

THE KAVLI NANOSCIENCE INSTITUTE
USER HANDBOOK
AND
OPERATION PROCEDURES

31 JULY 2008

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1.0 PURPOSE

The Kavli Nanoscience Institute (KNI) at California Institute of Technology (Caltech) is a multi-user environment that brings together a diverse, interdisciplinary group of people to synergistically investigate exciting and interesting topics at the forefront of nano-biotechnology, nano-photonics, and nano-systems fabrication. To ensure the greatest probability of success, it is important that all who use these facilities understand and agree to comply with a set of rules and operational procedures. These are not intended to burden or hinder one's research, but rather to foster an environment of mutual respect and safety. All KNI users are expected to read and understand the contents of these procedures prior to entering the facility. This document does not include every conceivable situation that may occur, but where a situation is not documented common sense and a professional manner must be implemented at all times. If there are any questions please seek out the Associate Director or Assistant Laboratory Manager for clarification. Any non-compliance with these rules and guidelines may result in privileges in the facility being suspended along with remedial training and certification to these rules and guidelines before re-entry would be permissible.

This document is intended to be the basis for compliance using "ISO 14644-5 Rules and Guidelines," along with "OSHA Laboratory standard 29CFR 1910.1450," and thus will ensure the maintenance of ISO Class 5 / 6 cleanroom (Class 100 / 1000) in a safe and effective manner.

All KNI users and support personnel shall be certified annually.

Visitors (all non-certified personnel) must be escorted. Escorts must be certified users and are responsible for ensuring that visitors adhere to cleanroom policies and procedures.

As part of the Caltech Community, all KNI laboratory users are expected to comply with the [Caltech Honor Code](#): "No member of the Caltech community shall take unfair advantage of any other member of the Caltech community."

2.0 SCOPE

This Handbook applies to all users who will be using the KNI facility area.

This procedure covers the following topics:

Referenced Documents	3.0
Safety Requirements	4.0
General laboratory requirements and protocols	5.0
Chemical Safety	6.0

3.0 REFERENCED DOCUMENTS

- 3.1 Material Safety Data Sheets (MSDS) for all chemicals used in the laboratories are available in print and electronic format. The Caltech Safety department maintains links to a comprehensive list of MSDS information, and this can be found at <http://www.safety.caltech.edu/msds.html>. In addition, the computers in the KNI laboratory all have an MSDS library for the chemicals in use. Paper versions are available in the Caltech Safety office as well as in Steele Laboratory.
- 3.2 OSHA Laboratory standard 29CFR 1910.1450. This document can be found http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standard&p_id=10106. A paper copy is also available in Steele Laboratory.
- 3.3 ISO Standard 14644-5 “Cleanrooms and associated controlled environments -- Part 5: Operations” is available on the KNI website, and a paper version is located in Steele Laboratory.
- 3.4 Caltech Chemical Hygiene Plan is [available online](#).

4.0 SAFETY REQUIREMENTS

Basic Caltech training is required for incoming researchers prior to entering the facility. KNI staff can assist users in scheduling training with the Safety department.

Users shall comply with laboratory-specific safety training as outlined in this document and by the KNI Research Staff.

5.0 OPERATING PROCEDURES

5.1 Laboratory Users General Protocol

These are general overall laboratory requirements designed to minimize the potential for transferring and generating particulate matter, which could adversely affect the quality of our processes and environment.

- 5.1.1 Drinking, eating and gum chewing are not allowed in any part of the laboratory.
- 5.1.2 No personal electronic devices are allowed including; MP3 players, iPod's and or hand held game devices. Any item that would cause distraction during an emergency situation or that could interfere with safe operation of equipment is prohibited.
- 5.1.3 Full clean-room attire must be worn at all times within the Cleanroom section of the Laboratory, north of the air shower. The remaining rooms south of the air shower require bonnets, shoe covers, and cleanroom jacket only. Long pants and closed-toe shoes must be worn at all times inside the KNI laboratory. Do not wear sandals or shorts, as the cleanroom suit does not protect against chemical spills.

- 5.1.4 Safety glasses must be worn at all times in the cleanroom areas with the exception of microscope inspection stations. Prescription glasses are not considered sufficient eye protection by the Caltech Safety Office. In addition, contact lenses are incompatible with many solvents, and their use in the laboratory should be avoided.
 - 5.1.5 Be discrete when coughing or sneezing, use the face mask and replace the contaminated face mask as soon as possible. The best possible practice is to turn away from product and equipment and use the facemask for this intended purpose instead of injecting fluids into the environment.
 - 5.1.6 Keep stored items to a minimum in the Laboratory.
 - 5.1.7 Before working at any station or with product verify that gloves are clean and intact, replace gloves that are dirty or torn. You should also change gloves when moving between “chemical” and “clean” procedures to protect personnel and equipment from chemical exposure.
 - 5.1.8 Gloves are to be worn at all times, powder free Nitrile gloves can be found at several stations in the laboratory.
 - 5.1.9 Wear acid-resistant gloves when working with any chemicals.
 - 5.1.10 Cleanroom notebooks, cleanroom paper, cleanroom pens and post-its are available and should be used when needed.
- 5.2 Acceptable Materials in the KNI Cleanroom
- The following materials are approved for use in the cleanroom.
- 5.2.1 Cleanroom notebooks, cleanroom paper, cleanroom pens and post-its.
 - 5.2.2 Wafers, photo-masks and fixtures.
 - 5.2.3 Tweezers and diamond scribes
 - 5.2.4 Pens (preferably ball point pens, Sharpies, Laboratory Markers and Vis – a-Vis markers).
 - 5.2.5 Materials with smooth, hard surfaces to be cleaned with IPA and cleanroom wipes.
 - 5.2.6 Plastic boxes and wafer trays for transporting materials.
 - 5.2.7 Portable / notebook computers and mobile phones.
- 5.3 Unacceptable (non-cleanroom compatible) materials
- 5.3.1 Non-cleanroom paper; wood pulp based paper products; paper, tissue, cardboard boxes, books, blueprints and magazines
 - 5.3.2 Packaging materials or Styrofoam (polystyrene) products
 - 5.3.3 Any powders

- 5.3.4 Erasers, pencils, felt tipped pens; such as dry erase markers or any other type marker other than described by line item 5.2.4.
- 5.3.5 Any item that can easily shred or aerosolizes including WD40. Generally any item that may generate or be a source of particles is prohibited.
- 5.3.6 Candy, gum, food, etc.
- 5.3.7 Staplers and hole punches.
- 5.3.8 Wooden handled tools or corroded or rusty tools.
- 5.3.9 Masking tape
- 5.4 All Laboratory Users must demonstrate or describe the following:
 - 5.4.1 The proper gowning sequence; including shoe covers, hairnets, facemasks, coveralls, gloves and safety eye protection.
 - 5.4.2 How to store a cleanroom garment
 - 5.4.3 How to bring working materials, notebooks, pens, tools and etc. into the facility.
 - 5.4.4 Recognize what is an acceptable verses unacceptable material for use in the facility.
 - 5.4.5 The location of all eye wash stations, emergency showers and emergency exits as well as the emergency evacuation route and where to meet during an emergency situation.
- 5.5 Personal Attire:
 - Tie hair up, wash hands and take a drink of water.
 - Clean shoes with closed toe and heel must be worn at all times. (No sandals, open toe, or sling back shoes, and heels should be kept to a minimum).
 - No shedding fabrics – such as angora or mohair, remove prior to entry
 - Long pants must be worn.
 - No bare legs or sleeveless shirts.
 - No cosmetics (with the exception of water proof mascara).
 - When wearing perfume, cologne, and aftershave - use moderately.
- 5.6 Laboratory entry and gowning procedure:
 - 5.6.1 Shoe covers – upon entry to the sub-basement put on shoe covers immediately.
 - 5.6.2 To enter the facility swipe access card – this monitors entry in the facility.
UNDER NO CIRCUMSTANCES ARE YOU TO ALLOW ANYONE BESIDES YOURSELF TO USE THIS CARD. EACH PERSON

MUST SWIPE HIS/HER OWN CARD, EVEN WHEN ENTERING WITH A GROUP.

To violate this policy will cause immediate suspension of rights to the facility. If your card malfunctions, notify KNI staff immediately so it can be corrected through the security office. Persons without card authorization are not allowed into the facility, except for brief tours accompanied by an authorized user. All visitors must sign in and out of the Visitor Log located inside the gowning room to the right of the exit. Your card authorization is essentially your documentation that you have received the required orientation and safety training, and your PI has authorized payment of your laboratory membership. Non-authorized persons are thus also prohibited from the role of laboratory “buddy,” nor may they operate ANY equipment.

- 5.6.3. Garments are to be changed weekly, before laundry pick up.
- 5.6.4 Replace garments that have touched the floor above the knee or are soiled.
- 5.6.5 Leave garments hanging until needed, (Do not store garments on benches).
- 5.6.6 Always gown in a top down manner.
- 5.6.7 Enter the Fabrication area via the air shower one person at a time.
- 5.6.8 De-gown in reverse order. Hang garments as they are removed. Do not remove shoe covers until leaving the sub-basement level. Throw consumables away.

Gowning Procedure Chart

Micro Fabrication Laboratory (North of air shower)		
a.	Bouffant	Verify that all hair is contained.
b.	Face mask	Verify that mouth and facial hair are covered
c.	Gloves	Use nitrile gloves and change when necessary
d.	Bonnet	Verify that Bouffant and hair are contained
e.	Coveralls	Pull gloves over the cuffs
f.	Boots	Tuck coverall pant legs into the boots
g.	Safety Glasses	Prescription eyeglasses are not sufficient for protection by Caltech Safety

Electron Microscopy Laboratory (South)		
a.	Bouffant	Verify that all hair is contained.
b.	Gloves	Use nitrile gloves and change when necessary
c.	Smock	Place gloves over the cuff of the garment

De-Gowning Procedure Chart

Micro Fabrication Laboratory (North of air shower)		
a.	Safety Glasses	Store item
b.	Boots	Remove and place in lower rack
c.	Coveralls	Remove and hang up
d.	Bonnet	remove and snap onto coverall.
e.	Gloves	Discard into trash receptacle
f.	Face mask	Discard into trash receptacle.
g.	Bouffant	Discard into trash receptacle.

Electron Microscopy Laboratory (South)		
a.	Smock	Remove and hang up
b.	Gloves	Discard into trash receptacle
c.	Bouffant	Discard into trash receptacle.
d.		

5.7 Detailed Entry and Exit Procedures

5.7.1 On entering the gowning room, the following must be done:

Put on hair net. Make sure all your hair is covered

At this point you may enter the Electron Microscopy Laboratory by putting on a cleanroom smock and nitrile gloves, or continue with the gowning procedure to enter the cleanroom portion of the facility.

Put on facemask

Obtain a bonnet, coverall and boots.

Garments are stored by assigned hanger once opened from packaging. (New garments are stored at entrance of laboratory).

Change your clean-room suit every week or more often if needed and or soiled.

Put on nitrile gloves provided.

Try not to touch the outside of the gloves with bare hands. When selecting a pair of gloves try not to touch the fingertips of the gloves with bare hands, instead pick up the glove at the cuffed end.

Put on protective eyewear.

Prescription eyeglasses are not sufficient for protection according to Caltech Safety.

Check yourself in the mirror or with your laboratory “buddy.” Make sure everything is tucked in, zipped up and snapped. Refer to the Gowning Procedure Chart for details.

Ensure that the materials you are bringing into the laboratory are cleanroom compatible. Wipe down belongings that you plan to bring with you with IPA/H₂O solution and Texwipes that are provided in the gowning area.

Entry to the cleanroom is allowed only by passing through the air shower.

5.7.2 Exiting the Laboratory, de-gowning:

Clean up after yourself.

Leave stations and equipment neat and ready for the next person.

Remove all personal items, including notebooks and clean-room post-its, from general-use areas after you are done processing or finished for the day.

Exit the cleanroom via the air shower.

In the gowning area: Remove items in reverse gowning order.

Remove and store safety glasses

Remove and hang shoe covers and coverall, followed by the bonnet last.

At this time the Electron Microscopy Laboratory can be accessed by putting on a smock and clean gloves or continue with the exiting procedure.

Remove face mask and dispose in trash receptacle.

Remove hair net and dispose in trash receptacle.

Remove gloves and dispose in trash receptacle.

5.8 Exit and external material handling

5.8.1 Sample or item removal

Place sample into an external handling container (to be sealed sufficiently to prevent contaminants to get inside).

Label the container so that it is not compromised and opened inadvertently in a non-clean area.

Place item in the pass-thru, or, if too large, in the gowning room.

After exiting facility, retrieve sample from the pass-thru transfer box.

As a minimum, the following protective measures are required for handling items outside of the KNI that are to return to the facility:

Bouffant

Face Mask

Gloves

To reduce cross-contamination, clean all items that are to come into contact with samples including, but not limited to; tweezers, holders, storage containers, beakers, etc. You are responsible for not only your items, but maintaining the cleanliness of the laboratory and process for all users.

5.8.2 Returning items to the cleanroom

Place samples into the pass-thru, follow proper gowning sequence, with gloved hands retrieve the items and remove outer transport container. Note if sample was in treated in a non-cleanroom environment replace outer container or wipe down with IPA:H₂O 1:1 mixture with clean wipes prior to re-introducing to the cleanroom.

5.9 Equipment and Parts

5.9.1 Entrance:

Remove all cardboard, packing materials, etc., before bringing them into the laboratory thru the gowning area or pass-thru. Gas bottles are to be brought into the facility through room 03A and 035A. Larger tools are to have the prior approval from the Facilities Manager to enter through double doors from the external corridor. All items are to be wiped down with an IPA:H₂O (1:1) solution using lint free clean room wipes.

Items are to have an initial cleaning prior to entry just outside the cleanroom and followed with another immediate cleaning as it is transferred into the clean area. If needed, a HEPA-filtered vacuum cleaner is available to remove excess dust from equipment prior to entry.

5.9.2 Exit:

Place items into a transfer container if possible. Refer to section 5.8.1. Small items should be placed into the pass-thru or, for larger items, remove through the gowning area. Remove gas bottles through the grey space areas of 03A and 035A. Gas bottle removal should be coordinated with the campus delivery personnel. For larger equipment removal please speak with the Facilities Manager to make arrangements.

5.10 Laboratory access and the Buddy System

The laboratory is open to qualified users both day and night, weekdays and weekends. Certain instruments and procedures may, however, be restricted to the normal work day, or only allowed in the presence of a staff member. In general, a “buddy” is another knowledgeable user within the facility who can and will watch out for you in case of trouble. Laboratory “buddies” must of necessity communicate with each other to be effective. The use of chemicals in particular is restricted to the buddy system after normal hours, i.e. all time outside 8 a.m.-5 p.m. normal workdays.

You may not wet etch, mix chemicals, or dispose of waste without another user in the area. **A “visitor” is not considered a knowledgeable user for the purpose**

of the “buddy” system. The buddy system particularly applies to all wet chemical use during off hours. Additional procedures may apply to specific instruments. You will be advised of these when you are trained on each instrument.

Each piece of equipment will have a training requirement before a user is permitted to use it without supervision. A probationary period of operation, consisting of a minimum of fifteen (15) hours of daytime use without user-caused problems, will then be required before the user will be allowed to operate the equipment off-hours. If a user-caused incident occurs after that, the individual will need to obtain additional training (amount at the discretion of the KNI staff) and repeat the probation on the equipment during daytime hours M-F to re-gain the off-hour privileges.

6.0 Chemical Safety Information

Note: This section is intended to supplement, not replace, [Caltech’s Chemical Hygiene Plan](#).

- 6.1 All laboratory personnel need to be aware of any surrounding chemicals in their work area.
- 6.2 The chemicals used in the KNI laboratories can be extremely hazardous. It is important that the proper safety precautions are taken to avoid improperly mixing incompatible chemicals that may cause a dangerous reaction to occur, or which could spoil a process of another user. The following tables list some properties of the more common chemicals to be found in the laboratory. These tables are not intended to be comprehensive. Contact the Associate Director of Technical Operations or the Assistant Facilities Manager in writing and provide the MSDS for the proposed substance if you wish to bring any other chemical(s) into the facility. This is necessary to assist the staff in determining if and/or where inside the laboratory the proposed chemical(s) can be used.

Table 1 below is a supplement list with common chemicals found in the KNI Laboratories.

Table 1: Concentrations of Common Chemicals in the KNI fabrication Area			
Chemical type	Chemical or common name	Formula	Concentration
Acid and Oxidizers	Acetic Acid	CH ₃ COOH	95%
	Hydrofluoric Acid	HF	49%
	Hydrochloric Acid	HCl	36%
	Nitric Acid	HNO ₃	68%
	Phosphoric Acid	H ₃ PO ₄	86%
	Sulfuric Acid	H ₂ SO ₄	96%
	Hydrogen Peroxide	H ₂ O ₂	30%
	Buffered HF or Buffered Oxide etch (BOE)	HF	10%
Solvents	2-Propanol or Isopropanol or IPA	CH ₃ CHOHCH ₃	100%
	Acetone	CH ₃ COCH ₃	100%
	HMDS or hexamethyldisilazane	C ₆ H ₁₉ NSi ₂	
	Methanol	CH ₃ OH	100%
	Toluene	C ₆ H ₅ CH ₃	100%
	TMCS (trimethylchlorosilane)	(CH ₃) ₃ SiCl	

Many of these chemicals can cause severe damage to human tissue. Therefore, you must be **alert and cautious** when using these chemicals to avoid all contact with them.

- 6.3 The eye wash stations and showers are located near the wet benches and etching bay. You are responsible to know how and when to use them.
- 6.4 Tell your supervisor about any unsafe situation. Use your judgment, for example if a beaker of chemicals is sitting around without proper notification report it **immediately**.
- 6.5 If you are not sure and safety is in question, ask your supervisor. Use common sense.

- 6.6 When you follow the safety procedures outlined below, your **risk of injury will be minimized.**

In the event of an Emergency Contact X5000 Campus Security for immediate assistance, **DO NOT UNDER ANY CIRCUMSTANCES CALL 911 ON CAMPUS.** IT WILL ONLY DELAY THE RESPONSE.

- 6.7 DO NOT use a chemical in the clean-room without first reading the MSDS and understanding the purpose and reaction of the substance.
- 6.8 Know which chemicals and containers are compatible. For example, some chemicals such as HF cannot be used with glass beakers.
- 6.9 Precautionary measures and safety procedures must be performed at all times when working with chemicals:
- 6.9.1 Always work with chemicals under a fume hood.
 - 6.9.2 Wear acid resistant gloves
 - 6.9.3 Use a chemical apron.
 - 6.9.4 Use a face mask when handling hazardous chemicals in the cleanroom.

Table 2 below contains a list of some of the corrosive liquids in the laboratory.

Health Hazard CBC Table		
B1 Corrosives		
Chemical	Formula	Concentration
Acetic acid	CH ₃ COOH	95%
Hydrofluoric acid	HF	49%
Nitric acid	HNO ₃	68%
Sulfuric acid	H ₂ SO ₄	96%
Hydrochloric acid	HCl	36%
Ferric chloride	FeCl ₃ 6H ₂ O	90% - 100%
Ammonium hydroxide (caustic)	NH ₃ OH	
Hydrogen peroxide	H ₂ O ₂	30
Dichloro-methane	CH ₂ Cl ₂	
Potassium hydroxide	KOH	20%
Buffered oxide etch (10%HF/Water)	BOE	10%

6.9.5 Use the **dedicated** beakers with the chemicals and / or process labeled on the beaker. Do not cross contaminate the beakers.

6.9.6 Some processes may require the use of personal glassware. Label personal glassware.

Do not remove beakers from the clean-room – unless you are disposing of the container.

6.9.7 When mixing chemicals use only one bottle at a time, if there is an open container use the remaining product before opening a new bottle. When chemical supplies run low, follow appropriate procedures to replenish.

6.9.8 Pour the chemical slowly; do not let the liquid gulp out of the container. Allow the chemical to “breathe” during pouring,

Remember the Triple A rule **“Always Add Acid to Water”**; NEVER the reverse. A reversed order could result in a violent exothermic reaction or explosion.

Do not pour chemicals back into storage, if too much product is poured, dispose of it properly.

Verify that the cap has been placed back on the chemical bottle, but do not over-tighten the cap. Rinse the outside of the bottle with DI water before you return it to the proper storage cabinet.

6.9.9 Do not leave your chemicals unattended or uncovered.

6.9.9.1 If the chemicals will be in use for several hours, arrange to leave them with the laboratory manager or a laboratory technician.

6.9.9.2 In addition, clearly label the name of the chemical, the date, and time, and the initials of owner of the solution.

6.9.9.3 **Leave this information next to or on the container:**

The disposal date and time and when experiment will be completed; initial and leave a telephone number / email on the label in order that the owner can be contacted.

6.9.9.4 Containers must be covered, including beakers and Petri dishes left unattended for any length of time.

6.9.10 Exercise Extreme Caution at all times! Most chemicals used in the laboratory can have the appearance of water, therefore, always assume any liquid is dangerous.

6.9.11 When using hot plates, check that your beaker is both suitable for hot plate use and smaller than the area of the hot plate.

Never use a Teflon or plastic beaker on a hot plate.

Always monitor the temperature of the chemicals on a hot plate with the appropriate thermometer.

Table 3 below lists some of the flammable chemicals encountered in the laboratory.

Combustible Liquid Class II		
Chemical	Formula	Concentration
Acetic acid	CH ₃ COOH	95%
Photoresist		
Anisole	C ₆ H ₅ OCH ₃	
Flammable Liquid I-B		
Chemical	Formula	Concentration
Acetone	CH ₃ CHOCH ₃	100%
Methanol	CH ₃ OH	100%
SU-8 small		
Photoresist developer		
IPA	CH ₃ CHOHCH ₃	100%
Methylisobutlyketone (MIBK)		
Total 3.3 I-B		
3.3 Flammable Liquid I-C		
Chlorobenzene	C ₆ H ₅ Cl	
Total 3.3 I-C		

6.9.12 Rinse the Acid gloves with DI water before you take them off. If you feel that acid might be on the gloves dispose of them into the acid receptacle.

6.9.13 Always clean up your work area before you leave. Thoroughly rinse beakers you used with DI water and store upside down in their appropriate locations.

6.9.14 Hydrofluoric Acid (HF) special safety notes:

HF is more dangerous than it seems. HF resembles water which makes the acid difficult to see.

All water drops on or near an HF bench should be treated as if it were HF. Wipe small drops using clean wipe and wearing heavy duty acid resistant gloves.

HF does not hurt upon contact with skin; the HF will be absorbed into the skin seeking Calcium (bones). When this happens over time an extreme burning sensation will occur, burns badly when it

makes contact with the body. Wipe down surrounding area with DI wetted wipes as well.

HF attacks calcium deposits such as bone matter.

The pain may start after 6 hours from initial contact and may last for days. For any suspected HF exposure, get medical help immediately. Call x5000, and be prepared to tell them what concentration of HF you suspect you were in contact with. This will help the response if you need to go to Huntington Hospital.

Calcium Gluconate is available for immediate application. See Laboratory Manager.

6.9.15 Wash your hands when you leave the facility, restrooms are available in the Sub-Basement.

6.10 Using Acids and Solvents:

6.10.1 When handling Acids: Acid resistant gloves, apron and face shield must be worn.

6.10.2 All acid and base work must be done in the appropriate, exhausted fume hood.

6.10.3 Acids are stored in the cabinet labeled "Acids."

6.10.4 Never work with acid and solvents in the same hood. Violent reactions can occur.

6.10.5 Disposal of acids and bases through the drain can occur only after a pH level between 6 and 8 is achieved through neutralization.

6.10.6 Know the difference between "chemical waste" and "chemical recovery," and use accordingly. A fully-completed "Caltech Chemical Waste Tag" must be affixed to the container when the first drop of waste is put into that container.

6.10.7 Storage of waste acids will be done by storing the acids in **clearly labeled waste containers** for that particular acid. **Do not mix acids together.** Waste acids should be stored in separate containers and labeled.

6.10.8 Always pour the acid into the properly labeled disposal can.

6.10.9 Storage of the waste acids will be in the acid cabinets as seen in the following pages.

6.10.10 Small quantities of the concentrated acids or bases (less than 75ml) can be poured down the drain as long as it is diluted with large amounts of water and baking soda.

6.11 Chemical Label Identification system

6.11.1 Always make sure that you read the labels.

6.11.2 It is important to be able to identify simple hazards that are associated with chemical products. Labels can help provide this critical information. This rule should apply to all faculty, staff and workers.

6.11.3 Manufacturer Labels

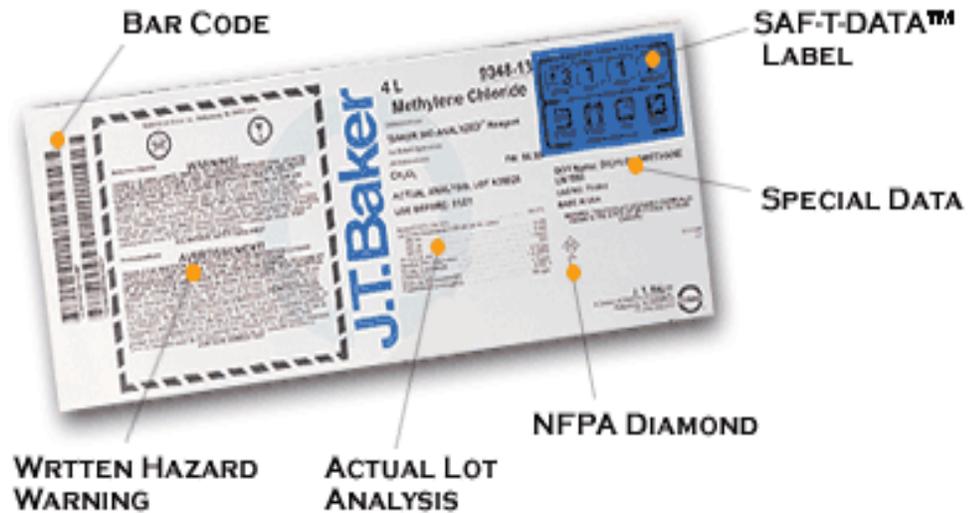
Chemical manufacturers provide pertinent labeling information on their original containers making them a good reference for information on chemicals hazards. Labels on containers of purchased chemicals may include:

The common name of the substance

An appropriate hazard warning

Proper handling, storage and emergency response information.

Example of a chemical label is shown below:



6.12 Hazardous Materials Container Labels

6.12.1 If a container is labeled with any of the following terms, it contains a hazardous chemical

Corrosives: Destroy living tissue upon contact

Toxics: Hazardous to your health

Flammables: React violently with materials in otherwise stable situations

6.12.2 All Laboratory personnel need to be made aware of what the exposure numbers on the chemical symbol mean for chemicals they work with or are in their area.

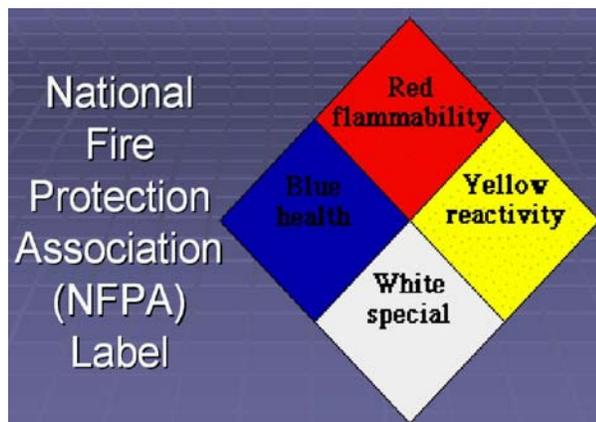
Flashpoint indication

Flammability

Toxicity

6.12.3 National Fire Protection Association (NFPA) Labels

The NFPA hazard ranking system shows the type and degree of a chemical hazard. The labels are diamond-shaped and color coded as can be seen in the example below:



Example #2 of NFPA label:



6.12.3.1 Blue indicates the health hazard.

Health Hazard Ratings

- 4. Deadly
- 3. Extreme Danger
- 2. Hazardous
- 1. Slightly Hazardous
- 0. Normal Material

6.12.3.2 Red indicates the fire hazard.

Fire Hazard Ratings (Flash Point)

- 4. Below 73 °F
- 3. Below 100 °F
- 2. Below 200 °F
- 1. Above 200 °F
- 0. Will not burn

6.12.3.3 Yellow indicates the reactivity hazard.

Reactivity Hazard Ratings

- 4. May detonate

3. Shock and heat may detonate

2. Violent chemical change

1. Unstable if heated

0. Stable

6.12.3.4 White gives special information such as water or oxidizer incompatibility.

Specific Hazard Ratings

Oxy – Oxidizer

Acid – Acid

Alk – Alkali

Cor – Corrosive

W – Use No Water

Rad – Radiation hazard

6.12.3.5 In each field, the degree of the hazard is rated from 0 to 4, with 4 being the greatest hazard and 0 indicating no significant hazard.

6.13 Material Safety Data Sheets (MSDS)

6.13.1 An important element described in the law for chemical safety awareness is the **Material Safety Data Sheet (MSDS)**.

6.13.2 Just as important as the product label, the MSDS provides you with information regarding the hazards associated with a chemical. However, the information provided is much more comprehensive.

6.13.3 It is important to consult an MSDS before introducing a new chemical to your work area or when questions arise while working with hazardous substances.

6.13.4 Prepared by its manufacturer, an MSDS provides information to help you understand the intrinsic hazards of the chemical including the following:

Physical and chemical properties

Stability and reactivity information

Health hazard information

Acute and chronic effects of exposure

Permissible exposure limits

6.13.5 What products are NOT covered?

Chemicals being transported in state as part of a shipment in interstate or intrastate commerce.

Chemicals covered by the Federal Atomic Energy Act and the Federal Resource Conservation and Recovery Act.

6.13.6 MSDS Format: Paper Notebook

All laboratory users need to be made aware of where to locate the MSDS Notebook.

6.13.7 MSDS Format: Electronic Version

Refer to the path: <http://www.safety.caltech.edu/msds.html>