Burns**

Cool the burn with running water or a cold damp cloth. Do not use ice--this may result in more damage to the skin.

Do not use butter, grease, oils, or ointments on the burn.

Cover the burn with sterile gauze or a clean cloth.

Do not use a fluffy cloth such as a towel or blanket.

Take an over-the-counter pain reliever, like acetaminophen (Tylenol).

Do not break or pop any blisters. This may result in an infection

If you see signs of infection, get medical attention.



Once a minor burn is completely cooled you can consider using a fragrance free lotion or moisturizer to prevent drying and make the area more comfortable.

### **Special Cases:**

#### **First Aid for Chemical Burns**

1. If the chemical causing the burn is a powder, brush the powder away from the skin first.
2. Check the package insert for emergency information. For certain dry or powdered chemicals it may not be appropriate to flush the skin with water.
3. If indicated, flush the skin with cool running water for 20 minutes or more.
4. Remove any contaminated clothing or jewelry while flushing the skin.
5. If the eyes are affected, flush eyes with cold water until medical help arrives.
6. Cover burn with sterile gauze or a clean cloth. Do not use a fluffy cloth such as a towel or blanket.
7. Do not break or pop any blisters.
8. Keep the person from becoming chilled or overheated.
9. Seek medical attention and bring MSDS sheet of chemical involved with you.

#### **First Aid for Electrical Burns**

Stop the electrical current by unplugging the appliance from the electrical outlet. **Do not touch the person until the current has been stopped.**

If you cannot turn off the source of the electricity, move the source away from you and the person by using a non-conducting object, such as cardboard, plastic, or wood.

Once you and the person are clear of the source of electricity, check the person for airway, breathing, and circulation. Start CPR if necessary and call the campus police (x6000).

Do not break or pop any blisters.

Keep the person from becoming chilled or overheated.

All patients with electrical burns or jolts need to go to a hospital immediately. Electrical burns can cause serious internal damage, without much evidence on the skin. In such cases, people need to be evaluated for heart rhythm disturbances as well as burns.

### **First aid for Cold Burns**

If a cold burn occurs such as in accidental contact with liquid nitrogen, once warmed up, it will appear very similar to, and should be treated the same as, a sunburn of comparable magnitude. Warm affected skin slowly using tepid water. Wrap the damaged area in sterile dry gauze, there is almost certainly going to be blistering but be careful to not break open the blisters and seek medical attention at once.

#### **2.6.6.5 Burning Chemicals on Clothing**

- Extinguish burning clothing by using the stop, drop and roll technique or by dousing with cold water, or use an emergency shower **if it is immediately available**.
- Remove contaminated clothing; however, avoid further damage to the burned area. If possible, send clothing with the victim.
- Remove heat with cool water or ice packs until tissue around burn feels normal to the touch.
- Cover injured person to prevent shock.
- Get medical attention promptly.

### **2.7 FIRE AND FIRE RELATED EMERGENCIES**

If you discover a fire or fire-related emergency such as abnormal heating of material, a flammable gas leak, a flammable liquid spill, smoke, or odor of burning, immediately follow these procedures:

- Notify the Campus Police (x6000)
- Activate the building alarm (fire pull station). If not available or operational, verbally notify people in the building.
- Isolate the area by closing windows and doors and evacuate the building.
- Shut down equipment in the immediate area, if possible.
- Use a portable fire extinguisher to:
  - assist oneself to evacuate;
  - assist another to evacuate; and
  - control a small fire, if possible.

Provide the fire/police teams with the details of the problem upon their arrival. Special hazard information you might know is essential for the safety of the emergency responders.

### **If the fire alarms are ringing in your building:**

- You must evacuate the building (even if there is an anticipated fire drill) and stay out until notified to return.
- Move up wind from the building and stay clear of streets, driveways, sidewalks and other access ways to the building.
- Each lab needs to designate a pre-assigned area outside the building for personnel to assemble after a fire alarm so that a count can be taken. If you are a supervisor, account for your employees, keep them together and report any missing persons to the emergency personnel at the scene.

## **2.8 HAZARDOUS WASTE DISPOSAL PROGRAM**

Laboratory hazardous "chemical" waste must be disposed of in accordance with local, state, federal and Rice University requirements. These waste management practices are designed to ensure maintenance of a safe and healthful environment for laboratory employees and the surrounding community without adversely affecting the environment. This is accomplished through regular removal of hazardous waste and disposal of these wastes in compliance with all regulations and policies.

**Specific guidance on how to identify, handle, collect, segregate, store and dispose of chemical waste is available from the Environmental Health and Safety Department (x4444).**

### **2.8.1 GENERAL GUIDELINES**

- Hazardous waste shall be disposed of in a timely manner.
- Hazardous waste containers must be closed at all times during storage, except when waste is being added or removed.
- All hazardous waste must be properly labeled and dated at the time the waste is first placed in the container.
- Do not use sinks, fume hood sinks or trash containers for hazardous waste disposal.
- Generators of hazardous waste are required to incorporate waste minimization into their process generating hazardous waste.
- Empty containers should be rinsed with compatible solvents to remove residual chemicals from container. If chemical is not compatible with water, a compatible solvent must be used to rinse container with the waste being generated transferred to the proper waste container. If chemical is water-compatible, rinse with water and dispose of washes in the aqueous waste container (not down the drain). If bottle can be rinsed and completely dried with no further chemical residue it can be disposed of according to your buildings container disposal process. Deface label with a

permanent marker and mark “Trash” on it and initial it (in case questions arise about the origin of the bottle) when ready for disposal.

## **2.8.2 BULK CHEMICAL WASTE**

Because you work in the laboratory, you spend a great deal of time in close proximity with various hazardous substances. Yet, you may not be aware that the cost of chemical waste disposal in some cases is two to three times the purchase cost of the chemical. For cost control reasons, it is very important that you follow the waste disposal guidelines of the university.

5-gallon waste containers designated for the disposal of spent organic materials, are available free of charge from EH&S. Spent chlorinated and non chlorinated organic materials must be collected in separated containers. Containers should not be stacked, Instead, call for waste pick-up or place in a safety cabinet. If additional 5-gallon plastic containers are needed, please contact the Environmental Health & Safety Department, x4444.

## **2.8.3 OTHER CHEMICAL WASTE**

Chemical waste that cannot be poured into the 5-gallon waste containers may be disposed of by lab-pack procedures. EH&S has contracted with a waste disposal company to "lab-pack" materials that cannot be fuel blended. To have lab-pack waste removed from your laboratory, complete a Hazardous Waste Disposal Tag (available from EH&S), attach the tag to the container of waste and contact EH&S at x4444 for a pick up. Guidelines for appropriate waste containers are on the back of the tags.

All containers must be labeled with the chemical contents and dated when the container was placed in use. Under no circumstances should any container of spent material remain in the laboratory more than 90 days. These requirements are federal law!

## **2.8.4 BIOHAZARDOUS CHEMICAL WASTE**

Currently, Texas' solid waste disposal regulations do not permit pathological or biohazardous waste in industrial or municipal landfills. EH&S has contracted with a company to pick up this type of waste from campus on a routine basis. Waste must be placed in a box provided by the contractor and sealed prior to shipment. Each box is limited to 40 lbs. Please contact EH&S to obtain biohazard disposal boxes or to schedule a pickup.

Do not use biohazard waste bags for disposal of ordinary trash. If additional trash bags are needed, contact Custodial Services at x2536.

## **2.8.5 SHARPS DISPOSAL**

What are sharps? Any material that has the potential to penetrate a trash bag and cut or puncture housekeeping personnel. Examples include razor blades, needles, scalpels, etc. All sharps should be disposed by placing these items in a sharps container (obtain from EH&S or chemistry storeroom at no cost).

## **2.8.6 BROKEN GLASS**

Broken glass should be disposed of in a broken glass container (available from the Chemistry Stockroom). If a broken glass container is not available, a heavy-duty cardboard box will do. Place the material in the box. When you are ready for disposal, tape the lid closed, mark the box "broken glass," and take the box to the loading dock of your building. Do not overload the box or place any liquid in the box.

### **2.8.7 GAS CYLINDERS**

If a gas cylinder was purchased through the Chemistry Storeroom, contact the Storeroom (x 3275 or [chst@rice.edu](mailto:chst@rice.edu)) for information regarding pick-up/return. If a gas cylinder is from an unknown source and needs to be disposed contact EH&S (x4444). All gas cylinders must be safely secured and have a cap securely in place.

### **2.8.8 RADIOACTIVE WASTE**

Radioactive waste/materials require special handling. Short half-life waste should be held for decay and then disposed of as chemical waste or placed in the trash. **If you have any questions, please contact the Environmental Health & Safety Department, x4444.**

# **3 HEALTH AND SAFETY INFORMATION FOR WORK WITH CHEMICALS OF SPECIFIC HAZARD CLASS**

## **3.1 FLAMMABLE LIQUIDS**

### **3.1.1 GENERAL INFORMATION**

Flammable liquids are among the most common of the hazardous materials found in laboratories. They are usually highly volatile (have high vapor pressures at room temperature) and their vapors, mixed with air at the appropriate ratio, can ignite and burn. By definition, the lowest temperature at which they can form an ignitable vapor/air mixture (the flash point) is less than 37.8 °C (100°F) and for several common laboratory solvents (ether, acetone, toluene, acetaldehyde) the flash point is well below that. As with all solvents, their vapor pressure increases with temperature and, therefore, as temperatures increase they become more hazardous.

For a fire to occur, three distinct conditions must exist simultaneously:

1. the concentration of the vapor must be between the upper and lower flammable limits of the substance (the right fuel/air mix);
2. an oxidizing atmosphere, usually air, must be available; and
3. a source of ignition must be present.

Removal of any of these three conditions will prevent the start of a fire. Flammable liquids may form flammable mixtures in either open or closed containers or spaces (such as refrigerators), when leaks or spills occur in the laboratory, and when heated.

Control strategies for preventing ignition of flammable vapors include removing all sources of ignition or maintaining the concentration of flammable vapors below the lower flammability limit by using local exhaust ventilation such as a hood. The former strategy is more difficult because of the numerous ignition sources in laboratories. Ignition sources include: open flames, hot surfaces, operation of electrical equipment, and static electricity.

The concentrated vapors of flammable liquids are heavier than air and can travel away from a source a considerable distance (across laboratories, into hallways, down elevator shafts or stairways). If the vapors reach a source of ignition, a flame can result that may flash back to the source of the vapor.

The danger of fire and explosion presented by flammable liquids can usually be eliminated or minimized by strict observance of safe handling, dispensing, and storing procedures.

### 3.1.2 SPECIAL HANDLING PROCEDURES

While working with flammable liquids you should wear gloves, protective glasses, and long sleeved lab coats. Wear goggles if dispensing solvents or performing an operation which could result in a splash to the face.

Large quantities of flammable liquids should be handled in a chemical fume hood or under some other type of local exhaust ventilation. Five gallon containers must be dispensed to smaller containers in a hood or under local exhaust ventilation. When dispensing flammable solvents into small storage containers, use metal or plastic containers or safety cans (avoid glass containers).

Make sure that metal surfaces or containers through which flammable substances are flowing are properly grounded, discharging static electricity. Free flowing liquids generate static electricity which can produce a spark and ignite the solvent.

Large quantities of flammable liquids must be handled in areas free of ignition sources (including spark emitting motors and equipment) using non-sparking tools. Remember that vapors are heavier than air and can travel to a distant source of ignition.

Never heat flammable substances by using an open flame. Instead, use any of the following heat sources: steam baths, water baths, oil baths, heating mantles or hot air baths.

Do not distill flammable substances under reduced pressure.

Store flammable substances away from ignition sources. The preferred storage location is in flammable storage cabinets. Flammable storage cabinets are to remain closed at all times except when chemicals are being transferred in or out of the cabinet. If no flammable storage cabinet is available, ask about alternate flammable storage near to the lab. Five gallon flammable containers should only be stored in a flammable storage cabinet or under a hood. You can also keep the flammable liquids inside the hood for a short period of time. Storage in chemical fume hood is not preferred because it reduces hood performance by obstructing air flow.

**The volume of flammable liquids stored (not including safety cans) in the open areas of laboratories should not exceed 10 gallons in most laboratories.** Never store glass containers of flammable liquids on the floor.

Oxidizing and corrosive materials should not be stored in close proximity to flammable liquids.

Flammable liquids should not be stored or chilled in domestic refrigerators and freezers but only in units specifically designed for this purpose (manufacturers clearly label these special refrigerators/freezers as to whether they are rated for flammable storage).

If flammable liquids will be placed in ovens, make sure they are appropriately designed for flammable liquids (no internal ignition sources and/or vented mechanically).

## 3.2 HIGHLY REACTIVE CHEMICALS & HIGH ENERGY OXIDIZERS

### 3.2.1 GENERAL INFORMATION

Highly reactive chemicals include those which are inherently unstable and susceptible to rapid decomposition as well as chemicals which, under specific conditions, can react alone, or with other substances in a violent uncontrolled manner, liberating heat, toxic gases, or leading to an explosion. Reaction rates almost always increase dramatically as the temperature increases. Therefore, if heat evolved from a reaction is not dissipated, the reaction can accelerate out of control and possibly result in injuries or costly accidents.

Air, light, heat, mechanical shock (when struck, vibrated or otherwise agitated), water, and certain catalysts can cause decomposition of some highly reactive chemicals, and initiate an explosive reaction. Hydrogen and chlorine react explosively together in the presence of light. Alkali metals, such as sodium, potassium and lithium, react violently with water liberating hydrogen gas. Examples of shock sensitive materials include acetylides, azides, organic nitrates, nitro compounds, and many peroxides.

**Organic peroxides** are a special class of compounds that have unusual stability problems, making them among the most hazardous substances normally handled in the laboratories. As a class, organic peroxides are low powered explosives. Organic peroxides are extremely sensitive to light, heat, shock, sparks, and other forms of accidental ignition; as well as to strong oxidizing and reducing materials. All organic peroxides are highly flammable.

**Peroxide formers** can form peroxides during storage and especially after exposure to the air (once opened). Peroxide forming substances include: aldehydes, ethers (especially cyclic ether), compounds containing benzylic hydrogen atoms, compounds containing the allylic structure (including most alkenes), vinyl and vinylidene compounds.

Examples of shock sensitive chemicals, high energy oxidizers and substances which can form explosive peroxides are listed at the end of this section.

### 3.2.2 SPECIAL HANDLING PROCEDURES

Before working with a highly reactive material or high energy oxidizer, review available reference literature to obtain specific safety information. The proposed reactions should be discussed with your supervisor. Always minimize the amount of material involved in the experiment; the smallest amount sufficient to achieve the desired result should be used. Scale-ups should be handled with great care, giving consideration to the reaction vessel size and cooling, heating, stirring and equilibration rates.

Excessive amounts of highly reactive compounds should not be purchased, synthesized, or stored in the laboratories. The key to safely handling reactive chemicals is to keep them isolated from the substances that initiate their violent reactions. Unused peroxides should not be returned to the original container.



Do not work alone. All operations where highly reactive and explosive chemicals are used should be performed during the normal work day or when other employees are available either in the same laboratory or in the immediate area.

Perform all manipulations of highly reactive or high energy oxidizers in a chemical fume hood. (Some factors to be considered in judging the adequacy of the hood include its size in relation to the reaction and required equipment, the ability to fully close the sash, and the composition of the sash.)

Make sure that the reaction equipment is properly secured. Reaction vessels should be supported from beneath with tripods or lab jacks. Use shields or guards which are clamped or secured.

If possible, use remote controls for controlling the reaction (including cooling, heating and stirring controls). These should be located either outside the hood or at least outside the shield.

Handle shock sensitive substances gently; avoid friction, grinding, and all forms of impact. Glass containers that have screw-cap lids or glass stoppers should not be used. Polyethylene bottles that have screw-cap lids may be used. Handle water-sensitive compounds away from water sources. Light-sensitive chemicals should be used in light-tight containers. Handle highly reactive chemicals away from the direct light, open flames, and other sources of heat. Oxidizing agents should only be heated with fiberglass heating mantles or sand baths.

High energy oxidizers, such as perchloric acid, should only be handled in a wash down hood (contact EH&S for campus locations) if the oxidizer will volatilize and potentially condense in the ventilation system. Inorganic oxidizers such as perchloric acid can react violently with most organic materials.

When working with highly reactive compounds and high energy oxidizers, always wear the following personal protection equipment: lab coats, gloves, and protective glasses/goggles. During the reaction, a face shield long enough to give throat protection should be worn.

### **IMPORTANT:**

Labels on peroxide forming substances should contain the date the container was received, first opened and the initials of the person who first opened the container. They should be checked for the presence of peroxides before using, and quarterly while in storage (peroxide test strips are commercially available). If peroxides are found, the materials should be decontaminated, if possible, or disposed. The results of any testing should be placed on the container label. Never distill substances contaminated with peroxides. Peroxide forming substances that have been opened for more than one year should be discarded. *Never use a metal spatula with peroxides. Contamination by metals can lead to explosive decompositions.*

Store highly reactive chemicals and high energy oxidizers in closed cabinets segregated from the materials with which they react and, if possible, in secondary containers. You can

also store them in the cabinet under a hood. Do not store these substances above eye level (5 feet) or on open shelves.

Store peroxides and peroxide forming compounds at the lowest possible temperature. If you use a refrigerator, make sure it is appropriately designed for the storage of flammable substances. Store light-sensitive compounds in the light-tight containers. Store water-sensitive compounds away from water sources.

**Shock sensitive materials should be discarded after one year if in a sealed container and within six months of opening unless an inhibitor was added by the manufacturer.**

### 3.2.3 LIST OF SHOCK SENSITIVE CHEMICALS

Shock sensitive refers to the susceptibility of the chemical to rapidly decompose or explode when struck, vibrated or otherwise agitated. The following are examples of materials which can be shock sensitive:

Acetylides of heavy metals	Heavy metal azides	Picramic acid
Aluminum ophrite explosive	Hexanite	Picramide
Amatol	Hexanitrodiphenylamine	Picratol
Ammonal	Hexanitrostilbene	Picric acid
Ammonium nitrate	Hexogen	Picryl chloride
Ammonium perchlorate	Hydrazinium nitrate	Picryl fluoride
Ammonium picrate	Hyrazoic acid	Polynitro aliphatic compounds
Ammonium salt lattice	Lead azide	Potassium nitroaminotetrazole
Butyl tetryl	Lead mannite	Silver acetylide
Calcium nitrate	Lead mononitroresorcinate	Silver azide
Copper acetylide	Lead picrate	Silver styphnate
Cyanuric triazide	Lead salts	Silver tetrazene
Cyclotrimethylenetrinitramine	Lead styphnate	Sodatol
Cyclotetramethylenetrinitramine	Trimethylolethane	Sodium amatol
Dinitroethyleneurea	Magnesium ophorite	Sodium dinitro-orthocresolate

Dinitroglycerine	Mannitol hexanitrate	Sodium picramate
Dinitrophenol	Mercury oxalate	Styphnic acid
Dinitrophenolates	Mercury tartrate	Tetrazene
Dinitrophenyl hydrazine	Mononitrotoluene	Tetranitrocarbazole
Dinitrotoluene	Nitrated carbohydrate	Tetrytol
Dipicryl sulfone	Nitrated glucoside	Trimonite
Dipicrylamine	Nitrated polyhydric alcohol	Trinitroanisole
Erythritol tetranitrate	Nitrogen trichloride	Trinitrobenzene
Fulminate of mercury	Nitrogen triiodide	Trinitrobenzoic acid
Fulminate of silver	Nitroglycerin	Trinitrocresol
Fulminating gold	Nitroglycide	Trinitro-meta-cresol
Fulminating mercury	Nitroglycol	Trinitronaphtalene
Fulminating platinum	Nitroguanidine	Trinitrophenetol
Fulminating silver	Nitroparaffins	Trinitrophenol
Gelatinized nitrocellulose	Nitronium perchlorate	Trinitroresorcinol
Germane	Nitrourea	Tritonal
Guanyl nitrosamino	Organic amine nitrates	Urea nitrate
Guanyl-tetrazene	Organic nitramines	
Guanyl nitrosaminoguanilydene-hydrazine	Organic peroxides	

### 3.2.4 LIST OF HIGH ENERGY OXIDIZERS

The following are examples of materials which are powerful oxidizing reagents:

Ammonium permanganate	Fluorine	Potassium perchlorate
Barium peroxide	Hydrogen peroxide	Potassium peroxide
Bromine	Magnesium perchlorate	Propyl nitrate
Calcium chlorate	Nitric acid	Sodium chlorate
Calcium hypochlorite	Nitrogen peroxide	Sodium chlorite
Chlorine trifluoride	Perchloric acid	Sodium perchlorate
Chromium anhydride or chromic acid	Potassium bromate	Sodium peroxide

### 3.2.5 LIST OF PEROXIDE FORMERS

The following are examples of the materials commonly used in laboratories that may form explosive peroxides:

Acetal	Dicyclopentadiene	3-Methyl-1-butanol
Acetaldehyde	Diethylene glycol dimethyl ether	Methyl cyclopentane
Benzyl Alcohol	Dioxane	Methyl isobutyl ketone
Butadiene	Divinyl acetylene	4-Methyl-2-pentanol
2-Butanol	Ethylene glycol dimethyl ether	2-Pentanol
Chloroprene	Ethyl ether	4-Penten-1-ol
Cyclohexanol	Furan	1-Phenylethanol
Cyclohexene	4-Heptanol	Tetrafluoroethylene
2-Cyclohexene-1-ol	2-Hexanol	Tetrahydrofuran
Cyclopentene	Isopropyl ether	Tetrahydronaphthalene
Decahydronaphthalene	Isopropyl benzene	Vinyl ethers
Diacetylene	Methyl acetylene	

**While much attention has been paid to peroxide forming chemicals, many non-peroxide chemicals are also explosive hazards. The bottom line is not all chemicals have to be peroxides or potential peroxide formers to pose an explosion hazard such as picric and perchloric acids.**

## 3.3 COMPRESSED GASES

### 3.3.1 GENERAL INFORMATION

Compressed gases are unique in that they represent both a physical and a potential chemical hazard (depending on the particular gas). Gases contained in cylinders may be from any of the hazard classes described in this section (flammable, reactive, corrosive, or toxic). Because of their physical state (gaseous), concentrations in the laboratory can increase instantaneously if leaks develop at the regulator or piping systems, creating the potential for a toxic chemical exposure or a fire/explosion hazard. Often there is little or no indication that leaks have or are occurring. Finally, the large amount of potential energy

resulting from compression of the gas makes a compressed gas cylinder a potential rocket or fragmentation bomb if the tank or valve is physically broken.

### 3.3.2 SPECIAL HANDLING PROCEDURES

The contents of any compressed gas cylinder should be clearly identified. No cylinder should be accepted for use that does not legibly identify its contents by name. Color coding is not a reliable means of identification and labels on caps have no value as caps are interchangeable.

Carefully read the label before using or storing compressed gas. The MSDS will provide any special hazard information.

Transport gas cylinders in carts one or two at a time only while they are secured and capped. All gas cylinders should be capped and secured when stored. Use suitable racks, straps, chains or stands to support cylinders. **All cylinders, full or empty, must be restrained and kept away from heat sources.** Store as few cylinders as possible in your laboratory.

Use only Compressed Gas Association standard combinations of valves and fittings for compressed gas installations. Always use the correct pressure regulator. Do not use a regulator adaptor.

All gas lines leading from a compressed gas supply should be clearly labeled identifying the gas and the laboratory served.

Place gas cylinders in such a way that the cylinder valve is accessible at all times. The main cylinder valve should be closed as soon as the gas flow is no longer needed. Do not store gas cylinders with pressure on the regulator. Use the wrenches or other tools provided by the cylinder supplier to open a valve if available. Do not use pliers to open a cylinder valve.

Use soapy water to detect leaks. Leak-test the regulator, piping system and other couplings after performing maintenance or modifications which could affect the integrity of the system.

Oil or grease on the high pressure side of an oxygen cylinder can cause an explosion. Do not lubricate an oxygen regulator or use a fuel/gas regulator on an oxygen cylinder.

Never bleed a cylinder completely empty. Leave a slight pressure to keep contaminants out (172 kPa or 25 psi). Empty cylinders should not be refilled in the laboratories unless equipped to prevent overfilling.

All gas cylinders should be clearly marked with appropriate tags indicating whether they are in use, full, or empty. Empty and full cylinders should not be stored in the same place.

Cylinders of toxic, flammable or reactive gases should be purchased in the smallest quantity possible and stored/used in a fume hood or under local exhaust ventilation. If at all possible, avoid the purchase of lecture bottles. These cylinders are not returnable and it is

extremely difficult and costly to dispose of them. Use the smallest returnable sized cylinder.

Wear safety goggles when handling compressed gases.

### **3.3.3 SPECIAL PRECAUTIONS FOR HYDROGEN**

Hydrogen gas has several unique properties which make it potentially dangerous to work with. It has an extremely wide flammability range (LEL 4%, UEL 74.5%) making it easier to ignite than most other flammable gases. Unlike most other gases, hydrogen's temperature increases during expansion. If a cylinder valve is opened too quickly, the static charge generated by the escaping gas may cause it to ignite. Hydrogen burns with an invisible flame. Caution should therefore be exercised when approaching a suspected hydrogen flame. A piece of paper can be used to tell if the hydrogen is burning. Hydrogen embrittlement can weaken carbon steel, therefore cast iron pipes and fittings shall not be used. Those precautions associated with other flammable substances also apply to hydrogen (see Section 3.1).

## **3.4 NANOPARTICLES**

### **3.4.1 GENERAL INFORMATION**

Occupational health risks associated with manufacturing and using nanomaterials are not yet clearly understood. The rapid growth of nanotechnology is leading to the development of new materials, devices and processes that lie far beyond our current understanding of environmental and human impact. Many nanomaterials and devices are formed from nanometer-scale particles (nanoparticles) that are initially produced as aerosols or colloidal suspensions. Exposure to these materials during manufacturing and use may occur through inhalation, dermal contact and ingestion. Minimal information is currently available on dominant exposure routes, potential exposure levels and material toxicity. What information does exist comes primarily from the study of ultra fine particles (typically defined as particles smaller than 100 nanometers).

Workers within nanotechnology-related industries have the potential to be exposed to uniquely engineered materials with novel sizes, shapes and physical and chemical properties, at levels far exceeding ambient concentrations. To understand the impact of these exposures on health, and how best to devise appropriate exposure monitoring and control strategies, much research is still needed. Until a clearer picture emerges, the limited evidence available would suggest caution when potential exposures to nanoparticles may occur.

### 3.4.2 REASONABLE CONTROL STRATEGIES FOR WORKING WITH NANOPARTICLES

- Total enclosure of the process
- Storage of all nano-materials in total enclosure
- Working with nanoparticles in a hood at all times
- General ventilation
- Limitation of numbers of workers and exclusion of others
- Reduction in periods of exposure, via SOP's and personnel training
- Regular wet-cleaning of wall and other surfaces; documented wet-cleaning schedule
- Use of appropriate personal protective equipment (lab coat, double gloves, safety glasses as well as a respirator such as a N95 or P100 if necessary)
- Prohibition of eating and drinking in laboratories and controlled areas
- Transport of nano-materials within secondary containment device
- Immediate wet-cleanup of all spills & discharges
- Collection of all nanoparticle waste materials for disposal in compliance with the Rice University Hazardous Waste Management Plan (see Section 2.8)

## 3.5 CORROSIVE CHEMICALS

### 3.5.1 GENERAL INFORMATION

The major classes of corrosive chemicals are strong acids and bases, dehydrating agents, and oxidizing agents. These chemicals can erode the skin and the respiratory epithelium and are particularly damaging to the eyes. Inhalation of vapors or mists of these substances can cause severe bronchial irritation. If your skin is exposed to a corrosive, flush the exposed area with water for at least fifteen minutes. Then seek medical treatment.

**Strong acids.** All concentrated acids can damage the skin and eyes and their burns are very painful. Nitric, chromic, and hydrofluoric acids are especially damaging because of the types of burns they inflict. Seek immediate medical treatment if you have been contaminated with these materials (particularly hydrofluoric acid, refer to **Section 2.6.2**).

**Strong alkalis.** The common strong bases used in the labs are potassium hydroxide, sodium hydroxide, and ammonia. Burns from these materials are often less painful than acids. However, damage may be more severe than acid burns because the injured person, feeling little pain, often does not take immediate action and the material is allowed to penetrate into the tissue. Ammonia is a severe bronchial irritant and should always be used in a well-ventilated area, if possible in a hood.

**Dehydrating agents.** This group of chemicals includes concentrated sulfuric acid, sodium hydroxide, phosphorus pentoxide, and calcium oxide. Because much heat is evolved on mixing these substances with water, mixing should always be done by adding the agent to water, and not the reverse, to avoid violent reaction and spattering. Because of their affinity for water, these substances cause severe burns on contact with skin. Affected areas should be washed promptly with large volumes of water.

**Oxidizing agents.** In addition to their corrosive properties, powerful oxidizing agents such as perchloric and chromic acids (sometimes used as cleaning solutions), present fire and explosion hazards on contact with organic compounds and other oxidizable substances. The hazards associated with the use of perchloric acid are especially severe. It should be handled only after thorough familiarization with recommended operating procedures (see section on reactives & high energy oxidizers).

### **3.5.2 SPECIAL HANDLING PROCEDURES**

Corrosive chemicals should be used in the chemical fume hood or over plastic trays when handled in bulk quantities (> 1 liter) and when dispensing.

When working with bulk quantities of corrosives, wear gloves, face shields, laboratory coats, and rubber aprons.

If you are handling bulk quantities on a regular basis, an eyewash station and a safety shower should be immediately available and close by. Spill materials - absorbent pillows, neutral absorbent materials or neutralizing materials (all commercially available) should also be available in the laboratory.

Store corrosive chemicals in cabinets, under the hood or on low shelves (preferably in impervious trays to separate them physically from other groups of chemicals). Keep containers not in use in storage areas and off bench tops.

**If it is necessary to move bulk quantities from one laboratory to another or from the stockroom, use a safety carrier (rubber bucket for secondary containment and protection of the container) or cart for transport.**

## **3.6 CHEMICALS OF HIGH ACUTE & CHRONIC TOXICITY**

### **3.6.1 GENERAL INFORMATION**

Substances that possess the characteristic of high acute toxicity can cause damage after a single or short term exposure. The immediate toxic effects to human health range from irritation to illness and death. Hydrogen cyanide, phosgene, and nitrogen dioxide are examples of substances with high acute toxicity. The lethal oral dose for an average human adult for highly toxic substances range from one ounce to a few drops. **The following procedures should be used when the oral LD<sub>50</sub> of a substance in a rat or mouse is less than 50 milligrams per kilogram body weight for solid materials or non-volatile liquids and 500 mg/kg body weight for volatile liquids or gases.** Oral LD<sub>50</sub> data for the rat or mouse is listed in the substance's MSDS. The LD<sub>50</sub> toxicity test is usually the first toxicological test performed and is a good indicator of a substance's acute toxicity.

Substances that possess the characteristic of high chronic toxicity cause damage after repeated exposure or exposure over long periods of time. Health effects often do not become evident until after a long latency period - twenty to thirty years. Substances that are of high chronic toxicity may be toxic to specific organ systems - hepatotoxins, nephrotoxins, neurotoxins, toxic agents to the hematopoietic system and pulmonary tissue



or carcinogens, reproductive toxins, mutagens, teratogens or sensitizers. The definition of each of these categories of toxic substances, and examples of substances which fall into each of these different categories, can be found in Section 4 of this manual.

Specific acute and chronic toxicity information on the substances used in your laboratory can be found on these substances' MSDS. See Section 1.5.2.1 for information on how to obtain/locate MSDSs. If you have additional questions, contact the Environmental Health and Safety Department

### **3.6.2 SPECIAL HANDLING PROCEDURES**

Avoid or minimize contact with these chemicals by any route of exposure. Protect hands and forearms by wearing gloves and a laboratory coat. Rinse gloves in hood prior to removing them.

Use these chemicals in a chemical fume hood or other appropriate containment device if the material is volatile or the procedure may generate aerosols (See guidelines for chemical fume hood use in Section 2.3.5.1). If a chemical fume hood is used, it should be evaluated to confirm that it is performing adequately (a face velocity of at least 80 linear feet per minute ( $\pm 20\%$ )) with the sash at the operating height.

Store volatile chemicals of high acute or chronic toxicity in the cabinet under the hood or other vented area. Volatile chemicals should be stored in unbreakable primary or secondary containers or placed in chemically resistant trays (to contain spills). Nonvolatile chemicals should be stored in cabinets or in drawers. *Do not store these chemicals on open shelves or counters.*

Decontaminate working surfaces with wet paper towels after completing procedures. Place the towels in plastic bags and secure. Call EH&S at x 4444 for pick-up.

Volatile chemicals should be transported between laboratories in durable outer containers.

Vacuum pumps used in procedures should be protected from contamination with scrubbers or filters.

If one or more of these substances are used in large quantities, on a regular basis (three or more separate handling sessions per week), or for long periods of time (4-6 hours) a qualitative and potentially quantitative exposure assessment should be performed. Contact the Environmental Health and Safety Department to perform this assessment.

Lab personnel of childbearing age should be informed of any known male and female reproductive toxins used in the laboratory. An employee who is pregnant, or planning to become pregnant, and who is working with potential reproductive toxins that might affect the fetus, should contact the Environmental Health and Safety Department to evaluate their exposure and inform her personal physician. The Director, Environmental Health and Safety can assess potential exposures and work with the employee and laboratory supervisor, if necessary, to adjust work practices to minimize the potential risk.

## **3.7 REGULATED CHEMICALS & PARTICULARLY HAZARDOUS CHEMICALS**

### **3.7.1 GENERAL INFORMATION**

This section establishes supplemental work procedures to control the handling of substances that are known to exhibit unusual acute or long-term chronic health hazards (carcinogens, reproductive toxins and highly acutely toxic substances). This set of procedures applies (as indicated in Appendix A) to chemical carcinogens listed and regulated by the Department of Labor, Occupational Safety and Health Administration (OSHA), and of human carcinogens listed by the International Agency for Research on Cancer (IARC) and the National Toxicology Program (NTP).

Appendix A identifies under what conditions and for what substances the special handling procedures listed below should be used. Please note that a key component in controlling the most hazardous substances is the controlled distribution and use of these substances. In some instances special authorization is required before purchasing and using these substances.

Appendix A lists the substances and/or procedures that require prior approval of the research protocol before beginning work. See Section 1.11 for the chemical safety protocol review process.

### **3.7.2 SPECIAL HANDLING PROCEDURES**

Use these chemicals only in a chemical fume hood or other appropriate containment device (glove box). If a chemical fume hood is used, it should be evaluated to confirm that it is performing adequately (a face velocity of at least 80 feet per minute with the sash at the operating height).

Volatile chemicals should be stored in a vented storage area in an unbreakable, primary or secondary container or placed in a chemically resistant tray (to contain spills). Nonvolatile chemicals should be stored in cabinets or in drawers. *Do not store these chemicals on open shelves or counters.* Access to all of these chemicals should be restricted.

Volatile chemicals should be transported between laboratories in durable outer containers.

All procedures with these chemicals should be performed in designated areas. Other employees working in the area should be informed of the particular hazards associated with these substances and the appropriate precautions that are necessary for preventing exposures. All designated areas should be posted with a sign which reads:

**WARNING**  
**DESIGNATED AREA FOR HANDLING THE FOLLOWING**  
**SUBSTANCES WITH HIGH ACUTE OR CHRONIC TOXICITY:**  
**[list of substances - identify acute or chronic hazard]**  
**[Example: Benzene - Carcinogen]**  
**AUTHORIZED PERSONNEL ONLY**

Vacuum pumps used in procedures should be protected from contamination with scrubbers or filters.

Analytical instruments or other laboratory equipment generating vapors and/or aerosols during their operation, should be locally exhausted or vented in a chemical fume hood.

Skin surfaces which might be exposed to these substances during routine operations or foreseeable accidents should be covered with appropriate protective clothing. Gloves should be worn whenever transferring or handling these substances. Consider using full body protection (disposable coveralls) if the potential for extensive personal contamination exists.

All protective equipment should be removed when leaving the designated area and decontaminated (washed) or, if disposable, placed in a plastic bag and secured. Call the Environmental Health and Safety Department for disposal instructions. Skin surfaces - hands, forearms, face and neck - should be washed immediately.

Work surfaces on which these substances will be handled should be covered with an easily decontaminated surface (such as stainless steel) or protected from contamination with plastic trays or plastic backed paper. Call the Environmental Health and Safety Department for decontamination and disposal procedures; these will be substance specific. Materials that will be disposed of should be placed in plastic bags and secured.

Chemical wastes from procedures using these substances should be placed in containers and disposed of as hazardous chemical waste. The wastes should be stored in the designated area (defined above) until picked up. If it is possible to safely chemically decontaminate all toxic substances to nontoxic materials during or at the end of the procedure, this should be done.

Normal laboratory work should not be conducted in a designated area until it has been decontaminated or determined to be acceptable by the principal investigator or the Environmental Health and Safety Department.

If one or more of these substances are used in large quantities, on a regular basis (three or more separate handling sessions per week), or for long periods of time (4-6 hours), a qualitative and potentially quantitative exposure assessment should be performed.

### **3.8 BIOSAFETY PROCEDURES**

Please contact Environmental Health & Safety (x 4444) regarding the University's policies and protocols on biosafety.

# 4 CHEMICAL TOXICOLOGY

## 4.1 CHEMICAL TOXICOLOGY OVERVIEW

(<http://www.agius.com/hew/resource/toxicol.htm>)

### 4.1.1 DEFINITIONS

**Toxicology** is the study of the nature and action of poisons.

**Toxicity** is the ability of a chemical substance or compound to produce injury once it reaches a susceptible site in, or on, the body.

A material's **hazard potential** is the probability that injury will occur after consideration of the conditions under which the substance is used.

### 4.1.2 DOSE-RESPONSE RELATIONSHIPS

The potential toxicity (harmful action) inherent in a substance is exhibited only when that substance comes in contact with a living biological system. The potential toxic effect increases as the exposure increases. All chemicals will exhibit a toxic effect given a large enough dose. The toxic potency of a chemical is thus ultimately defined by the dose (the amount) of the chemical that will produce a specific response in a specific biological system.

### 4.1.3 ROUTES OF ENTRY INTO THE BODY

There are three main routes by which hazardous chemicals enter the body:

- Absorption through the **respiratory tract** via inhalation.
- Absorption through the **skin** via dermal contact.
- Absorption through the **digestive tract** via ingestion. (Ingestion can occur through eating or smoking with contaminated hands or in contaminated work areas.)

Most exposure standards, such as the Threshold Limit Values (**TLV's**) and Permissible Exposure Limits (**PEL's**), are based on the inhalation route of exposure. These limits are normally expressed in terms of either parts per million (ppm) or milligrams per cubic meter ( $\text{mg}/\text{m}^3$ ) concentration in air. If a significant route of exposure for a substance is through skin contact, the MSDS, PEL and/or TLV will have a "skin" notation. Examples of substances where skin absorption may be a significant factor include: pesticides, carbon disulfide, carbon tetrachloride, dioxane, mercury, thallium compounds, xylene and hydrogen cyanide.

### 4.1.4 TYPES OF EFFECTS

**Acute poisoning** is characterized by sudden and severe exposure and rapid absorption of the substance. Normally, a single large exposure is involved. Adverse health effects are often reversible. Examples: carbon monoxide or cyanide poisoning.

**Chronic poisoning** is characterized by prolonged or repeated exposures of a duration measured in days, months or years. Symptoms may not be immediately apparent. Health effects are often irreversible. Examples: lead or mercury poisoning.

A **Local** effect refers to an adverse health effect that takes place at the point or area of contact. The site may be skin, mucous membranes, the respiratory tract, gastrointestinal system, eyes, etc. Absorption does not necessarily occur. Examples: strong acids or alkalis.

**Systemic** effect refers to an adverse health effect that takes place at a location distant from the body's initial point of contact and presupposes absorption has taken place. Examples: arsenic affects the blood, nervous system, liver, kidneys and skin; benzene affects bone marrow.

**Cumulative poisons** are characterized by materials that tend to build up in the body as a result of numerous chronic exposures. The effects are not seen until a critical body burden is reached. Example: heavy metals.

**Substances in combination:** When two or more hazardous materials are present at the same time, the resulting effect can be greater than the effect predicted based on the additive effect of the individual substances. This is called a **synergistic** or **potentiating effect**. Example: exposure to alcohol and chlorinated solvents; or smoking and asbestos.

#### **4.1.5 OTHER FACTORS AFFECTING TOXICITY**

*Rate of entry and route of exposure;* that is, how fast the toxic dose is delivered and by what means.

*Age* can affect the capacity to repair tissue damage.

*Previous exposure* can lead to tolerance, increased sensitivity or make no difference.

*State of health, physical condition and life style* can affect the toxic response. *Pre-existing disease* can result in increased sensitivity.

*Environmental factors* such as temperature and pressure.

Host factors including *genetic predisposition* and the *sex* of the exposed individual.

#### **4.1.6 PHYSICAL CLASSIFICATIONS**

**Gas** applies to a substance which is in the gaseous state at room temperature and pressure.

A **Vapor** is the gaseous phase of a material which is ordinarily a solid or a liquid at room temperature and pressure.

When considering the toxicity of gases and vapors, the solubility of the substance is a key factor. Highly soluble materials, like ammonia, irritate the upper respiratory tract. On the other hand, relatively insoluble materials, like nitrogen dioxide, penetrate deep into the

lung. Fat soluble materials, like pesticides, tend to have longer residence times in the body and be cumulative poisons.

An **aerosol** is composed of solid or liquid particles of microscopic size dispersed in a gaseous medium.

The toxic potential of an aerosol is only partially described by its airborne concentration. For a proper assessment of the toxic hazard, the size of the aerosol's particles must be determined. A particle's size will determine if a particle will be deposited within the respiratory system and the location of deposition. Particles above 10 micrometers tend to deposit in the nose and other areas of the upper respiratory tract. Below 10 micrometers particles enter and are deposited in the lungs.

#### 4.1.7 PHYSIOLOGICAL CLASSIFICATIONS

(<http://www.lbl.gov/EH&S/chsp/html/toxicology.shtml>)

**Irritants** are materials that cause inflammation of mucous membranes with which they come in contact. Inflammation of tissue results from exposure to concentrations far below those needed to cause corrosion. Examples include:

- Ammonia	- Alkaline dusts and mists
- Hydrogen chloride	- Hydrogen fluoride
- Halogens	- Ozone
- Phosgene	- Diethyl/dimethyl sulfate
- Nitrogen dioxide	- Phosphorus chlorides
- Arsenic trichloride	

Irritants can also cause changes in the mechanics of respiration and lung function. Examples include:

- Sulfur dioxide	- Acetic acid
- Formaldehyde	- Formic acid
- Sulfuric acid	- Acrolein
- Iodine	

Long term exposure to irritants can result in increased mucous secretions and chronic bronchitis.

A **primary irritant** exerts no systemic toxic action either because the products formed on the tissue of the respiratory tract are non-toxic or because the irritant action is far in excess of any systemic toxic action. Example: hydrogen chloride.

A **secondary irritant's** effect on mucous membranes is overshadowed by a systemic effect resulting from absorption. Examples include:

- Hydrogen sulfide	- Aromatic hydrocarbons
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**Asphyxiants** have the ability to deprive tissue of oxygen.

**Simple asphyxiants** are inert gases that displace oxygen. Examples include:

- Nitrogen	- Nitrous oxide
- Carbon dioxide	- Hydrogen
- Helium	

**Chemical asphyxiants** reduce the body's ability to absorb, transport, or utilize inhaled oxygen. They are often active at very low concentrations (a few ppm). Examples include:

- Carbon monoxide	- Cyanides
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**Primary anesthetics** have a depressant effect upon the central nervous system, particularly the brain. Examples include:

- Halogenated hydrocarbons	- Alcohols
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**Hepatotoxic agents** cause damage to the liver. Examples include:

- Carbon tetrachloride	- Tetrachloroethane	- Nitrosamines
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**Nephrotoxic agents** damage the kidneys. Examples include:

- Halogenated hydrocarbons	- Uranium compounds
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**Neurotoxic agents** damage the nervous system. The nervous system is especially sensitive to organometallic compounds and certain sulfide compounds. Examples include:

- Trialkyl tin compounds	- Tetraethyl lead
- Methyl mercury	- Carbon disulfide
- Organic phosphorus insecticides	- Thallium
- Manganese	

Some toxic agents act on the **blood or hematopoietic system**. The blood cells can be affected directly or the bone marrow (which produces the blood cells) can be damaged. Examples include:

- Nitrites	- Aniline	- Toluidine
- Nitrobenzene	- Benzene	

There are toxic agents that produce damage of the **pulmonary tissue** (lungs) but not by immediate irritant action. Fibrotic changes can be caused by free silica and asbestos. Other dusts can cause a restrictive disease called **pneumoconiosis**. Examples include:

- Coal dust	- Cotton dust	- Wood dust
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A **carcinogen** is an agent that can initiate or increase the proliferation of malignant neoplastic cells or the development of malignant or potentially malignant tumors. Known human carcinogens include:

- Asbestos	- 4-nitrobiphenyl
- Alpha-naphthylamine	- Methyl chloromethyl ether
- 3,3'-Dichlorobenzidine	- Bis-chloromethyl ether
- Vinyl chloride	- Inorganic arsenic
- Ethylene oxide	- 1,2-Dibromo-3-chloropropane (DBCP)
- N-nitrosodimethylamine	- Coal tar pitch volatiles

A **mutagen** interferes with the proper replication of genetic material (chromosome strands) in exposed cells. If germ cells are involved, the effect may be inherited and become part of the genetic pool passed onto future generations.

A **teratogen** (embryotoxic or fetotoxic agent) is an agent which interferes with normal embryonic development without causing a lethal effect to the fetus or damage to the mother. Effects are not inherited. Examples include:

- Lead	- Thalidomide
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A **sensitizer** is a chemical which can cause an allergic reaction in normal tissue after repeated exposure to the chemical. The reaction may be as mild as a rash (allergic dermatitis) or as serious as anaphylactic shock. Examples include:

- Epoxides	- Toluene diisocyanate
- Nickel compounds	- Chromium compounds
- Poison ivy	- Chlorinated hydrocarbons

## 4.2 SOME TARGET ORGAN EFFECTS

The following is a categorization of target organ effects which may occur from chemical exposure. Signs and symptoms of these effects and examples of chemicals which have been found to cause such effects are listed.

Toxins	Target organ effect	Signs and symptoms	Example chemicals
Hepatotoxins	Cause liver damage	Jaudice; liver enlargement	Nitrosamines, chloroform, toluene, perchloroethylene, cresol, dimethylsulfate
Nephrotoxins	Cause kidney damage	Edema; proteinuria	Halogenated hydrocarbons, uranium, chloroform, mercury, dimethylsulfate
Neurotoxins	Affect the nervous system	Narcosis; behavior changes; decreased muscle coordination	Mercury, carbon disulfide, benzene, carbon tetrachloride, lead, nitrobenzene
Hematopoietic toxins	Decrease blood function	Cyanosis; loss of consciousness	Carbon monoxide, cyanides, nitrobenzene, aniline, arsenic, benzene, toluene
Pulmonary toxins	Irritate or damage the lungs	Cough; tightness in chest, shortness of breath	Silica, asbestos, ozone, hydrogen sulfide, chromium, nickel, alcohols
Reproductive toxins	Affect the reproductive system	Birth defects; sterility	Lead, dibromodichloropropane
Skin hazards	Affect the dermal layer of the body	Defatting of skin; rashes; irritation	Ketones, chlorinated compounds, alcohols, nickel, phenol, trichloroethylene



Eye hazards	Affect the eye or vision	Conjunctivitis, corneal damage	Organic solvents, acids, cresol, quinone, hydroquinone, benzol, chloride, butyl alcohol, bases
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### 4.3 OCCUPATIONAL HEALTH STANDARDS

**TLV:** The **threshold limit value** is a recommended occupational exposure guideline published by the American Conference of Governmental Industrial Hygienists. TLV's are expressed as parts of vapor or gas per million parts of air by volume (ppm) or as approximate milligrams of particulate per cubic meter of air ( $\text{mg}/\text{M}^3$ ). The TLV is the average concentration of a chemical that most people can be exposed to for a working lifetime with no ill effects. The TLV is an advisory guideline. If applicable, a **ceiling concentration (C)** which should not be exceeded or a skin absorption notation (S) will be indicated with the TLV.

**PEL:** The **permissible exposure limit** is a legal standard issued by OSHA. Unless specified, the PEL is a time weighted average (**TWA**).

**TWA:** Most exposure standards are based on **time weighted averages**. The TWA is the average exposure over an eight (8) hour work day. Some substances have Ceiling (C) limits. **Ceiling limits** are concentrations that should never be exceeded.

The MSDS will list the occupational health standard(s) for the hazardous chemical or each component of a mixture.

# 5 RADIATION SAFETY

## 5.1 P&A RADIATION SAFETY PROGRAM

Each department has their own Radiation Safety Officer who is responsible for maintaining the departments' state radiation license and renewal. They are responsible for submitting the details of the radiation program to the state as required as well as monitoring the types of radioisotopes used within the department. In P&A the Radiation Safety Officer (RSO) is Dr. Stan Dodds (x2510).

**The Natelson Lab does not work with radioactive sources or materials** in general. If students need to work with possible x-ray sources (as in the SEA crystallography facilities), they shall be trained in appropriate safety precautions as part of that specific training.

Further information about radiation safety and procedures is available at the Rice EH&S website:

[http://safety.rice.edu/Radiation/Radiation\\_Safety/](http://safety.rice.edu/Radiation/Radiation_Safety/)

and there is a radiation safety manual:

<http://safety.rice.edu/uploadedFiles/Radiation%20Manual%202013.pdf> .

# 6 LASER SAFETY

## 6.1 LASER SAFETY MANUAL

This Laser Safety section of the manual is intended to be a resource for information, guidelines, policies, and procedures that will enable and encourage those working in the laboratory environment to work safely and reduce or eliminate the potential for exposure to laser radiation.

It is intended that the Principal Investigator will supplement this information with instruction, training and guidance regarding specific practices and procedures unique to the work being done in their laboratory area.

### 6.1.1. REFERENCES

Texas Regulation for Control of Laser Radiation Hazards (25 TAC 289.301)

<http://www.dshs.state.tx.us/radiation/laser.shtm>

ANSI Safe Use of Lasers in Educational Institutions (ANSI Z136.5 2009)

<http://www.lia.org/>

FDA Performance Standards for Light-Emitting Products (21 CFR 1040.10)

<http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?CFRPart=1040>

### 6.1.2. SCOPE

This program is applicable to all laboratories, research, service and support activities at Rice University that uses Class 3B (III) and 4 (IV) lasers.

### 6.1.3. LASER CLASSIFICATIONS

Lasers are assigned one of four classes depending on the potential for causing biological damage.

**Class 1** - lasers are considered to be safe for intended purposes and exempt from any safety controls.

**Class 2** – lasers produce low power visible laser radiation with a radiant power below 1mW. Limited safety controls are required. Must have caution labels affixed to the laser.

**Class 3A** – laser produce intermediate levels of visible and invisible laser radiation with an output power between 1 to 5mW. The normal eye response to bright lights will protect user from eye injury. However, no collecting optics can be used to directly view the beam. Requires Labeling and Controls.

**Class 3B** – laser may produce moderate levels of visible and/or invisible emissions with an output power range from 5 to 500mW. These lasers are capable of producing eye injury

and must have safety controls to minimize the viewing of the beam directly or reflectively. Requires labeling on the door and instrument; requires a Laser Warning light over the door that is active when the laser is in use and requires physical controls to prevent viewing of direct and reflected beam.

**Class 4** – laser may produce high levels of visible and/or invisible emissions with an output power above 0.5 W. These lasers are capable of inflicting damage to the skin and eye and may pose a fire hazard. Safety controls must be used to minimize the viewing of the beam directly, reflectively, or diffused. Requires labeling on the door and instrument and physical controls to prevent eye or skin contact with the direct or reflected beam, and also with the diffusely reflected beam.

Embedded systems:

Class 2, 3 or 4 lasers or laser systems contained in a protective housing and operated in a lower classification mode may be classified at a lower classification. Specific control measures may be required to maintain the lower classification. For embedded systems that are non- commercial design and construction the Department LSO shall determine the classification.

For purposes of laser safety, a direct laser beam which has been deflected from a mirror or polished surface is considered to be as intense as the direct beam. Lasers beams which hit flat or non-mirror like surfaces are considered to be diffuse and the diffusedly reflected beam is not as intense or as well defined as the direct beam.

#### **6.1.4. REGISTRATION REQUIREMENTS**

Class 1, 2, and 3A lasers are considered safe to use under prescribed operations and pose little to no hazard to the user unless viewed directly for a prolonged time period. Certain regulations apply only during the servicing or modification of the laser source or housing. No registration with the State of Texas is required.

**Class 3B and 4 lasers must be registered** with the State of Texas through the Department of Chemistry before purchasing or transferring between any labs or department. All necessary documentation and interlocks must be established and a lab-specific LSO appointed before operation is permitted.

**Each Class 3B or 4 laser must be registered with the State of Texas through the department of chemistry.**

**Please contact the Laser Safety Coordinator Christopher Mize <cem7@rice.edu> for more information regarding this process of registration.**

**Information needed for registration is as follows:**

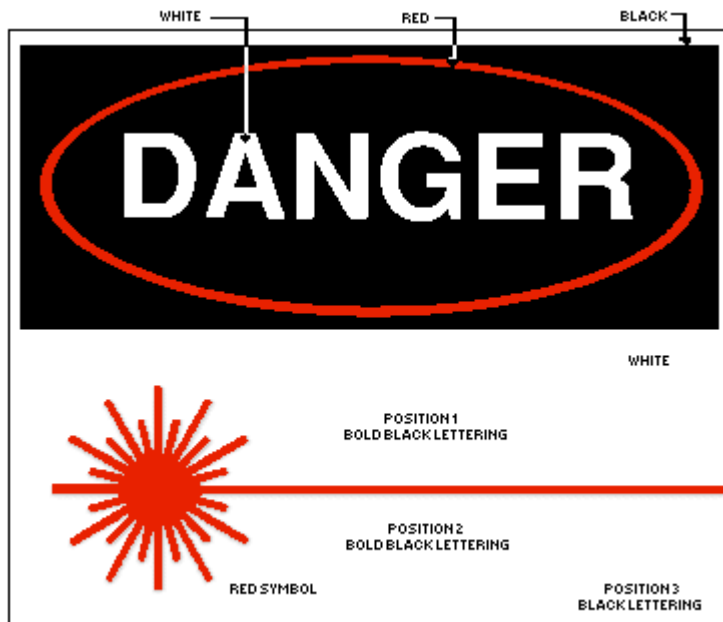
**Name of Principal Investigator**  
**Laser Class**  
**Location: Building**  
**Location: Room**  
**General Type of Laser**  
**Specific Type of Laser (Argon,  
ND-YAG, etc.)**  
**Manufacturer**  
**Make / Model of Laser**  
**Serial Number**  
**Equipment Asset Tag**  
**In use?**  
**Max or range of wavelength (nm)**  
**Max or range of power**  
**Rice Univ. fabricated laser?**  
**Rice Univ. modified laser?**  
**Laser Warning Sign Posted?**  
**Necessary Interlocks in place?**  
**Lab Laser Safety Officer**  
**Training Protocols in place?**  
**Please Describe.**

### 6.1.5. CONTROLS PROCEDURES

**Laser Safety Officer (LSO)** –The Department of P&A LSO is Christopher Mize [cem7@rice.edu](mailto:cem7@rice.edu) . The Lab-specific LSO (assigned by each lab) is responsible for administrating this Laser Safety Program with duties including but not limited to the following:

- Identify work area hazards and approve proper personal protective equipment.
- Evaluate facility for proper interlock controls, laser signs and labels, and equipment operation.
- Approve standard operating procedure
- Maintain inventory control of all lasers under the LSO jurisdiction
- Evaluate and update the programs as needed

**Posting Laser Warning Sign** – The following sign must be posted outside of the laser control area when using ONLY class 3B and 4 lasers:



Position 1: For Class 3B: “LASER RADIATION – AVOID DIRECT EYE EXPOSURE”

For Class 4: “LASER RADIATION – AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION”

Position 2: Type of laser or the emitted wavelength, pulse duration or maximum output

Position 3: Class of laser

**Personal Protective Equipment-** Eye protection must be worn when operating any Class 3B and 4 lasers and should be specific to the laser emission spectrum and power. Skin protection can be achieved by wearing a lab coat and gloves that adequately covers any exposed skin.

Laser goggles may be necessary. Be certain that the goggle in use is appropriate both in the attenuation factor provided by the goggle and that the goggle is for the proper wavelength. Laser goggles must be matched to the wavelength of the laser systems being used!

**Engineering Controls-** These controls should be incorporated into the facility design and operation of the laser in a controlled area. Some controls include but not limited to the following:

- a. Master kill switch – All class 3B and 4 lasers should have a master kill switch to safety power down the unit in case of an emergency.
- b. Laser in use sign – Any lab using class 3B and 4 lasers must activate the “Laser in use” sign during operation.
- c. A permanently attached beam stop or attenuator should be provided to reduce the output emission level.
- d. Do not align the beam with the naked eye.
- e. A beam stop must be provided to adequately stop the beam with the absence of scattered light emission. Be certain that scattered laser radiation is not escaping through a window to the outside.

**Please contact the Department LSO (Bruce Weisman) for additional information on laser safety.**

#### **6.1.6. TRAINING AND COMMUNICATION**

The Department Directors, P.I. or individual with primary supervisory responsibility must assure that all personnel who work with Class 3B and 4 lasers are informed of the hazards and are trained in the proper procedures and equipment needed to avoid overexposure and/or injury. All records must be maintained according to 25 TAC 289.301(ee).

<http://www.dshs.state.tx.us/radiation/laser.shtm>

## 7. CRYOGEN SAFETY (partly from the air products “safetygram” #16, “Safe handling of cryogenic liquids”)

### 7.1 CRYOGENS

Materials that are liquefied at atmospheric pressure at temperatures much lower than room temperature ( $< -100$  F or  $-73$  C), often for the purpose of cooling an experimental apparatus, are cryogenes. The most common examples encountered on the Rice campus are liquid nitrogen (LN<sub>2</sub>) and liquid helium (LHe). LN<sub>2</sub> has a boiling point of 77 K at atmospheric pressure. LHe has a boiling point of 4.2 K at atmospheric pressure.

Cryogenes are stored in vacuum-insulated containers known as dewars. The Natelson lab has two dewar-based cryostats that can hold tens of liquid liters of LHe; one is the Quantum Design PPMS, and the other is the Janis/Attocube cryostat in the shielded enclosure. The Natelson lab also has three “flow cryostats”, where the sample space or chamber is cooled by continuous flow of a cryogen, which then vents, either into the room in the case of LN<sub>2</sub>, or into the helium recovery system in the case of LHe. The flow cryostats are the Desert Cryogenics probe station and the two small microscope cryostats. The Natelson lab also has a third experimental rig that uses liquid cryogenes, intended for insertion into a standard 100 L LHe dewar. For all of these cryostats, individualized training is required prior to use. In addition to these cryostats, the Natelson lab usually has one LN<sub>2</sub> storage dewar from the chemistry stock room, one LHe storage dewar associated with the helium recovery system, and additional small (35 L or less) LN<sub>2</sub> storage dewars.

The chemistry stockroom provides LN<sub>2</sub> in 160 L dewars, and upon request can provide LHe in 60 L or 100 L dewars. (Very large volumes such as 230 L for LN<sub>2</sub> and 250 L for LHe are available upon special request, but are basically never used in that quantity in the Natelson lab.)

#### 7.1.1 DANGERS FROM CRYOGENS

Cryogenes are associated with several hazards:

- **Frostbite.** All cryogenic liquids are extremely cold. Cryogenic liquids and their vapors can rapidly freeze human tissue and can cause many common materials such as carbon steel, rubber, and plastics to become brittle or even break under stress. Cryogenic liquids in containers and piping at temperatures at or below the boiling point of liquefied air [ $-318^{\circ}\text{F}$  ( $-194^{\circ}\text{C}$ )] can actually condense the surrounding air and can cause a localized oxygen-enriched atmosphere. Extremely cold cryogenes such as hydrogen and helium can even freeze or solidify the surrounding air.
- **Pressure.** All cryogenic liquids produce large volumes of gas when they vaporize. For example, one volume of liquid nitrogen vaporizes to 694 volumes of nitrogen



gas at 68°F (20°C) at 1atm. A cryogenic liquid cannot be indefinitely maintained as a liquid even in well-insulated containers. If these liquids are vaporized in a sealed container, they can produce enormous pressures that could rupture the container. For this reason pressurized cryogenic containers are normally protected with multiple devices for over-pressure prevention. Common pressure-relief devices are a pressure-relief valve for primary protection and a rupture disc for secondary protection. All sections of equipment that may allow for the liquid to become trapped must be protected by a pressure-relief device. The product vented by these relief devices should be routed to a safe outdoor location. The dewar cryostats in the Natelson lab have appropriate pressure release valves.

- **Asphyxiation.** Vaporization of a cryogenic liquid, except oxygen, in an enclosed area can cause asphyxiation by displacing the air. Most cryogenic liquids are odorless, colorless, and tasteless when vaporized into the gaseous state. Most liquids also have no color except liquid oxygen, which is light blue. However, extremely cold liquids and their vapors have a built-in warning property that appears whenever they are exposed to the atmosphere. The cold “boil-off” gases condense the moisture in the surrounding air, creating a highly visible fog. This fog can also be formed around cold equipment when norelease of the cold liquid or vapors has occurred. Fog clouds do not define the vapor cloud. They define the area where the vapors are still cold enough to condense the moisture in the air. The vapors can extend well beyond the fog cloud, depending on the product and atmospheric conditions. Although fog clouds may be indicative of a release, they must never be used to define the leak area and should not be entered by anyone. The dense fog clouds associated with the handling or transfer of cryogenic liquids can obstruct visibility. Care should be exercised so that any clouds do not interfere with vehicle traffic or safety escape routes.

## 7.1.2 HANDLING

Always handle cryogenic liquids with care. To mitigate concerns about frostbite, wear appropriate clothing for handling cryogenics: no open-toed shoes; minimize exposed skin by wearing long pants and/or long sleeves; wear cryogen-safe gloves when touching materials that may be cooled directly by cryogen exposure and to avoid splashing of cryogenic liquids onto the hands. Wear eye protection, either safety glasses or a full faceshield when appropriate, to avoid splashing. Remember, ultracold gasses from evaporation or boiling of cryogenics can also harm sensitive tissue like eyes and nasal linings.

Be careful and slow in handling cryogenics, to avoid splashing. Work in well-ventilated areas.

With liquid helium, only use vacuum-jacketed transfer tubes. If the outside of the transfer tube frosts up or feels excessively cold, this is a sign that the vacuum space is compromised and must be re-pumped with a turbo pump. When transferring into a dewar that already contains liquid helium, make sure that a transfer tube is properly pre-cooled by gas flow

(until a dense white plume begins to emerge) before inserting the transfer tube into the dewar fill port (but do not wait until it is dripping liquid air).

**Remember:** liquid cryogenics expand by very large factors when they are converted to vapor. Never leave a liquid cryogen-containing volume in a configuration such that the path to a pressure relief port could become blocked by frozen air or moisture. For example, **NEVER** leave the main liquid port open to atmosphere on a 100 L helium storage dewar for more than a minute or two. Air and moisture can and will condense inside the throat of the dewar, freezing into a solid blockage. The main bathspace of the dewar then becomes a very dangerous pressure vessel.

If, for some reason, you do suspect that there is a water or nitrogen ice block within a dewar, contact Prof. Natelson asap, and leave the dewar in a configuration where you believe it will be able to vent safely should the block disappear.

Exercise care when moving cryogen storage dewars filled with liquid. Both nitrogen and helium dewars are heavy, and either one falling over would be extremely hazardous.

Both nitrogen and helium storage dewars are vacuum-jacketed for thermal insulation. If the outside of either dewar frosts over or feels very cold to the touch, the vacuum has been compromised. Make sure that the bath space of the dewar is able to vent appropriately through relief valves. Do not attempt to move a compromised dewar until it has warmed up to room temperature; any hazard should be minimized once the cryogen has boiled off completely.

Dewars should normally be quiescent. If you hear a dewar buzzing or humming, or feel a dewar spontaneously vibrating, this is either a sign of a compromised vacuum space (see above), or the onset of thermoacoustic oscillations (TOs). TOs, sometimes called Taconis oscillations, are very dissipative, and can boil off the contents of a dewar relatively quickly (in hours rather than days). With proper protective equipment, try venting such a dewar's storage space down to atmospheric pressure and re-closing it. If the humming recurs, then the dewar vacuum may be compromised.

## 8 GLOSSARY OF TERMS

**ACGIH** - The American Conference of Governmental Industrial Hygienists is a voluntary membership organization of professional industrial hygiene personnel in governmental or educational institutions. The ACGIH develops and publishes recommended occupational exposure limits each year called Threshold Limit Values (TLV's) for hundreds of chemicals, physical agents, and biological exposure indices.

**ACUTE** - Short duration, rapidly changing conditions.

**ACUTE EXPOSURE** - An intense exposure over a relatively short period of time.

**ANSI** - The American National Standards Institute is a voluntary membership organization (run with private funding) that develops consensus standards nationally for a wide variety of devices and procedures.

**ASPHYXIANT** - A chemical (gas or vapor) that can cause death or unconsciousness by suffocation. Simple asphyxiants, such as nitrogen, either remove or displace oxygen in the air. They become especially dangerous in confined or enclosed spaces. Chemical asphyxiants, such as carbon monoxide and hydrogen sulfide, interfere with the body's ability to absorb or transport oxygen to the tissues.

**BOILING POINT** - The temperature at which the vapor pressure of a liquid equals atmospheric pressure or at which the liquid changes to a vapor. The boiling point is usually expressed in degrees Fahrenheit. If a flammable material has a low boiling point, it indicates a special fire hazard.

**"C" OR CEILING** - A description usually seen in connection with ACGIH exposure limits. It refers to the concentration that should not be exceeded, even for an instant. It may be written as TLV-C or Threshold Limit Value-Ceiling. (See also THRESHOLD LIMIT VALUE).

**CARCINOGEN** - A substance or physical agent that may cause cancer in animals or humans.

**C.A.S. NUMBER** - Identifies a particular chemical by the Chemical Abstracts Service, a service of the American Chemical Society that indexes and compiles abstracts of worldwide chemical literature called Chemical Abstracts.

**cc** - Cubic centimeter, a volumetric measurement which is also equal to one milliliter (ml).

**CHEMICAL** - As broadly applied to the chemical industry, an element or a compound produced by chemical reactions on a large scale for either direct industrial and consumer use or for reaction with other chemicals.

**CHEMICAL REACTION** - A change in the arrangement of atoms or molecules to yield substances of different composition and properties. (see REACTIVITY)

**CHRONIC** - Persistent, prolonged or repeated conditions.

**CHRONIC EXPOSURE** - A prolonged exposure occurring over a period of days, weeks, or years.

**COMBUSTIBLE** - According to the DOT and NFPA, combustible liquids are those having a flash point at or above 100°F (37.8°C), or liquids that will burn. They do not ignite as easily as flammable liquids. However, combustible liquids can be ignited under certain circumstances, and must be handled with caution. Substances such as wood, paper, etc., are termed "Ordinary Combustibles".

**CONCENTRATION** - The relative amount of a material in combination with another material. For example, 5 parts of (acetone) per million (parts of air).

**CORROSIVE** - A substance that, according to the DOT, causes visible destruction or permanent changes in human skin tissue at the site of contact or is highly corrosive to steel.

**CUBIC METER (m<sup>3</sup>)** - A measure of volume in the metric system.

**CRYOGEN** – a compound or element that must be at cryogenic temperatures to be a liquid at atmospheric pressure; in the lab setting, most commonly liquid nitrogen (boils at 77 K at 1 atm) or helium (boils at 4.2 K at 1 atm).

**CUTANEOUS** - Pertaining to or affecting the skin.

**DECOMPOSITION** - The breakdown of a chemical or substance into different parts or simpler compounds. Decomposition can occur due to heat, chemical reaction, decay, etc.

**DERMAL** - Pertaining to or affecting the skin.

**DERMATITIS** - An inflammation of the skin.

**DILUTION VENTILATION** - See **GENERAL VENTILATION**.

**DOT** - The United States Department of Transportation is the federal agency that regulates the labeling and transportation of hazardous materials.

**DYSPNEA** -Shortness of breath; difficult or labored breathing.

**EH&S** - Office of Environmental Health and Safety (x4444)

**EPA** - The Environmental Protection Agency is the governmental agency responsible for administration of laws to control and/or reduce pollution of air, water, and land systems.

**EPA NUMBER** - The number assigned to chemicals regulated by the Environmental Protection Agency (EPA).

**EPIDEMIOLOGY** - The study of disease in human populations.

**ERYTHEMA** - A reddening of the skin.

**EVAPORATION RATE** - The rate at which a material is converted to vapor (evaporates) at a given temperature and pressure when compared to the evaporation rate of a given

substance. Health and fire hazard evaluations of materials involve consideration of evaporation rates as one aspect of the evaluation.

**°F** - Degrees, Fahrenheit; a temperature scale.

**FLAMMABLE LIQUID** - According to the DOT and NFPA a flammable liquid is one that has a flash point below 100°F. (See FLASH POINT)

<b>Classes Of Flammable Liquids</b>		
Flammable Solvent Class	Boiling Point	Flash Point
Class 1A	< 100°F	< 73°F
Class 1B	>= 100°F	< 73°F
Class 1C	>= 100°F	Between 73 and 100°F

**FLASH POINT** - The lowest temperature at which a liquid gives off enough vapor to form an ignitable mixture with air and burn when a source of ignition (sparks, open flames, cigarettes, etc.) is present. Two tests are used to determine the flash point: open cup and closed cup. The test method is indicated on the MSDS after the flash point.

**g** - See GRAM.

**GENERAL VENTILATION** - Also known as general exhaust ventilation, this is a system of ventilation consisting of either natural or mechanically induced fresh air movements to mix with and dilute contaminants in the workroom air. This is not the recommended type of ventilation to control contaminants that are highly toxic, when there may be corrosion problems from the contaminant, when the worker is close to where the contaminant is being generated, and where fire or explosion hazards are generated close to sources of ignition (See LOCAL EXHAUST VENTILATION).

**kg** - See GRAMS PER KILOGRAM.

**GRAM (g)** - A metric unit of weight. One ounce equals 28.4 grams.

**GRAMS PER KILOGRAM (g/kg)** - This indicates the dose of a substance given to test animals in toxicity studies. For example, a dose may be 2 grams (of substance) per kilogram of body weight (of the experimental animal).

**HAZARDOUS MATERIAL** - Any substance or compound that has the capability of producing adverse effects on the health and safety of humans.

**IGNITABLE** - A solid, liquid or compressed gas that has a flash point of less than 140°F. Ignitable material may be regulated by the EPA as a hazardous waste, as well.

**INCOMPATIBLE** - The term applied to two substances to indicate that one material cannot be mixed with the other without the possibility of a dangerous reaction.

**INGESTION** - Taking a substance into the body through the mouth, such as food, drink, medicine, or unknowingly as in contaminated hands or cigarettes, etc.

**INHALATION** - Breathing in of an airborne substance that may be in the form of gases, fumes, mists, vapors, dusts, or aerosols.

**INHIBITOR** - A substance that is added to another to prevent or slow down an unwanted reaction or change.

**IRRITANT** - A substance that produces an irritating effect when it contacts skin, eyes, nose, or respiratory system.

**kg** - See KILOGRAM.

**KILOGRAM (kg)** - A unit of weight in the metric system equal to 2.2 pounds.

**L** - See LITER.

**LC<sub>50</sub>**- See LETHAL CONCENTRATION<sub>50</sub>.

**LD<sub>50</sub>**- See LETHAL DOSE<sub>50</sub>.

**LEL** - See LOWER EXPLOSIVE LIMIT.

**LETHAL CONCENTRATION<sub>50</sub>** - The concentration of an air contaminant (**LC<sub>50</sub>**) that will kill 50 percent of the test animals in a group during a single exposure.

**LETHAL DOSE<sub>50</sub>** - The dose of a substance or chemical that will (**LD<sub>50</sub>**) kill 50 percent of the test animals in a group within the first 30 days following exposure.

**LFL** - See LOWER EXPLOSIVE LIMIT.

**LITER (L)** - A measure of capacity. One quart equals .9 liters.

**LOCAL EXHAUST VENTILATION** - (Also known as exhaust ventilation.) A ventilation system that captures and removes the contaminants at the point where they are being produced before they escape into the workroom air. The system consists of hoods, ducts, a fan and possibly an air cleaning device. Advantages of local exhaust ventilation over general ventilation include: it removes the contaminant rather than dilutes it; it requires less air flow and thus is more economical over the long term; and the system can be used to conserve or reclaim valuable materials. However, the system must be properly designed with the correctly shaped and placed hoods, and correctly sized fans and duct work.

**LOWER EXPLOSIVE LIMIT (LEL)** - (Also known as Lower Flammable Limit). The lowest concentration of a substance that will produce a fire or flash when an ignition source (flame, spark, etc.) is present. It is expressed in percent of vapor or gas in the air by volume. Below the LEL or LFL, the air/contaminant mixture is theoretically too "lean" to burn. (See also UEL).

**m<sup>3</sup>** - See CUBIC METER.

**MELTING POINT** - The temperature at which a solid changes to a liquid. A melting range may be given for mixtures.

**mg** - See MILLIGRAM.

**mg/kg** - See MILLIGRAMS PER KILOGRAM.

**mg/m<sup>3</sup>** - See MILLIGRAMS PER CUBIC METER.

**MILLIGRAM (mg)** - A unit of weight in the metric system. One thousand milligrams equal one gram.

**MILLIGRAMS PER CUBIC METER** - Units used to measure air (**mg/m<sup>3</sup>**) concentrations of dusts, gases, mists, and fumes.

**MILLIGRAMS PER KILOGRAM** - This indicates the dose of a substance (**mg/kg**) given to test animals in toxicity studies. For example, a dose may be 2 milligrams (of substance) per kilogram of body weight (of the experimental animal).

**MILLILITER (mL)** - A metric unit used to measure capacity. One milliliter equals one cubic centimeter. One thousand milliliters equal one liter.

**mL** - See MILLILITER.

**MSHA** - The Mine Safety and Health Administration; a federal agency that regulates the mining industry in the safety and health area.

**MUTAGEN** - Anything that can cause a change (or mutation) in the genetic material of a living cell.

**NARCOSIS** - Stupor or unconsciousness caused by exposure to a chemical.

**NFPA** - The National Fire Protection Association is a voluntary membership organization whose aims are to promote and improve fire protection and prevention. NFPA has published 16 volumes of codes known as the National Fire Codes. Within these codes is Standard No. 704, Identification of the Fire Hazards of Materials. This is a system that rates the hazard of a material during a fire. These hazards are divided into health, flammability, and reactivity hazards and appear in a well-known diamond system using from zero through four to indicate severity of the hazard. Zero indicates no special hazard and four indicates severe hazard.

**NIOSH** - The National Institute of Occupational Safety and Health is a federal agency that among its various responsibilities train's occupational health and safety professionals, conducts research on health and safety concerns, and tests and certifies respirators for workplace use.

**ODOR THRESHOLD** - The minimum concentration of a substance at which a majority of test subjects can detect and identify the substance's characteristic odor.

**ORAL** - Having to do with the mouth.

**OSHA** - The Occupational Safety and Health Administration - a federal agency under the Department of Labor that publishes and enforces safety and health regulations for most businesses and industries in the United States.

**OXIDATION** - The process of combining oxygen with some other substance to a chemical change in which an atom loses electrons.

**OXIDIZER** - Is a substance that gives up oxygen easily to stimulate combustion of organic material.

**OXYGEN DEFICIENCY** - An atmosphere having less than the normal percentage of oxygen found in normal air. Normal air contains 21% oxygen at sea level.

**PEL** - See PERMISSIBLE EXPOSURE LIMIT.

**PERMISSIBLE EXPOSURE LIMIT (PEL)** - An exposure limit that is published and enforced by OSHA as a legal standard. PEL may be either a time-weighted-average (TWA) exposure limit (8 hour), a 15-minute short term exposure limit (STEL), or a ceiling (C). The PEL's are found in Tables Z-1, Z-2, or Z-3 of OSHA regulations 1910.1000. (See also TLV).

**PERSONAL PROTECTIVE EQUIPMENT** - Any devices or clothing worn by the worker to protect against hazards in the environment. Examples are respirators, gloves, and chemical splash goggles.

**POLYMERIZATION**- A chemical reaction in which two or more small molecules combine to form larger molecules that contain repeating structural units of the original molecules. A hazardous polymerization is the above reaction with an uncontrolled release of energy.

**ppm** - Parts (of vapor or gas) per million (parts of air) by volume.

**REACTIVITY** - A substance's susceptibility to undergoing a chemical reaction or change that may result in dangerous side effects, such as explosions, burning, and corrosive or toxic emissions. The conditions that cause the reaction, such as heat, other chemicals, and dropping, will usually be specified as "Conditions to Avoid" when a chemical's reactivity is discussed on a MSDS.

**RESPIRATOR** - A device which is designed to protect the wearer from inhaling harmful contaminants.

**RESPIRATORY HAZARD** - A particular concentration of an airborne contaminant that, when it enters the body by way of the respiratory system or by being breathed into the lungs, results in some bodily function impairment.

**SENSITIZER** - A substance that may cause no reaction in a person during initial exposures, but afterwards, further exposures will cause an allergic response to the substance.

**SHORT TERM EXPOSURE LIMIT** - Represented as STEL or TLV-STEL, this is the maximum concentration to which workers can be exposed for a short period of time (15 minutes) for only four times throughout the day with at least one hour between exposures. Also the daily TLV-TWA must not be exceeded.



**"SKIN"** - This designation sometimes appears alongside a TLV or PEL. It refers to the possibility of absorption of the particular chemical through the skin and eyes. Thus, protection of large surface areas of skin should be considered to prevent skin absorption so that the TLV is not invalidated.

**STEL** - Short Term Exposure Limit.

**SUBSTANCE** - Any chemical entity.

**SYNONYM** - Another name by which the same chemical may be known.

**SYSTEMIC** - Spread throughout the body; affecting many or all body systems or organs; not localized in one spot or area.

**TERATOGEN** - An agent or substance that may cause physical defects in the developing embryo or fetus when a pregnant female is exposed to that substance.

**THRESHOLD LIMIT VALUE** - Airborne concentrations of substances devised by the ACGIH that represent conditions under which it is believed that nearly all workers may be exposed day after day with no adverse effect. TLV's are advisory exposure guidelines, not legal standards, which are based on evidence from industrial experience, animal studies, or human studies when they exist. There are three different types of TLV's: Time Weighted Average (TLV-TWA), Short Term Exposure Limit (TLV-STEL) and Ceiling (TLV-C). (See also PEL.)

**TIME WEIGHTED AVERAGE** - The average time, over a given work period (e.g. 8-hour work day), of a person's exposure to a chemical or an agent. The average is determined by sampling for the contaminant throughout the time period. Represented as TLV-TWA.

**TLV** - See THRESHOLD LIMIT VALUE.

**TOXICITY** - The potential for a substance to exert a harmful effect on humans or animals and a description of the effect and the conditions or concentrations under which the effect takes place.

**TRADE NAME** - The commercial name or trademark by which a chemical is known. One chemical may have a variety of trade names depending on the manufacturers or distributors involved.

**TWA** - See TIME WEIGHTED AVERAGE.

**UEL** - See UPPER EXPLOSIVE LIMIT.

**UFL** - See UPPER EXPLOSIVE LIMIT.

**UNSTABLE LIQUID** - A liquid that, in its pure state or as commercially produced will react vigorously in some hazardous way under shock conditions (i.e., dropping), certain temperatures, or pressures.

**UPPER EXPLOSIVE LIMIT** - Also known as Upper Flammable Limit. Is the highest concentration (expressed in percent of vapor or gas in the air by volume) of a substance that will burn or explode when an ignition source is present. Theoretically above this limit the mixture is said to be too "rich" to support combustion. The difference between the LEL and the UEL constitutes the flammable range or explosive range of a substance. That is, if the LEL is 1ppm and the UEL is 5ppm, then the explosive range of the chemical is 1ppm to 5ppm. (See also LEL).

**VAPOR** - The gaseous form of substances which are normally in the liquid or solid state (at normal room temperature and pressure). Vapors evaporate into the air from liquids such as solvents. Solvents with low boiling points will evaporate.

# APPENDIX A: CHEMICALS REQUIRING PRIOR APPROVAL

## I. Acutely Toxic Gases

The pressurized hazardous gases identified below have been classified as particularly hazardous and *require prior approval for purchasing of new materials, or handling and storage of existing material*. See Section 1.11, Research Protocol Review, for the approval procedure.

Pressurized Gases Requiring Review	
Compound	Exempt Quantity
Arsine and gaseous derivatives	None
Chloropicrin in gas mixtures	None
Cyanogen chloride	None
Cyanogen	None
Diborane	None
Germane	None
Hexaethyltetraphosphate	None
Hydrogen cyanide	None
Hydrogen selenide	None
Nitric oxide	None
Nitrogen dioxide	None
Nitrogen tetroxide	None
Phosgene	None
Phosphine	None

## II. Regulated Chemicals & Chemicals with High Chronic Toxicity

The substances listed in the table below (titled "Regulated Chemicals & Chemicals with High Chronic Toxicity Requiring Special Procedures") when stored or handled in quantities exceeding the exempt quantities must be stored and handled according to the special procedures outlined in Section 3.6.2. If it is not possible to utilize these procedures the proposed alternative procedures must be reviewed and approved by the Chemical Hygiene Officer prior to initiating the research. See Section 1.11, Research Protocol Review, for the approval procedure. If you are using any of these substances in quantities

less than the exempt amount, use the procedures outlined in Section 3.5.2, Chemicals of High Acute or Chronic Toxicity.

<b>Regulated Chemicals &amp; Chemicals With High Chronic Toxicity Requiring Special Procedures</b>		
Compound	Exempt Quantity(See Note 1 Below)	OSHA Regulated Substance
N-Acetoxy-2-acetylaminofluorene	2	
2-Acetylaminofluorene	2	Y
Acrylonitrile	1	Y
Aflatoxins	2	
o-Aminoazotoluene	2	
4-Aminodiphenyl	3	Y
2-Aminofluorene	2	
Asbestos	1	Y
Arsenic and arsenic compounds	2	Y
Azathiopurine	2	
Benz[a]anthracene	2	
Benzene	1	Y
Benzidine	3	Y
Benzo[a]pyrene	2	
Bromoethyl methanesulfonate	2	
1,4-Butanediol dimethanesulfonate (myleran)	2	
Carbon tetrachloride	1	
Chlorambucil	2	
Chloroform	1	
N,N-bis(2-chloroethyl)-2-naphthylamine	2	
Bis-chloromethyl ether	3	Y
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea	2	
Cycasin	2	
Cyclophosphamide	2	
Diazomethane	2	
Dibenz[a,h]anthracene	2	
1,2-Dibromo-3-chloropropane	1	Y
3,3'-Dichlorobenzidine (& its salts)	3	Y

Diepoxybutane	2	
4-Dimethylaminoazobenzene	2	Y
7,12-Dimethylbenz[a]anthracene	2	
3,3'-Dimethylbenzidine	2	
1,1-Dimethylethylenimine	1	
1,1-Dimethylhydrazine	2	
1,2-Dimethylhydrazine	2	
1,4-Dinitrosopiperazine	2	
p-Dioxane	1	
Ethylene dibromide	1	
Ethyleneimide	2	Y
Ethyl methanesulfonate	2	
Ethylene oxide	1	Y
Ethionine	1	
Ethylenimine	2	
Formaldehyde	1	Y
Hexavalent chromium and chromium compounds	1	
Hydrazine	2	
N-Hydroxy-2-acetylaminofluorene	2	
Lead and lead compounds	1	Y
Mercury and mercury salts	3	Y
3'-Methyl-4-aminoazobenzene	1	
Methyl chloromethyl ether	3	
3-Methylcholanthrene	2	
4,4'-Methylene bis(2-chloroaniline)	2	
Methylhydrazine	2	
Methyl mercury	3	
Methyl methanesulfonate	2	
1-Methyl-3-nitro-1-nitrosoguanidine	2	
alpha-Naphthylamine	2	Y
beta-Naphthylamine	3	Y
4-Nitrobiphenyl	3	Y
N-[4-(5-nitro-2-furyl)-2-thiazoyl]-formamide	2	
4-Nitroquinoline-1-oxide	2	
N-Nitrosodiethylamine	2	
N-Nitrosodimethylamine	2	Y

N-Nitrosodi-n-butylamine	2	
N-Nitrosodi-n-propylamine	2	
N-Nitroso-N-ethylurea	2	
N-Nitroso-N-ethylurethane	2	
N-Nitroso-N-methylurea	2	
N-Nitroso-N-methylurethane	2	
N-Nitrosopiperidine	2	
Polychlorinated biphenyls	2	
Procarbazine	2	
1,3-Propane sulfone	2	
beta-Propiolactone	2	Y
Propylenimine	1	
Thorium dioxide	2	
m-Toluenediamine	2	
Uracil mustard	2	
Urethane	1	
Vinyl chloride	2	Y

Note 1 - The exempt quantities are defined as:

**Exempt Quantities**

<u>Number</u>	<u>For Laboratory Storage</u>	<u>For Laboratory Use</u>
1	<1 liter or 1000 grams	<50 milliliters or 50 grams
2	<0.1 liter or 100 grams	<5 milliliters or 5 grams
3	None	None

# **APPENDIX B: OSHA'S LABORATORY HEALTH STANDARD**

## **"Occupational Exposures to Hazardous Chemicals in Laboratories"**

### **29 CFR 1910.1450**

The Laboratory Health Standard requires laboratories to develop procedures which help to ensure that occupational exposure to hazardous chemicals in the laboratory environment is reduced or minimized.

OSHA summarizes the intent of the standard in the preamble:

"The new standard differs from many OSHA health standards in that it does not establish new exposure limits, but sets other performance provisions designed to protect laboratory workers from potential hazards in their work environment. By permitting a greater degree of flexibility to laboratories in developing and implementing employee safety and health programs, OSHA expects benefits to result from increased worker awareness of potential risks, improved work practices, appropriate use of existing personal protective equipment and greater use of engineering controls. Given the flexibility to design and implement innovative measures to reduce employee exposure to hazardous substances, employers also will reap rewards in terms of lower insurance premiums, lower property damage costs, lower turnover costs, less absenteeism and, in general, increased productivity. Finally, the potential decrease in acute and chronic health problems will result in overall benefits to society through the associated reduction in medical and productivity costs."

This quote summarizes the basic goals and approach of the Laboratory Health Standard. It is primarily a performance oriented standard, allowing individual laboratories to tailor their approaches to meeting the requirements of the standard to their individual circumstances.

The text of the standard, including the appendices, is included for reference purposes into this Chemical Hygiene Plan.





## **APPENDIX C: DEPARTMENT STANDARD OPERATING PROCEDURES**

For certain hazards and classes of chemicals not covered under the General Standard Operating Procedures for Working with Chemicals, principal investigators and department chemical hygiene officers/laboratory supervisors must develop their own site specific standard operating procedures. These site specific standard operating procedures must be kept in this appendix with your hard copy of the Laboratory Chemical Hygiene Plan.



**APPENDIX D: ACCIDENT/INCIDENT REPORT**  
***(SEE NEXT THREE PAGES)***

**RICE UNIVERSITY**  
**ACCIDENT/INJURY REPORT**  
*Please Print*

**Section A: Details of incident**

- Injury                       Work related illness       Non work-related illness       Electrical incident
- Environmental incident       Property damage               Dangerous event               Laboratory incident

Name of person completing report: .....

Department: ..... Phone: .....

Date incident occurred: ..... Time incident occurred: ..... am / pm

Name of injured person: .....

**Incident occurred while:**

- At work               Traveling to/from work               On meal break               Other

Date reported: ..... Reported to: .....

Location of Incident: *(external area / building & room etc)*

.....

.....

.....

What happened? *(What were you doing at the time of the incident? Briefly describe how it happened.)*

.....

.....

.....

.....

List any witnesses: *(names, telephone )*

.....

.....

.....

**Section B: Details of injured person and injury**

Student/Staff ID: \_\_\_\_\_ M F Date of birth: \_\_\_\_\_

Telephone: \_\_\_\_\_ Position title: \_\_\_\_\_ Department: \_\_\_\_\_

Employment status:

- Faculty  Staff  Graduate student  
 Undergraduate student  Visitor/member of public  Volunteer  
 Other: \_\_\_\_\_

Employment basis:  Full-time  Part-time

Name of injured person's supervisor: \_\_\_\_\_

Details of treatment required:  None  Self  First aid \*\*  
 Hospital  Seen by other Medical Doctor

\*\*Describe first aid treatment given:

\_\_\_\_\_  
\_\_\_\_\_

Nature of injury:

- |  |   |  |
|--|---|--|
| <input type="checkbox"/> Allergy or sensitivity  | <input type="checkbox"/> Fracture/dislocation | <input type="checkbox"/> Occupational overuse injury           |
| <input type="checkbox"/> Respiratory             | <input type="checkbox"/> Burn / scalds        | <input type="checkbox"/> Exposure effects heat/cold            |
| <input type="checkbox"/> Asphyxiation            | <input type="checkbox"/> Contusion/crush      | <input type="checkbox"/> Communicable disease                  |
| <input type="checkbox"/> Internal injuries       | <input type="checkbox"/> Puncture             | <input type="checkbox"/> Concussion or other neuro injury      |
| <input type="checkbox"/> Fainting                | <input type="checkbox"/> Bruising             | <input type="checkbox"/> Skin condition eg dermatitis/ eczema  |
| <input type="checkbox"/> Poisoning/toxic effects | <input type="checkbox"/> Laceration/deep cut  | <input type="checkbox"/> Hearing loss                          |
| <input type="checkbox"/> Hernia                  | <input type="checkbox"/> Sprain/strain        | <input type="checkbox"/> Vision impairment                     |
| <input type="checkbox"/> Foreign body            | <input type="checkbox"/> Nausea/vomiting      | <input type="checkbox"/> Electric shock or effects             |
| <input type="checkbox"/> Amputation              | <input type="checkbox"/> Multiple injuries    | <input type="checkbox"/> Psychological disorder/stress effects |
| <input type="checkbox"/> Other                   |   |  |

\_\_\_\_\_

Part of body affected:

- |                                |  |                                    |  |                                    |                               |
|--------------------------------|--|------------------------------------|--|------------------------------------|-------------------------------|
| <input type="checkbox"/> Left  | <input type="checkbox"/> Back            | <input type="checkbox"/> Buttock   | <input type="checkbox"/> Forearm       | <input type="checkbox"/> Thigh     | <input type="checkbox"/> Head |
| <input type="checkbox"/> Right | <input type="checkbox"/> Neck            | <input type="checkbox"/> Internal  | <input type="checkbox"/> Wrist         | <input type="checkbox"/> Knee      | <input type="checkbox"/> Face |
|                                | <input type="checkbox"/> Groin /hip      | <input type="checkbox"/> Shoulder  | <input type="checkbox"/> Hand          | <input type="checkbox"/> Shin/calf | <input type="checkbox"/> Ear  |
|                                | <input type="checkbox"/> Chest           | <input type="checkbox"/> Upper arm | <input type="checkbox"/> Fingers/thumb | <input type="checkbox"/> Ankle     | <input type="checkbox"/> Eye  |
|                                | <input type="checkbox"/> Stomach / trunk | <input type="checkbox"/> Elbow     |  | <input type="checkbox"/> Foot/toe  |                               |

Further description of injury/illness (if required):

\_\_\_\_\_  
\_\_\_\_\_

Agency of injury (what?)

- Vehicle/transport
  - Lifting/ Carrying
  - Repetitive work
  - Needle/sharp
  - Noise
  - Electrical
  - Objects
  - Other (please specify):
- Radiation
  - Biological agent (eg pathogens)
  - Chemical
  - Explosion/implosion
  - Non-power tool
  - Power tools
  - Surface (slippery/rough)
- Thermal (heat/cold)
  - Animal/Insect
  - Mobile plant/equipment
  - Machinery/fixed plant
  - Workstation design
  - Situation (violence, assault)
  - Psychological/social

Action/ mechanism which caused injury (how?)

- Fall from height
  - Muscle stress – repetitive
  - Muscle stress- loads
  - Hitting object
  - Noise
  - Slip/trip
  - Other (please specify):
- Exposure to chemicals
  - Exposure to electricity
  - Exposure to heat/cold
  - Exposure to radiation
  - Insect/animal bite
  - Pressure
- Exposure to biological material
  - Hit by/trapped in moving object
  - Exposure to vibration
  - Mental stress factors
  - Vehicle accident

Section C: Incident Investigation

*This section is to be completed by the local supervisor or department head for any incident involving personal injury, and for a serious incident or near miss where required.*

Identify any factors contributing to the incident.

- Design issues
- Inadequate supervision
- Inadequate/ lack of training
- Failure to follow work procedures
- Lack of experience
- Lack of appropriate Personal Protective Equipment
- Environment (eg floor/ground surface)
- Inadequate space
- Unforeseeable event
- Inadequate safety procedures
- Improper use/storage of materials
- Other environmental conditions (eg weather, lighting, ventilation, temperature)
- Equipment malfunctioning
- Poor/lack of suitable equipment
- Personal factors-stress, fatigue
- Inadequate equipment maintenance
- Poor housekeeping
- Other

Preventative/Corrective Actions:

*Describe the follow up actions planned or taken to prevent a similar incident.*

.....

.....

.....

.....

Completion date .....

Supervisor/Department head signature .....

- Copy filed with department
- Copy sent to Environmental Health and Safety
- Copy sent to Risk Management

**APPENDIX E: FIRST REPORT OF INJURY OF  
ILLNESS FORM (*SEE NEXT THREE PAGES*)**

**DWC FORM-1  
(Employer's First Report of Injury or Illness)**

The **employer** is required to file an **Employer's First Report of Injury or Illness** [DWC FORM -1 (Rev. 10/05)] with the injured worker's insurance carrier, and the injured claimant or the claimant's representative within 8 days after the employee's absence from work or receipt of notice of occupational disease.

The **Employer's First Report of Injury or Illness** provides information on the claimant, employer, insurance carrier and medical practitioner necessary to begin the claims process. Details of the claimant's employment and circumstances surrounding the injury or illness are also requested.

Send the specified copies to your **Workers' Compensation Insurance Carrier** and the injured employee. **\*Employers - Do not send this form to the Texas Department of Insurance, Division of Workers' Compensation, unless the Division specifically requests a direct filing.**

*[Workers' Compensation Rule 120.2]*





INSTRUCTIONS FOR EMPLOYERS FIRST REPORT OF  
INJURY OR ILLNESS (DWC FORM-1)

Type (or print in black ink) each item on this form. Failure to complete each item may delay the processing of the injury claim.

Article 8308 - 5.05, Texas Workers' Compensation Act, requires an Employer's First Report of Injury or Illness (DWC FORM - 1 (Rev. 10/05) to be filed with the Workers' Compensation Insurance Carrier not later than the eighth day after the receipt of notice of occupational disease, or the employee's first day of absence from work due to injury or death. A copy of this report must be sent to the employee or the employee's representative. For purposes of this section, a report is filed when personally delivered, or postmarked. Send the specified copies to your Workers' Compensation Insurance Carrier and the injured employee. \*Employers - Do not send this form to the Texas Department of Insurance, Division of Workers' Compensation, unless the Division specifically requests a direct filing.

If a report has not been received by the carrier, the employer has the burden of proving that the report was filed within the required time frame. The employer has the burden of proving that good cause existed if the employer failed to file the report on time.

An employer who fails to file the report without good cause may be assessed an administrative penalty not to exceed \$500.00. An employer who fails to file the report without good cause waives the right to reimbursement of voluntary benefits even if no administrative penalty is assessed.

Once the employer has completed all information pertaining to the injury the employer should maintain the copy of this report to serve as the Employer's Record of Injury required by Article 8308 - 5.04. Send the specified copies to your Workers' Compensation Insurance Carrier and the injured employee. \*Employers - Do not send this form to the Texas Department of Insurance, Division of Workers' Compensation, unless the Division specifically requests a direct filing. The Division's Health and Safety will use data from this report for the Job Safety Information System established in Article 8308 - 7.03 of the Texas Workers' Compensation Act.

This report may not be considered a admission or evidence against the employer or the insurance carrier in any proceeding before the Division or a court in which facts set out in the report are contradicted by the employer or insurance carrier.

" SPECIAL INSTRUCTIONS FOR CERTAIN ITEMS "

- Items 2,7,8: Article 8308 - 2.13(e), Texas Workers' Compensation Act requires the Division to maintain information as to the race, ethnicity and sex on every compensable injury. This information will be maintained for non-discriminatory statistical use.
- Item 4: If no home phone, please provide a phone number where the employee can be reached.
- Items 5,15,17,26,29,30: Enter data in month, day, year format. Example: 08-13-54.
- Item 18: List nature of accident or exposure, e.g., fall from scaffold, contact with radiation, etc. If occupational disease, so state.
- Item 19: List specific body part, e.g., chin, right leg, forehead, left upper arm, etc. If more than one body part is affected, list each part.
- Item 20: Describe in detail (1) the events leading up to the injury/illness, (2) the actual injury, e.g., cut left forearm, broken right foot, etc., and (3) the reason(s) why accident/injury occurred. Use an additional sheet of paper if necessary.
- Item 22: State the exact work-site location of the injury, e.g., construction site, office area, storage area, etc.
- Item 24: List object, substance, or exposure that directly inflicted the injury or illness, e.g., floor, hammer, chemicals, etc.
- Items 32,33: Enter date in month-year format. Example: 02-56.
- Item 37: Enter the number of days or hours that make up a full work week for your employees.
- Item 45: Enter the 6-digit North American Industry Classification System (NAICS) Code of the employer. The primary code is the code which appears in block 5 of Form C-3, "Employer's Quarterly Report" to the Texas Workforce Commission.
- Item 46: For companies with a single NAICS code, the specific code is the same as the primary code. For companies with multiple NAICS codes, enter the code that identifies the specific business, activity, or work-site location the employee was working in at the time of the injury. This may or may not be the same as the primary code.



Send the specified copies to your  
Workers' Compensation Insurance Carrier  
and the injured employee.

\*Employers - Do not send this form to the  
Texas Department of Insurance, Division of Workers' Compensation,  
Unless the Division specifically requests a direct filing.

CLAIM # \_\_\_\_\_

CARRIER'S CLAIM # \_\_\_\_\_

**EMPLOYERS FIRST REPORT OF INJURY OR ILLNESS**

1. Name (Last, First, M.I.)		2. Sex <input type="checkbox"/> F <input type="checkbox"/> M		15. Date of Injury (m-d-y)	16. Time of Injury : am <input type="checkbox"/> pm <input type="checkbox"/>	17. Date Lost/Time Began (m-d-y)	
3. Social Security Number	4. Home Phone ( )	5. Date of Birth (m-d-y)		18. Nature of Injury*		19. Part of Body Injured or Exposed*	
6. Does the Employee Speak English? If No, Specify Language YES <input type="checkbox"/> NO <input type="checkbox"/>				20. How and Why Injury/Illness Occurred*			
7. Race White <input type="checkbox"/> Black <input type="checkbox"/> Asian <input type="checkbox"/>		8. Ethnicity Hispanic <input type="checkbox"/> Native American <input type="checkbox"/> Other <input type="checkbox"/>		21. Was employee doing his regular job? YES <input type="checkbox"/> NO <input type="checkbox"/>		22. Workable Location of Injury (e.g., dock, e.t.c.)	
9. Mailing Address (Street or P.O. Box) City State Zip Code County				23. Address Where Injury or Exposure Occurred (Name of business if incident occurred on a business site) Street or P.O. Box City State Zip Code			
10. Marital Status Married <input type="checkbox"/> Widowed <input type="checkbox"/> Separated <input type="checkbox"/> Single <input type="checkbox"/> Divorced <input type="checkbox"/>				24. Cause of Injury (fall, tool, machine, e.t.c.)			
11. Number of Dependent Children		12. Spouse's Name		25. List Witnesses			
13. Doctor's Name				26. Return to work date (or expected (m-d-y))			
14. Doctor's Mailing Address (Street or P.O. Box) City State Zip Code				27. Did employee die? YES <input type="checkbox"/> NO <input type="checkbox"/>		28. Supervisor's Name	
						29. Date Reported (m-d-y)	

30. Date of Hire (m-d-y)	31. Was employee hired or recruited in Texas? YES <input type="checkbox"/> NO <input type="checkbox"/>	32. Length of Service in Current Position Months _____ Years _____	33. Length of Service in Occupation Months _____ Years _____
34. Employee Payroll Classification Code		35. Occupation of Injured Worker	
36. Rate of Pay at this Job \$ _____ Hourly \$ _____ Weekly	37. Full Work Week is: _____ Hours _____ Days		38. Last Paycheck was: \$ _____ for _____ Hours or _____ Days
			39. Is employee an Owner, Partner, or Corporate Officer? YES <input type="checkbox"/> NO <input type="checkbox"/>

40. Name and Title of Person Completing Form		41. Name of Business	
42. Business Mailing Address and Telephone Number Street or P.O. Box Telephone ( ) City State Zip Code		43. Business Location (if different from mailing address) Number and Street City State Zip Code	
44. Federal Tax Identification Number	45. Primary North American Industry Classification System Code (6 digit)	46. Specific NAICS Code (6 digit)	47. Texas Comptroller Taxpayer No.
48. Workers' Compensation Insurance Company		49. Policy Number	

50. Did you request accident prevention services in past 12 months?  
YES  NO  If yes, did you receive them? YES  NO

51. Signature and Title (READ INSTRUCTIONS ON INSTRUCTION SHEET BEFORE SIGNING)  
X \_\_\_\_\_ Date \_\_\_\_\_



**APPENDIX F: RELEASE AND HOLD  
HARMLESS AGREEMENT FORM (*SEE NEXT  
PAGE*)**



Renee A. Block, ARM  
Director of Risk Management

### Release and Hold Harmless Agreement

I desire to have my child, \_\_\_\_\_, use the facilities and equipment of William Marsh Rice University, and in consideration thereof, I hereby agree as follows:

1. I release and hold harmless William Marsh Rice University, including, but not limited to, its trustees, officers, employees, representatives, volunteers, agents, and affiliates, from any and all liabilities or claims made, including, but not limited to, personal injuries and damage to or loss of personal property arising directly or indirectly in connection with my child's use of the facilities and equipment of William Marsh Rice University.
2. My child has medical/hospitalization insurance with \_\_\_\_\_ company, policy number \_\_\_\_\_. I understand that should my child require medical treatment, an attempt will be made to notify me by telephone. In the Event I cannot be reached, I consent to any medical treatment which may be deemed necessary under the circumstances in the event of injury, accident and/or illness during this activity. Any expense not covered by insurance shall be my sole responsibility.

By signing below I certify that I understand and agree to abide by the release of liability and medical authority as set forth above.

Parent's Name \_\_\_\_\_

Parent's Signature \_\_\_\_\_

Telephone Number \_\_\_\_\_

Emergency Contact  
Information \_\_\_\_\_

Telephone Number \_\_\_\_\_

Date: \_\_\_\_\_

# APPENDIX G: ACKNOWLEDGEMENT OF RECEIPT

Research Investigator: \_\_\_\_\_

I have read and understand the information provided in the **2016 Safety Manual & Laboratory Hygiene Plan**. I also agree the document provides an overview of the Laboratory's EH &S Program and a general description of how the laboratory manages the EH&S activities. It is designed to serve as a reference to laboratory managers, supervisors, and other interested staff and visitors.

Signature: \_\_\_\_\_

Signature: \_\_\_\_\_

Printed name: \_\_\_\_\_

Printed Name: \_\_\_\_\_

Title/Date: \_\_\_\_\_

Title/Date: \_\_\_\_\_

Signature: \_\_\_\_\_

Signature: \_\_\_\_\_

Printed name: \_\_\_\_\_

Printed Name: \_\_\_\_\_

Title/Date: \_\_\_\_\_

Title/Date: \_\_\_\_\_

Signature: \_\_\_\_\_

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Printed name: \_\_\_\_\_

Printed Name: \_\_\_\_\_

Title/Date: \_\_\_\_\_

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Signature: \_\_\_\_\_

Signature: \_\_\_\_\_

Printed name: \_\_\_\_\_

Printed Name: \_\_\_\_\_

Title/Date: \_\_\_\_\_

Title/Date: \_\_\_\_\_

Signature: \_\_\_\_\_

Signature: \_\_\_\_\_

Printed name: \_\_\_\_\_

Printed Name: \_\_\_\_\_

Title/Date: \_\_\_\_\_

Title/Date: \_\_\_\_\_

(List Continued, pg 2)

Research Investigator: \_\_\_\_\_

I have read and understand the information provided in the **2016 Safety Manual & Laboratory Hygiene Plan**. I also agree the document provides an overview of the Laboratory's EH &S Program and a general description of how the laboratory manages the EH&S activities. It is designed to serve as a reference to laboratory managers, supervisors, and other interested staff and visitors.

Signature: \_\_\_\_\_

Signature: \_\_\_\_\_

Printed name: \_\_\_\_\_

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Title/Date: \_\_\_\_\_

Title/Date: \_\_\_\_\_

(List Continued, pg 3)

Research Investigator: \_\_\_\_\_

I have read and understand the information provided in the **2016 Safety Manual & Laboratory Hygiene Plan**. I also agree the document provides an overview of the Laboratory's EH &S Program and a general description of how the laboratory manages the EH&S activities. It is designed to serve as a reference to laboratory managers, supervisors, and other interested staff and visitors.

Signature: \_\_\_\_\_

Signature: \_\_\_\_\_

Printed name: \_\_\_\_\_

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Printed Name: \_\_\_\_\_

Title/Date: \_\_\_\_\_

Title/Date: \_\_\_\_\_

**Insert additional pages as necessary. When a new version is published, new signature sheets must be signed and kept with that version of the Manual.**