Laboratory Safety

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Laboratory Accidents

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Accidents in waiting

Every researcher and institution should question their own attitudes to safety in the lab after the death of an undergraduate student in a Yale University workshop.

The shocking death of physics and astronomy undergraduate student Michele Dufault in a machine shop at Yale University in New Haven, Connecticut, last week should grab the attention of researchers and safety officers at universities across the United States, and the wider world. Rightly, the immediate focus is on whether the university could have taken more precautions to prevent the a
But whatever the verdict, Dufault's death — late at night and p
while working alone — should remind every researcher to consi
own attitude to safety, and whether it is crowded out by other p

Most scientists are well aware of poor safety practices in thei
tories — such as too many people working on their own, stud
properly trained to use equipment, or a general reluctance to we
glasses and lab coats. But, just as bottles of unidentified solvent
stashed guiltily in the depths of a fume cupboard, so such probl
often pushed to the back of the mind, and only properly con

The UCLA centre would be a good place to pool this knowled
make it widely available — and not just between health and safety
ers, who already discuss experiences and data. There are useful exa
of collaboration on safety issues elsewhere, such as an MIT peer-r
process with the National University of Singapore, in which each
d safety programmes of the other. If
than happy to make safety policies av
Imperial College London and UCL
ke their safety plans widely availabl
nt requests for information from res
in other countries.

To see safety precautions as a dr
earch is an irresponsible and cou
oductive attitude, but one that is h
ange. At UCLA, for example, too

"Poor safety practices are often pushed to the back of the mind and only confronted after an accident."

Laboratory Accidents

Felony charges filed against UC and a UCLA chemistry professor after fatal laboratory fire

A research assistant was fatally burned when chemicals burst into flame. Her death three years ago has focused attention on safety issues.

December 28, 2011 | By Kim Christensen, Los Angeles Times

C&EN CHEMICAL & ENGINEERING NEWS

Learning From UCLA:
Details of the experiment that led to a researcher's death prompt evaluations of academic safety practices

August 3, 2009 | Volume 87, Number 31 | PP 29-31, 33-34

Laboratory Accidents

New Haven Register

'A TRUE TRAGEDY': Yale student asphyxiated in lathe accident at chemistry lab, medical examiner rules

nature International weekly journal of science

A death in the lab

Fatality adds further momentum to calls for a shake-up in academic safety culture.

Richard Van Noorden

Laboratory Accidents

LubbockOnline

Blast probe finds 20 safety violations

Texas Tech investigators have linked a Jan. 7 laboratory explosion that severely injured a doctoral candidate to 20 surrounding violations of the university's safety policy, according to documents released Monday.

Laboratory Accidents

Laboratory Accidents

CNN U.S.

CHEMICAL REACTION

University chemistry lab fire injures 2

September 26, 2011|By the CNN Wire Staff

Laboratory Accidents

- What are the common failures?
  - Insufficient training
  - Insufficient hazard evaluation
  - Lack of appropriate PPE
  - Failure to follow safety policies

Today's Program

- Emergency Procedures and Reporting
- Responsibilities
- Hazard Identification and Risk Assessment
- Personal Protective Equipment
- Specific Hazard Information

Emergencies

- Emergency irrigation equipment
  - Eyewashes
    - Flush eye for a full 15 minutes
    - Users should flow the eyewash weekly
    - Facilities Management will check annually
    - Do not block
  - Safety showers
    - Flush for a full 15 minutes
    - Remove clothing under shower
    - Facilities Management will check annually
    - Do not block

Emergencies

- Seek medical attention:
  - Eye contact with chemical
  - Significant chemical exposure
  - Chemical exposure that results in symptoms
    - Inhalation of any substance that causes coughing
    - Burning or severe irritation
  - Electric shock
  - Laser injury

Emergencies

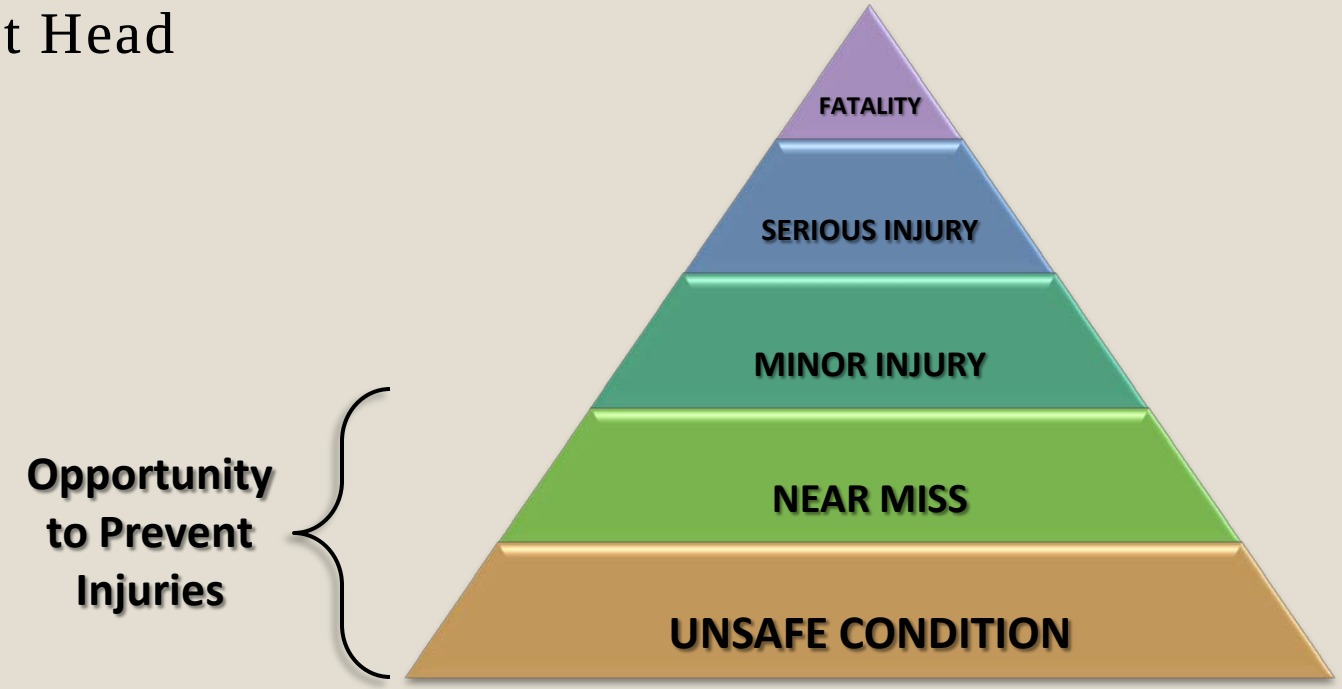
- Chemical spills
  - All spills should be cleaned up in a timely fashion
  - Small spills can be cleaned up by lab staff unless:
    - Toxic
    - Flammable

Emergencies

- Building Evacuation or Closure
  - Stabilize reactions in progress
  - Close fume hood sashes
  - Notify safety or emergency response personnel if any unusual hazards exist

Reporting

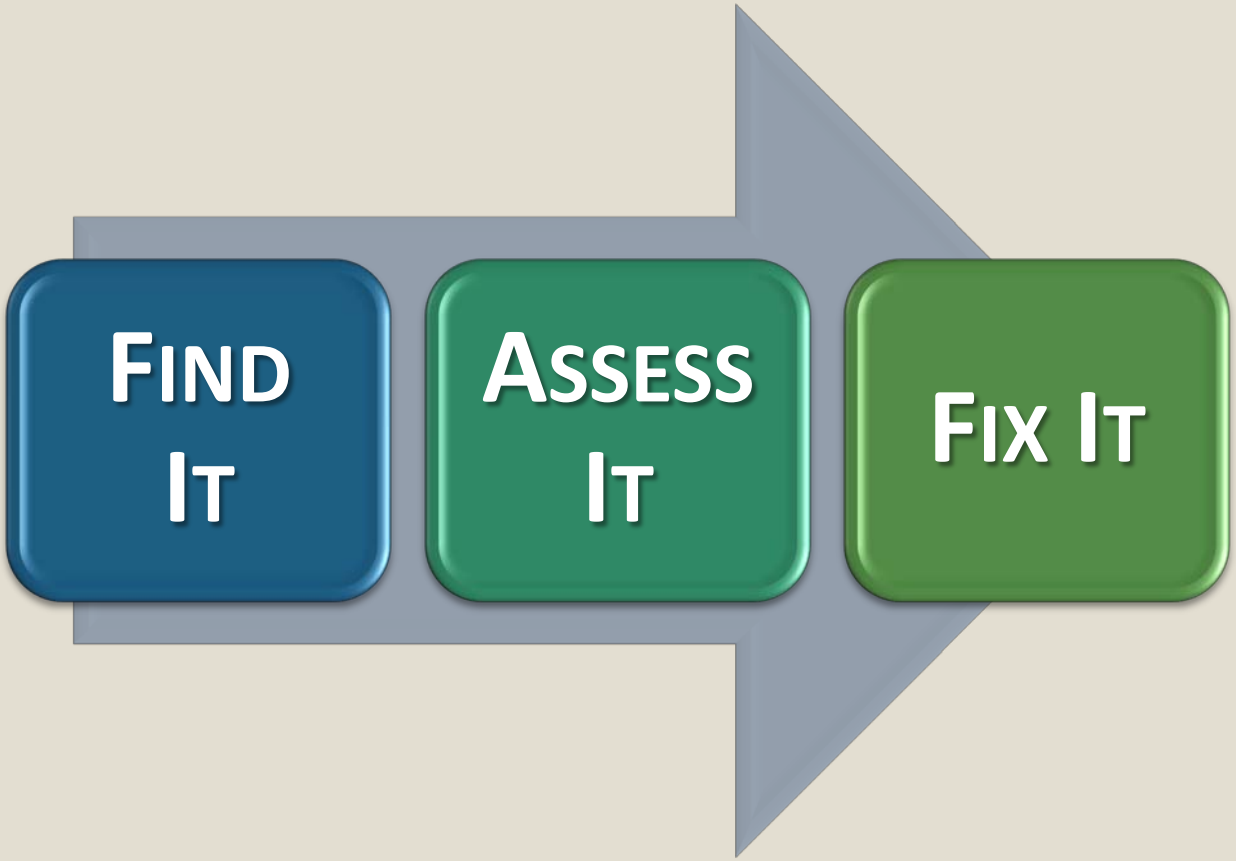
- Report incidents, near misses and unsafe conditions
  - P.I.
  - Safety Officer
  - Department Head



Responsibilities

- Who is responsible for safety in the lab?
  - PI
  - You
- Support
  - Safety Committee
  - Safety Officer
  - Department

Hazard Identification & Risk Assessment



Hazard Identification & Risk Assessment

- A **hazard** can cause harm or adverse effects
- **Risk** is the chance or probability that a person will be harmed or experience an adverse effect if exposed to a hazard
- **Risk Assessment** is the process where you:
  - Identify the hazards
  - Analyze or evaluate the risk associated with that hazard
  - Determine appropriate ways to eliminate or control the hazard
- Perform hazard identification and risk assessment prior to new experimental procedures and new chemical usage

Hazard Identification

- Identify **health hazards** associated with the chemicals
  - Irritant or sensitizer
  - Corrosive
  - Acute toxin
  - Carcinogen or potential carcinogen
  - Reproductive or developmental toxin
  - Other systemic toxin
- Identify routes of exposure
  - Inhalation
  - Skin/eye contact
  - Skin absorption
  - Injection
  - Ingestion

Hazard Identification

- Identify **physical hazards** associated with the chemicals
  - Flammable
  - Explosive
  - Cryogen
  - Other physical hazard
  - Air or water reactive
  - Strong oxidizer
  - Compressed gas
- Identify **process hazards** associated with the experiment
  - Pressure
  - Heat
  - Other process hazards
  - Vacuum
  - Electricity

Risk Assessment

- Identify circumstances of use, handling and storage
  - Quantity
  - Concentration
  - Frequency of use
  - Experiment location
  - Storage location
- Evaluate hazards posed by chemical changes over course of experiment
  - Pressure changes
  - Heat generation
  - Gas production
  - Other products of reaction
- Consider additional hazards posed by scaling up a reaction

Risk Assessment

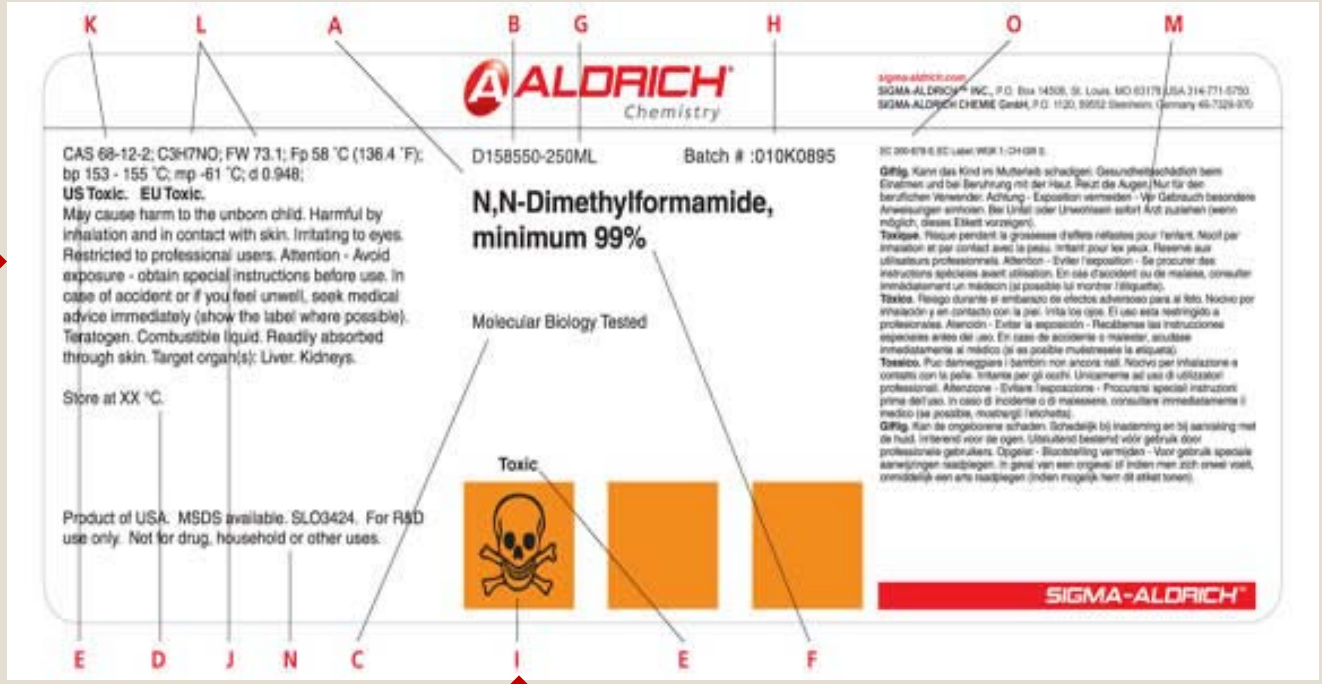
- Identify appropriate controls
  - Administrative
    - Training
    - Procedures
    - Signage
    - Prior approval
  - Engineering
    - Local exhaust ventilation
    - Gas cabinets
    - Storage cabinets
    - Shielding/isolation
  - Personal Protective Equipment (PPE)
    - Eye protection
    - Face protection
    - Gloves
    - Clothing
    - Respiratory protection

Hazard Information Resources

- Chemical container label
  - Chemical name and CAS number
  - Supplier identification
  - Signal words
    - Warning
    - Danger
  - Hazard statements
  - Hazard symbols/pictograms
  - Numerical hazard rating system
    - Numbers from 0-4 indicate severity of hazard for health, flammability and reactivity
    - Higher the number, higher the hazard

Hazard Information Resources

Hazard Statement

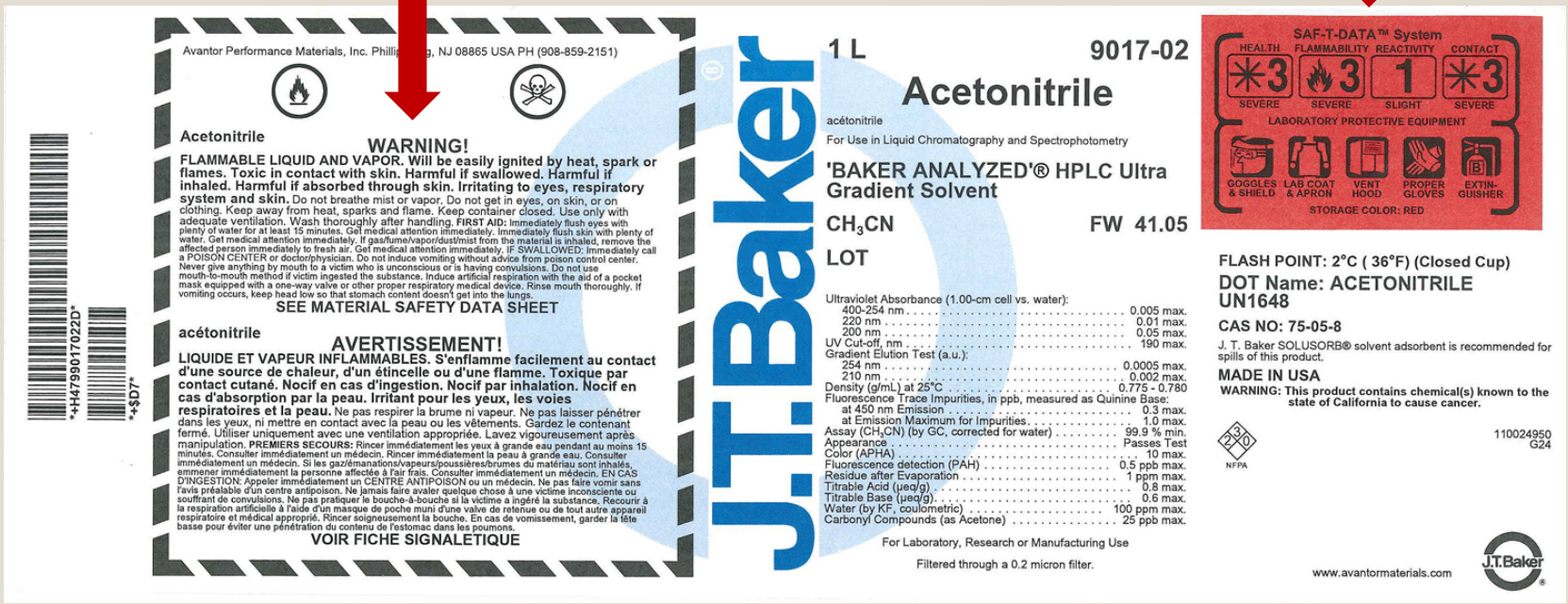


Hazard Pictogram

Hazard Information Resources

Signal Word and Hazard Statement

Numerical Rating System



Hazard Information Resources

- Material Safety Data Sheets (MSDS) contain:
  - Manufacturer information
  - Chemical name, synonyms, CAS number
  - Ingredients, if applicable
  - Exposure limits
  - Detailed hazard information
    - Health
    - Physical
    - Environmental
  - Symptoms of overexposure and first aid information
  - Chemical and physical properties
  - Precautions for safe handling, use and disposal

Hazard Information Resources

Y IDENTIFICATION

: Nitric acid, 70%

: 438073
: Sigma-Aldrich

: Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA
: +1 800-325-5832
: +1 800-325-5052
or : (314) 776-6555

: Sigma-Aldrich Corporation
Product Safety - Americas Region
1-800-521-8956

ON

, Corrosive, Oxidizer

, Corrosive

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ts, including precautionary statements

Danger

)

May intensify fire; oxidiser.
Causes severe skin burns and eye damage.

HMIS Classification
Health hazard: 3
Chronic Health Hazard: *
Flammability: 0
Physical hazards: 3

NFPA Rating
Health hazard: 3
Fire: 0
Reactivity Hazard: 2
Special hazard.: OX

Health hazard: 3
Fire: 0
Reactivity Hazard: 0

Components	CAS-No.	Value	Control parameters	Basis
Nitric acid	7697-37-2	TWA	2 ppm	USA. ACGIH Threshold Limit Values (TLV)
Remarks	Eye & Upper Respiratory Tract irritation Dental erosion			

Materials to avoid
Alkali metals, Organic materials, Acetic anhydride, Acetonitrile, Alcohols, Acrylonitrile, Ammonia, Crotonaldehyde, Halogenated hydrocarbon, Acids, Bases, Metals, hexalithium disilicide, Hydrogen peroxide, Ketones, metal acetylides, Water, Fluorine, Amines, Thiols, cadmium, Bromine, Copper, Hydrazine, Hydrazinium nitrate, Nitro compounds, Cyanides, Phosphorus trihydride (phosphine), Diphosphine, Halides, Organic halides, May set fire to wood or paper., Polyethers, Methyl vinyl ether

Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - nitrogen oxides (NOx)
Other decomposition products - no data available

Potential health effects

Inhalation	May be harmful if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract.
Ingestion	May be harmful if swallowed.
Skin	May be harmful if absorbed through skin. Causes skin burns.
Eyes	Causes eye burns. Causes severe eye burns.

Signs and Symptoms of Exposure
Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin., Inhalation may provoke the following symptoms:, spasm, inflammation and edema of the bronchi, spasm, inflammation and edema of the larynx, pneumonitis, pulmonary edema, Symptoms and signs of poisoning are:, burning sensation, Cough, wheezing, laryngitis, Shortness of breath, Headache, Nausea, Vomiting, Pulmonary edema. Effects may be delayed., Large doses may cause: conversion of hemoglobin to methemoglobin, producing cyanosis; marked fall in blood pressure, leading to collapse, coma, and possibly death.

Hazard Information Resources

- MSDS resources:
  - Internet
    - Manufacturer/distributor website (Fisher Scientific, Sigma Aldrich, Alfa Aeser, J.T. Baker, Mallinckrodt, etc.)
  - Paper
    - Your laboratory
  - Vendor

Hazard Information Resources

- Other sources of chemical hazard information:
  - Laboratory Chemical Safety Summaries (LCSS)
    - www.nap.edu
  - International Chemical Safety Cards
    - www.cdc.gov/niosh

Hazard Information Resources

NITRIC ACID p1/2

SYNONYMS		CAS#	Formula
Conc. nitric acid is 68 to 70% HNO_3 by wt White fuming nitric acid is 97.5% HNO_3, 2% H_2O, <0.5% NO_x by wt Red fuming nitric acid contains 85% HNO_3, <5% H_2O, and 6 to 15% NO		7697-37-2	

PHYSICAL PROPERTIES			
Odor:	Suffocating fumes detectable at <5.0 ppm	**Appearance:**	Colorless, yellowish, or reddish-brown fuming liquid
Water Solubility:	Miscible with water in all proportions	**Vapor Density:**	>1 (air = 1.0)
Flash Point:	Not flammable	**Vapor Pressure:**	White fuming nitric acid: 57 mmHg at 25 °C 70% nitric acid: 49 mmHg at 20 °C
Autoignition:	Explodes above 60 °C	**bp/mp:**	Concentrated: 122 °C White fuming: 83 °C/−42 °C

TOXICITY		EXPOSURE LIMITS	
LC_{50} inhal. (rat):	2,500 ppm (1 h)	**TLV-TWA (ACGIH):**	2 ppm (5.2 mg/m^3)
		STEL (ACGIH):	4 ppm (10 mg/m^3)
		PEL (OSHA):	2 ppm (5 mg/m^3)

HEALTH AND SYMPTOMS

General Concentrated nitric acid and its vapors are highly corrosive to the eyes, skin, and mucous membranes.
An oral dose of 10 mL can be fatal in humans. Tests in animals demonstrate no carcinogenicity or developmental toxicity for nitric acid. Tests for mutagenic activity or for reproductive hazards have not been performed.

Skin Dilute solutions cause mild skin irritation and hardening of the epidermis. Contact with concentrated nitric acid stains the skin yellow and produces deep painful burns.

Eyes Eye contact can cause severe burns and permanent damage.

Ingestion Ingestion of nitric acid may result in burning and corrosion of the mouth, throat, and stomach.

Inhalation High concentrations can lead to severe respiratory irritation and delayed effects, including pulmonary edema, which may be fatal.

FIRST AID

Skin Immediately flush with water and remove contaminated clothing. Wash clothing before reuse.

Eyes Immediately flush with copious amounts of water for 15 minutes (lifting upper and lower lids occasionally) and obtain medical attention.

NITRIC ACID p2/2

Ingestion Seek medical attention immediately.

Inhalation If the individual is overcome by fumes, move the person to fresh air and seek medical attention at once.

FLAMMABILITY & EXPLOSIVITY

NFPA rating (flammability) = 0; LEL = NA; UEL = NA

Not a combustible substance, but a strong oxidizer. Contact with easily oxidizible materials including many organic substances may result in fires or explosions.

REACTIVITY & INCOMPATIBILITY

Nitric acid is a powerful oxidizing agent and ignites on contact or reacts explosively with a variety of organic substances including acetic anhydride, acetone, acetonitrile, many alcohols, thiols, and amines, dichloromethane, DMSO, and certain aromatic compounds including benzene. Nitric acid corrodes steel and reacts violently with many bases, reducing agents, alkali metals, copper, phosphorus, and ammonia.

STORAGE & HANDLING

Gloves: Butyl rubber

Splash goggles and rubber gloves should be worn when handling this acid, and containers of nitric acid should be stored in a well-ventilated location separated from organic substances and other combustible materials.

CLEANUP & DISPOSAL

In the event of a spill, soak up nitric acid with a spill pillow or absorbent material, place in an appropriate container, and dispose of properly. Respiratory protection may be necessary in the event of a large spill or release in a confined area. Excess and waste material should be placed in an appropriate container, clearly labeled, and handled according to your organization's waste disposal guidelines.

ADDITIONAL CONSIDERATIONS

None

The information in this LCSS has been compiled by a committee of the National Research Council from literature sources and MSDSs and is believed to be accurate as of February 2011. This summary is intended for use by trained laboratory personnel in conjunction with the NRC report *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards*. It is advisable to consult comprehensive references in addition to these summaries. This information should not be used as a guide to the nonlaboratory use of this chemical.

Engineering Controls

- Fume hoods
  - Perform all work > 6” into hood
  - Elevate large objects above hood deck
  - Don’t use hood for *excessive* storage
  - Follow instructions for sash position
  - Avoid rapid movements around hood

Engineering Controls

- Fume hoods
  - Minimize storage

Engineering Controls

- Storage cabinets
  - Flammable liquids storage cabinets
  - Corrosives storage cabinets
- Proper segregation and storage
  - Flammables
  - Acids
  - Bases
  - Oxidizers
  - Water reactives
  - Pyrophorics

Personal Protective Equipment

- Proper laboratory attire:
  - Lab coat
  - Safety glasses
  - Long pants
  - Closed toe shoes

Personal Protective Equipment

- Eye and face protection
  - Safety glasses
  - Splash goggles
  - Face shield



- Gloves
  - Disposable nitrile
    - Accidental splash protection only
  - Chemical resistant gloves
    - Chemical specific



Personal Protective Equipment

- Respirators
  - Contact Safety Officer
    - Training
    - Fit-testing
    - Medical clearance
    - Voluntary use

Specific Hazardous Chemicals

- Good Practice Requires Designated Areas for:
  - Acute Toxins
  - Carcinogens
  - Teratogens
  - Mutagens

Specific Hazardous Chemicals

- Peroxide Formers:
  - Ethyl Ether
  - Isopropyl Ether*
  - Dioxane
  - Acetal
  - Tetrahydrofuran*
  - Tetrahydronaphthalene
- Date chemicals when open
- Dispose of within 12 months of opening

  *Dispose of within 3 months of opening

Specific Hazardous Chemicals

- Hydrofluoric Acid
  - Corrosive
    - > 50% immediate pain and tissue destruction
    - 20-50% symptoms delayed 1-8 hours
    - < 20% symptoms delayed up to 24 hours
  - Systemic toxin
    - Penetrates deep into tissue prior to dissociating
    - F- avidly binds to calcium and magnesium causing electrolyte imbalances (hypocalcemia and hypomagnesemia)
  - First aid kit with calcium gluconate gel

Cryogenic Liquids

- Hazards
  - Extreme cold
  - Asphyxiation
- Protective Equipment
  - Cryogenic gloves
  - Face shield

Compressed Gases

- Compressed gas cylinders have mechanical and possibly chemical hazards
- Large potential energy from the compression of the gas turns gas cylinders into potential rockets

Compressed Gases

- Cylinders must always be properly secured
- Regulators and tubing must be compatible with gas and should never be interchanged
- Toxic gases must be in a ventilated gas cabinet
- Incompatible gases must be segregated

Electrical Safety

Electrical Safety

Laboratory safety

- Laboratory Hygiene
- Sharps Safety
- Safety Equipment
- Fire Safety
- Chemical Safety
- Personal Safety

Laboratory Hygiene

- Scrub hands thoroughly when finished
- Avoid cross contamination
  - Do not touch self, faucets, doorknobs, notebooks, pens etc. with gloves on.
  - Keep a pen or two in your drawer for lab use only
- Clean and disinfect your workspace

Sharps Safety

- Sharps include
  - Razor and scalpel blades
  - Needles and pins
  - Microscope cover slips
  - Broken glass
- Place sharps in sharps boxes
- Broken Glass into glass box (ask for help)
- NO SHARPS or GLASS in the TRASH

Equipment safety

Eye wash and Shower

Fire Blanket

Fire Extinguisher

Fume Hood

Fire Safety

- Never leave flames unattended
- Do not use flammables near ignition sources
- Fire Extinguishers
  - Pull ring, aim at fire's base, squeeze handle, sweep back and forth (evacuate if >1 m^3)
- Fire Blanket
- Fire alarm pulls

Chemical safety

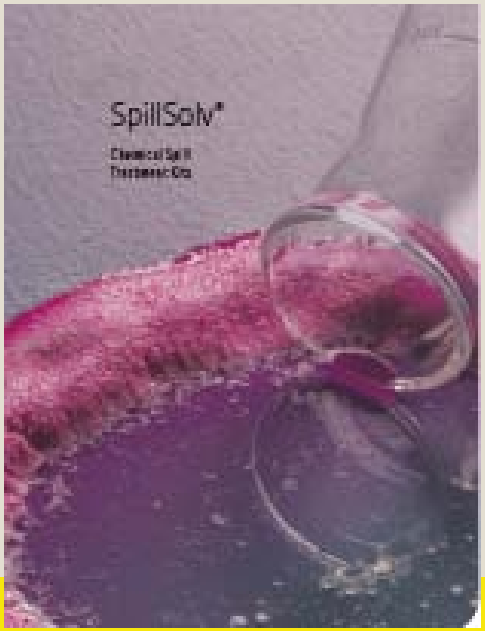
- Wear gloves and glasses where appropriate
- Follow instructor's directions
- Dispose of waste properly-**Do Not** pour down the drain

Personal safety

- Lab coat to be worn all the time
- Safety goggles must be worn all the time while working in the lab.
- Wear sensible clothing and
- Wear shoes.
- Appropriate gloves while handling chemicals
- Working of alone student is not allowed

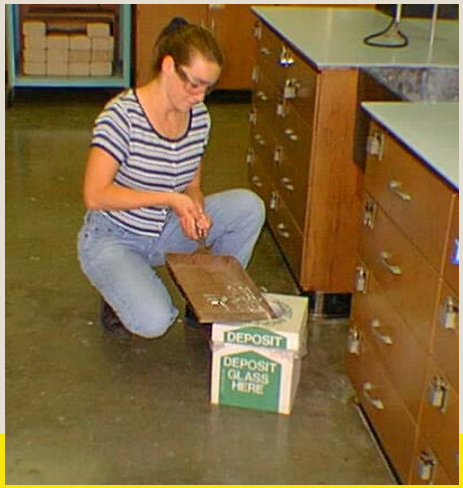
Safety Rules

- Keep tabletops clean. Return all equipment to its original location before leaving the lab. Clean all spills immediately.



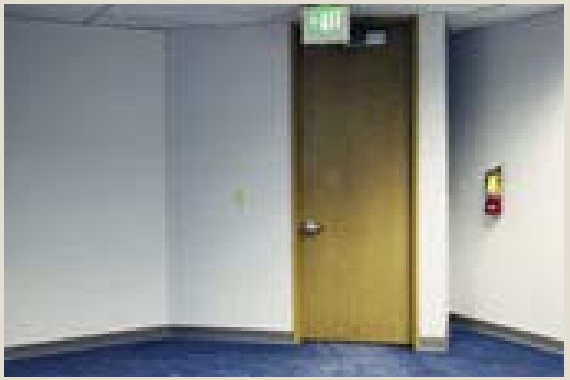
Safe Cleaning

- Report all accidents, no matter how minor, to the PI, Safety Committee. If you break something made of glass, be sure to use dustpan and hand broom to sweep it up and dispose of it in the glass waste receptacle.



Safe Exit

- In case of an emergency where we have to evacuate, proceed out through the nearest exit.
- Both the door should remain open all the time while working in the lab.



Safety Rules

- Never put anything in your mouth while in the lab (including chemicals, solutions, food and drink).
- All food and drinks should be restricted to sitting area only.

Laboratory Etiquette

- ✓ Clean your personal workspace after use
- ✓ Wipe down benches with disinfectant before and after use
- ✓ Ensure that no trash is left behind
- ✓ No trash in the sinks
- ✓ Push in chairs
- ✓ Place lab items back on carts and trays

Chemical Informations

- Prepare the complete list of chemicals and paste it to respective places such as chemicals cupboard and refrigerators
- Segregate the chemicals according to their compatibility groups for storage
- It is important to know as much about a chemical as possible.
- The most dangerous substance is the one that has no label.

Waste Disposals Practice

- All the waste should be isolate in the following categories

- Halogenated solvents
- Non-Halogenated solvents
- Heavy metals waste
- Silica waste

Precautions/Announcements

- In absence of any students no house keeping person should be allowed to enter the lab.
- Keep check on First Aid Box utilities
- No vendors
- No visitors
- Always keep atleast 1 litre of dil $NaHCO_3$ solution in stock.
- Contact details of all the person related to discipline of chemistry

And finally

- Examination on laboratory safety and is compulsory to everyone

Questions?