CENSE SAFETY MANUAL

Safety and Emergency Protocols

Version 2.03

This document lists the safety protocols that need to be followed by all laboratories in CeNSE. It also mentions the procedures to be followed in emergency situations.
It was last updated in May 2018

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Version Changes

2.01: Fixed some typos in the chemical waste flow chart

2.02: (Aug 2015) Fixed another type in chemical waste chart

2:03: (May 2018) Added sections on gas-tank safety, bio-safety, and laser safety.

CONTENTS

1 CeNSE Checklist

These are a summary list of things all laboratories are expected to follow. Details are given in subsequent sections.

1.1 General

1. Each lab should have a designated lab-in charge who is responsible for day-to-day enforcement of safety protocols. Each lab will also have a faculty associated with it who is ultimately responsible for safety in the lab.
1. Each lab will an updated "Laboratory Hazard Sheet" posted outside the door. Look in the appendix for the template. The hazard sheet needs to be reviewed every 6 months and signed.
2. Each lab will maintain a working landline near the exit.
3. All labs must maintain a list of emergency contact numbers posted near the landline at eye level. The emergency list should include cell phone numbers of the faculty in charge, the lab in charge, and other regular lab users. The emergency list should also include numbers of the IISc health centre, the campus security, as well as the local police and the fire station.
4. Laboratory safety procedures must be followed while working.
5. Safety clothing, e.g. safety glasses, aprons and shoes must be worn at all times. Labs are required to maintain public (i.e. not locked) stocks of safety gloves, safety glasses, splash googles and laser-safety glasses at all times.
6. No food should be allowed inside labs.
7. Safety equipment such as fire extinguishers must be available at easily accessible locations and not hiding behind equipment and under tables.

1.2 Fire Safety

8. Ensure each lab has at least 1 carbon dioxide type and 1 powder type fire extinguisher for general fire safety
9. Labs with flammable chemicals and organics must also maintain at least one fire extinguisher suitable for solvent fires, near the chemical storage/usage area.
10. Ensure that fire extinguishers are serviced and inspected. (Date should be mentioned on the equipment)
11. Flammable chemicals are stored in safe/recommended containers in limited quantities near the workplace.
12. Maintain adequate walking space (minimum of 2 feet) and unobstructed access to exits.

1.3 Chemical & High Pressure Safety

1. All pressurized cylinders must be chained to walls. All cylinders needs to be clearly labeled with gas tags. See Appendix for samples.
2. Ensure that all chemicals are clearly labelled with their names, composition, concentration and the individual responsible. For custom mixtures use the CeNSE chemical label given in the appendix.
3. Use volatile and flammable materials inside a fume hood only and ensure that the fume hood is functional with a flow of atleast 200 ft/s.
4. At the very least, segregate of solvents/bases from acids/oxidizers. Oxidizers and acids needs to be separated by a secondary container. No flammable materials should be stored in wooden cupboards.

5. Make arrangements for an eyewash in case you use corrosive chemicals.
6. Hard-copy of MSDSs for all hazardous chemicals must be available and stored at a visible and handy location near the exit.
7. Maintain electronic list (excel files) of all the chemicals in all labs.

1.4 LASER SAFETY

8. Ensure that you have a laser warning label on the lab door.
9. Laser safety goggles must be mandatory for class 3 and above lasers.
10. Paste laser specifications (class) on equipment and surroundings.
11. For class 3 lasers and above, have an electric bulb at the door, to indicate whether the laser is active.

1.5 ELECTRICAL SAFETY

1. At a minimum one tube light must be connected to the UPS line.
2. As much as possible always use 3 pin plugs. Ground the metal chassis of all large equipment.
3. Maintain adequate ventilation near electrical equipment/appliances that heat up during operation.

2 INTRODUCTION & SAFETY PRINCIPLES

The purpose of this manual is to make all users of CeNSE facilities aware of safety and emergency protocols (do and don't) that need to be followed at all times. The aim is to give you general safety guide lines. While it does cover a wide variety of hazards -- chemical, electrical, biological, etc. – the document does not (cannot) cover all possible hazards. Please use your discretion and more importantly common sense. Remember that the ultimate responsibility of conducting a safe experiment resides with the experimenter himself/herself. ***CONSISTENT VIOLATION OF SAFETY PROTOCOLS OR WILLFUL NEGLECT OF SAFETY WOULD RESULT IN STRICT PENALTIES THAT INCLUDE PROBATIONS, FINES, AND IN EXTREME CASES PERMANENT EXPULSION FROM CENSE.***

The Centre works with several hazardous materials and equipment. The institute and government allow us to operate with considerable autonomy, trusting us to maintain highest levels of safety. We need to sustain this trust by maintaining a safe working environment. Furthermore, safety is an important part of any training in nanoelectronics. Potential job givers, be it industry or academia, expect a certain awareness about safety. This is especially true for leadership positions where project managers are responsible for the safety of their whole group.

The four essential principles of safety are:

1. Follow Rules
2. Collective Responsibility
3. Trust structures more than people
4. Respond to Emergencies

They are discussed below:

2.1 FOLLOW RULES

Safety may mean different things to different people, sometime because of ignorance and sometime because of lack of sufficient forethought. To prevent confusion, this manual clearly defines standards for safe work practices. These rules need to be followed by everyone in CeNSE, both in letter and spirit, even if they sometime appear burdensome and/or pointless (trust us there is a reason for everything). ***REMEMBER PRACTICING SAFETY MEANS DOING THINGS THE RIGHT WAY, NOT THE QUICK WAY.***

2.2 COLLECTIVE RESPONSIBILITY

Concern for safety must also include others. All hazards should be clearly labeled in a manner that it easily understood by others, e.g. use warning notes/labels extensively. One should act responsibly in the event of an accident, e.g. pull the alarm to warn others. Finally, unsafe behavior should be confronted everywhere, e.g. remind your friend to wear safety glasses. CeNSE is an open-access laboratory and ***SAFETY IS EVERYONE'S RESPONSIBLITY.***

2.3 TRUST STRUCTURES MORE THAN PEOPLE

No matter how careful they are, people often make mistakes. An effective safety policy does not rely on people but relies on systems to reduce the probability of accidents. Prior to beginning any project or process, it is essential to think about all that potential hazards – all the things that can possibly go wrong. Focus should be on reducing the probability of all the hazards by intelligently designed safety precautions. Try to seek solutions that are inherently faulty tolerant, i.e. "idiot-proof". "I will be careful with chemicals" is a not an "idiot-proof" safety precaution, chemical-resistant gloves are.

Safety precautions also include learning how to store, handle and dispose all hazardous materials. Experiments should only be conducted in designated area with proper ventilation wearing appropriate safety accessories. Equipment should be well maintained with periodic scheduled inspections.

2.4 RESPOND TO EMERGENCIES

Everyone must be prepared to respond quickly and effectively in an emergency. Become familiar with the work area, available exits, and safety equipment such as eyewash stations, fire extinguishers, sinks, spill kits, and first aid boxes. Just a few moments spent in training could save a life during emergency.

3 GENERAL SAFETY

This section describes some practices which are basic or fundamental to safety in any laboratory where potential hazards exist. Following these simple, somewhat "common sense" rules are important. They will save you from most of the common accidents that happen in laboratory.

3.1 SAFETY PRACTICES

1. Each lab should have a designated lab-in charge who is responsible for day-to-day enforcement of safety protocols. Each lab will also have a faculty associated with it who is ultimately responsible for safety in the lab.
2. Known and anticipated hazards are considered for all materials or equipment being used. Before using unfamiliar chemicals, equipment, or new products, please read the labels, material safety datasheets (MSDS) and/or user manuals.
3. Training should provided for all new lab users. Training of existing users must also be provided when new hazards are introduced into a lab, e.g. during introduction of new substances, processes, or equipment.
4. Material Safety Data Sheets (MSDSs) must be reviewed for product specific handling, storage, and disposal information. All labs are expected to maintain a clearly-labeled folder with hard copies of MSDSs of all the chemicals in the lab. The folder must be stored in a visible location, preferably near the door.
5. Only proper equipment, in good condition, should be used. Before trying something very different from an equipment's intended use, please talk to the lab-incharge.
6. Boxes, chairs, cartons, shelves, chairs with wheels, or anything else that is not a ladder, should not be used as a ladder.
7. Emergency equipment (e.g. fire extinguishers, emergency eyewash/shower units, etc.) should be unobstructed, clearly visible, and in good working condition.
8. First aid kits are available in quickly accessible, visible and designated places. Ensure that first-aid kits have not expired.
9. Eating, drinking, or applying cosmetics near hazardous materials (radioactive, bio-hazardous, or chemical) is not permitted. Since all labs in CeNSE count as hazardous, ***NO FOOD/DRINK SHOULD BE ALLOWED INSIDE THE LAB.***
10. Food and drinks should not be stored in the refrigerator or freezer used to store hazardous materials. Refrigerators storing hazardous materials should have a clearly visible label saying, "No food or drinks" (see appendix for a sample).
11. All labs need to fill, update and periodically review the "Laboratory Hazard Sheet" (see appendix) and post it on the laboratory door. To conform that the sheet is current, the lab in charge much sign and date the sheet.
12. All labs must maintain a working landline which is kept near the door.
13. All labs must maintain a list of emergency contact numbers posted very near the phone at eye level. The emergency list should include cell phone numbers of the faculty in charge, the lab in charge, and other regular lab users. The emergency list should also include the number for the IISc health centre, the campus security, as well as the local police and the fire station.

3.2 Good Housekeeping Practices

1. Work areas are kept uncluttered and are cleaned upon completion of operations or at the end of each workday. This is particularly important for areas with hazardous materials and equipment.
2. Floors are maintained free from tripping, slipping, and falling hazards (e.g. cords, cables, wires, equipment, and tools).
3. Spills are cleaned immediately and thoroughly.
4. Emergency equipment and controls are not blocked, and hallways and stairways are not used as storage areas.
5. Workbenches and shelves are not overloaded with unused equipment, chemicals, or other materials.

3.3 Personal Hygiene

Maintain personal cleanliness, so that hazardous chemical used in labs are not accidently ingested after you leave the lab.

1. Wash hands after leaving the lab even if you were wearing gloves. Long term exposure to even minuscule amounts of toxin can have very adverse effects on your long term health. Such chronic exposures are very hard to diagnose or detect. Prevention is the only option.
2. Confine long hair and loose clothing when in the laboratory to keep them from catching fire, dipping into chemicals, or becoming entangled in moving machinery. (http://www.nytimes.com/2011/04/14/nyregion/yale-student-dies-in-machine-shop-accident.html?_r=0)
3. Avoid wearing finger rings and wrist-watches which may become contaminated, react with chemicals, or be caught in the moving parts of equipment.
4. Remove laboratory coats and gloves before you leave the laboratory to prevent spreading contamination to other areas.
5. Do not store, eat or drink food inside a lab.

3.4 Personal Protective Clothing and Equipment

Protective clothing and equipment safeguard against harmful chemical spills on the body, inhalation, projectiles etc. You are responsible for wearing the proper protective gear according to the activity you are doing in your lab.

3.4.1 Body and Feet

1. Clothing can prevent small chemical spills from coming into contact with skin. Cover unprotected skin whenever possible. No shorts inside labs please.
2. Aprons or laboratory coats must be worn especially when handling chemicals in lab.
3. Wear stable hard-toe shoes in lab area to protect feet from chemical splashes and sharp objects on the floor. No slippers, sandals, or high heels.

3.4.2 Eyes

4. Eyes are the most easily injured external organ, so whenever in the vicinity of sharp objects, rapidly moving machines, hot material, or flying particles, safety glasses with side shields must be worn. In fact, it is strongly advisable that safety glasses be worn in the lab at all time.
5. Eyes are also covered with blood capillaries, so they can quickly absorb many harmful chemicals. Splash goggles must be worn when there is danger of splashing chemicals.

6. When working with large amount of chemicals (e.g. 4 liter bottles) or in vicinity of explosive/implosive hazards (e.g. vacuum systems with glass jars), a face shield with safety or splash goggles offers maximum protection.
7. Prescription lenses in spectacles do not provide sufficient protection. In fact unless they are shatter resistant, they are hazardous in their own right. People who need to wear prescription glasses must wear safety-glasses/splash-goggles over their prescription glasses.

3.4.3 Hands

8. Gloves need to be worn anytime you are handling something in the lab.
9. Gloves are worn to prevent contact with toxic or biological agents, burns from hot or extremely cold surfaces or corrosives, or cuts from sharp objects. Several types of safety gloves are available, each for specific hazards. For adequate protection, select the correct glove for the hazard in question (see for example http://www.ansellpro.com/download/Ansell_7thEditionChemicalResistanceGuide.pdf). A simple list of most common gloves is given below.

Situation	Appropriate gloves	Remarks
General purpose	Thin nitrile (<2 mil thick)	Purple/blue nitrile gloves.
Solvents, salts, biological samples	Thin nitrile (<2 mil thick)	Purple/blue nitrile gloves.
Handling acids	Thick nitrile (>2 mil thick) OR neoprene/nitrile blend (thick gloves)	NOT the purple/blue gloves
Cryogenic liquids or surface	Padded gloves with cryo rated insulation	Cryo rated part if important
Hot furnaces or labware	Padded gloves with heat rated insulation	Do NOT get asbestos gloves

10. Chemicals will eventually penetrate all glove materials. Change gloves periodically to minimize penetration.
11. The most frequent cause of cuts in the laboratory is the mishandling of glassware. Insertion of glass tubing into rubber or cork stoppers should be carried out only after applying a lubricating agent (glycerol) and wrapping the glass in a towel. It is important to hold the glass tubing as close to the stopper as possible to avoid excessive strain on the tubing. Care should be exercised while inserting pipettes into rubber pro pipettes because the top of the pipette may break under pressure. A towel should be used when breaking a glass rod.

3.4.4 Breathing Apparatus

12. Lab facilities with hazardous gasses are supposed to install automatic sensors for detection and warning of harmful gas leaks. Hand held detectors are strongly recommended.
13. Proper respirators (self-contained breathing apparatus) must be used whenever there is a chance to inhale hazardous chemicals, gases or nano-particles.
14. Proper respirators (self-contained breathing apparatus) must be used whenever hazardous gas cylinders are being installed/changed.

4 CHEMICAL & BIOLOGICAL SAFETY

A wide variety of hazardous chemical and biological agents, are used in CeNSE laboratories. Therefore, it is required to undergo proper orientation to be aware of possible hazards/accidents. This section's focus is on chemical and biological safety.

4.1 BASICS

1. Before a researcher begins to work in a laboratory, he/she must be made aware of potential hazards (chemicals, lasers, autoclaves, etc.) associated with the particular laboratory by the lab in charge.
2. All researchers are responsible to teach themselves about the hazards posed by the chemicals in their vicinity. If using a material, the researcher should also know the safe way to store, handle, and dispose-off the hazardous chemical. If you do not know, ask someone who does or read the MSDS.
3. Become familiar with the location of fire extinguishers, spill kits, and first-aid boxes in your area. Familiarize yourself with their use. All laboratories with heavy hazardous chemical use must have access to a spill kit.
4. Before finishing ensure that the work bench and work areas are clean and that all waste chemicals are properly removed and disposed. Any chemical that are to be leftover must be clearly labelled. There should also be a note with the users name, phone number, and expected time of return.
5. All chemical bottles must be properly labeled. Custom mixtures need to have the CeNSE chemical label (see Appendix).
6. Chemical and biological waste should be segregated, labeled (using CeNSE Waste Label, see Appendix), and appropriately disposed-off.
7. An electronic inventory of hazardous chemicals should be maintained in each laboratory by the lab in charge.
8. It must be reemphasized, that no set of rules can substitute for common sense and a professional attitude toward laboratory safety.

4.2 SPECIAL PRECAUTIONS FOR HYDROGEN FLUORIDE

1. Contact with hydrogen fluoride or hydrofluoric acid will lead to excruciatingly painful burns. Thus, an apron, gloves, and a face shield should always be worn when handling these chemicals and procedures should be carried out in the hood.
2. If you work with any fluoride material there should be a 2.5% calcium gluconate ointment nearby.

4.3 CHEMICAL HOOD USAGE

1. The proper functioning of the laboratory fume hood is dependent upon unobstructed flow through the hood cabinet. To maintain good flow, minimize the amount of chemicals stored in the hood. Periodic housekeeping is recommended to remove unnecessary chemicals from hoods.
2. Chemical activities taking place within the hood should be conducted at least 6 inches inside the face of the hood. The hood user should remain outside the hood at all times.

4.4 Chemical Storage

1. Safety cabinets are best for storage of chemicals. Liquid chemicals cannot be stored in wooden cupboards or in easily flammable materials, like cardboard boxes.
2. Acids, bases and oxidizers must be stored with a secondary containment (to contain the spill in case the first container ruptures). Corrosion resistant plastic trays are a low-cost option for secondary containment.
3. Containers on shelves should not extend over the edge of the shelf
4. Large bottles and bottles containing toxic, flammable, or corrosive liquids should be stored on shelves below eye level (maximum 5 feet).
5. Volatile or unstable materials may be stored in a flammable rated refrigerator only in properly sealed containers. Never store flammable solvents (ether, benzene) in the refrigerator in open containers (beakers).
6. Food or drink should never be stored in a laboratory refrigerator or freezer. A “No food/drink” (see appendix) is required on all laboratory refrigerators.
7. Label all open chemical bottles samples with the contents, owner's name, and date of preparation. Commercially obtained samples should be dated on the day they were opened.
8. Be careful with materials that may form peroxides (diethyl ether, tetrahydrofuran, dioxane). Opened containers of these materials should be discarded within one year of opening. All such containers should be dated upon receipt and upon opening.
9. Never leave an unlabeled bottle of "something" behind when you depart.
10. Always store the four classes of chemicals, acids, bases, solvents and oxidizers, separately. If there is an issue of space, solvents and basses can be stored together, and acids and peroxides can be stored together. Solvents must NEVER be placed along with oxidants and acids.
11. Solid materials, such as salts of heavy metal like Cr, Pb, etc. and fluorides have to be stored with a secondary containment. It is suggested that these materials be stored with concentrated acids and hydrofluoric acid respectively.

4.5 Waste Disposal

4.5.1 Chemical waste

The disposal of waste chemicals needs to be segregated and disposed in the following manner to comply with the departmental waste management policy.

1. Material should be placed into compatible storage containers with secure screw-on tops and labeled with the “CeNSE Waste Label” (see appendix).
2. In general waste must be stored in the type of container in which the component materials were purchased (glass, plastic or metal). However, metal cans should not be used for acidic and corrosive solutions (alkali, acid, etc.). Also, as much as possible avoid glass containers for storage as they can shatter easily.
3. Small amount of waste can be collected in the labs. Once a month, lab incharges are required to collect all the waste and bring it to the waste collection shed (next the utility building). Only labelled and segregate waste will be collected so please make sure all the rules of segregation and labelling are followed. No mystery chemicals please.
4. Acids + solvents mixture can spontaneously ignite. Never store/leave a solvent + acid mixture in the lab unattended. If you do happen to make such a solution, segregate it and take it outside of the building to the waster shed.
5. Acidic waste with fluoride ions must be collected separately in plastic containers, e.g. dilute hydrofluoric acid, ammonium fluoride and buffered-oxide etch.

6. Acidic wastes which contain toxic metal salts (Cr, Pb, etc.) cannot be buried in a chemical landfill, so must be collected separately.
7. Acid waste that does not contain metallic toxins or fluoride and have a pH>4 can be disposed into the drain with copious amounts of water
8. Acid waste that does not contain metallic toxins or fluoride and have a pH<4 must be separately collected in plastic containers. CeNSE does not allow individuals to neutralize acids.
9. Acids + oxidizers react and evolve gas. So unattended acids+oxidizer mixtures present an explosion hazard -- in extreme cases plastic bottle can burst spraying acid everywhere. Fresh acids+oxidizer mixtures must be collected separately and kept inside the fume hood for 1 day. This allows time for the reaction to complete and gasses to escape. Nitric acid is both a strong acid and an oxidizer so solutions containing HNO3 it should be treated as an acid+oxidizer.
10. Solvents + oxidizer mixture can also spontaneously ignite. Never stote/leave a solvents + oxidizer mixture in the lab unattended. If you do happen to make such a solution, segregate it and take it outside of the building to the waste shed.
11. Base + solvent mixtures also evolve gasses. So unattended base+oxidizer mixtures present an explosion hazard -- in extreme cases plastic bottle can burst spraying base everywhere. Fresh base+oxidizer mixtures must be collected separately and kept inside the fume hood for 1 day. This allows time for the reaction to complete and gasses to escape.
12. Solvents must be separately collected in plastic or metal containers, e.g. benzene, ether, ethyl acetate, acetone, alcohols, hydrocarbons, etc.
13. Non-toxic basic waste with a pH<10 can be disposed into the drain with copious amounts of water
14. Basic waste with pH > 10, must be separately collected in plastic container. CeNSE does not allow individuals to neutralize bases. If they do not have any oxidizer, bases can be stored with solvents.

4.5.2 Bio-Waste disposal

1. The dry waste, i.e. napkins, blood-stained wipes, etc can most go to a Red bin that must be labelled “Bio-waste”. This will be disposed off as dry medical waste.
2. Sharps, such as needles, must be disposed in red-colored hard containers. These must be labelled as “Bio-waste: Sharps”.
3. Wet waste, such as blood or tissue/bacteria cultures, can be diluted with sodium hychlorite solution (final concentration 0.5%) and disposed down the drain. If the waste includes other toxic materials, such as acids, bases or liquids between pH of 4-10, then please bottle the waste and bring for monthly waste collection to the shed next the utility building.
4. All dead-bodes, e.g. dead rats, must be stored in dedicated refrigerators. Currently we cannot process dead-bodies. Labs producing such waste must contact the Bio-departments and come with a individual waste-management plan.

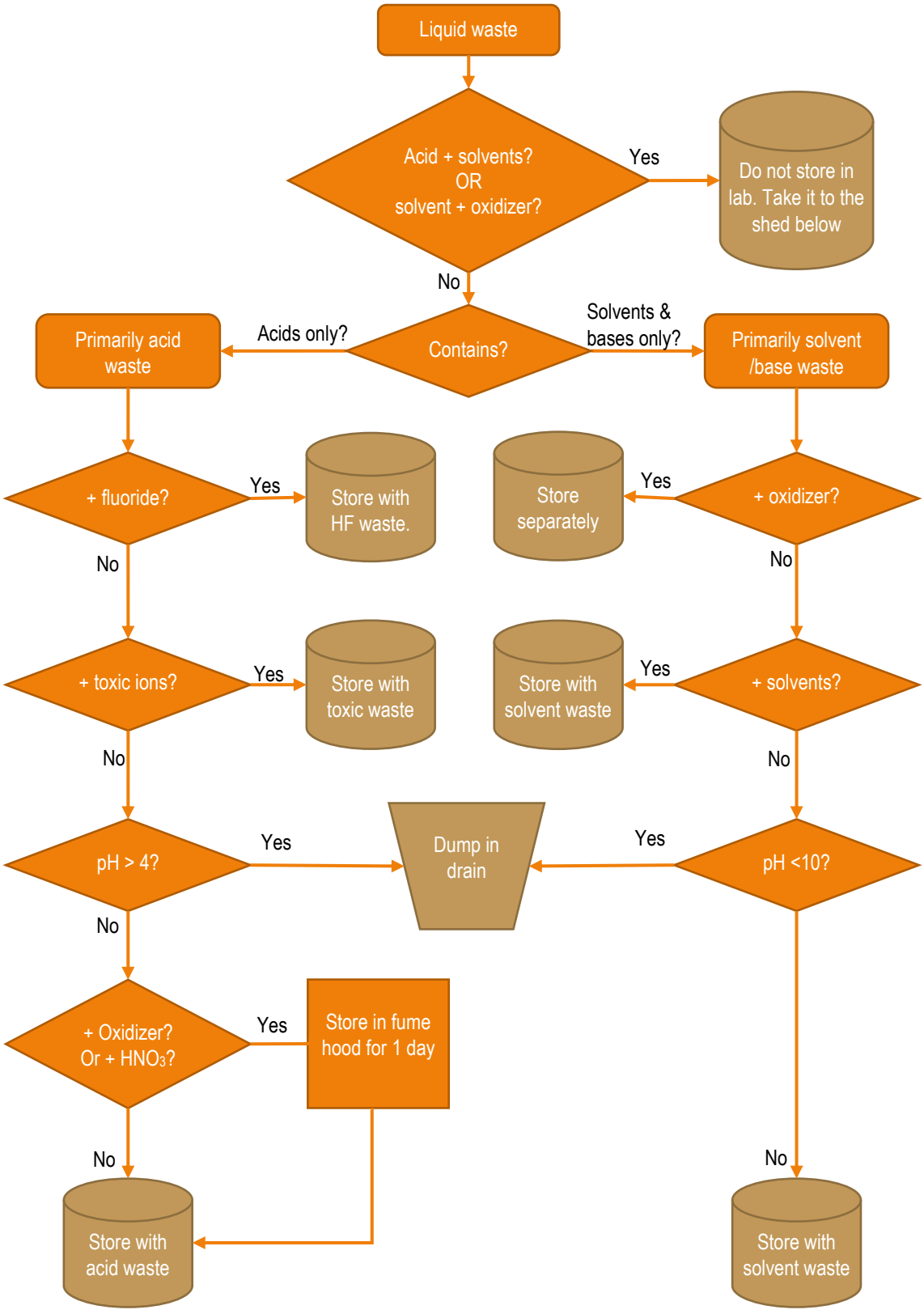


Fig XX: Liquid segregation waste flow chart. Err on the side of caution – when in doubt, store separately

5 FIRE AND ELECTRICAL SAFETY

Fire is probably the most high impact hazard because the consequences of one person's fault are suffered by the whole community. The best defense against fire is to prevent the fire from starting. Everyone is responsible for fire prevention and for knowing how to handle a fire emergency.

5.1 PRECAUTIONARY PROCEDURES

1. Each lab will maintain a working landline near the exit.
2. All labs must maintain a list of emergency contact numbers posted very near the phone at eye level. The emergency list should include cell phone numbers of the faculty in charge, the lab in charge, and other regular lab users. The emergency list should also include utility numbers such as the number for the IISc health centre, for the campus security, as well as the local police and the fire station
3. Locate the fire exits, fire alarms and extinguishers in your laboratory. Each laboratory should be equipped with extinguishers. See the following section to learn about different types of fire extinguishers.
4. Maintain adequate walking space in laboratory, minimum of 2 feet and unobstructed access to exits.
5. Ensure adequate ventilation around objects that heat up (e.g.: lamps, CPUs, etc.).
6. Avoid storing carton boxes, thermocole and other plastic/packaging materials. These are a major cause of fire incidents.
7. Papers, binders and manuals must be stored in enclosed containers/cupboards, away from hot objects.
8. Do not block access to fire escape routes, even outside of the laboratory. For example the stairs should be free of debris, nothing should be stored in front of fire hoses, etc.
9. Keep your workspace neat and tidy. Oily rags, carton boxes, waste or papers improperly stored are common causes of spontaneous combustion. Store these materials in covered metal containers.
10. Ensure that fire extinguishers are serviced and inspected regularly.
11. Keep a small handy fire extinguisher near flammable chemicals and organics.

5.2 ELECTRICAL SAFETY

1. Access to electrical equipment (e.g. plugs and switches) should be maintained free from obstruction.
2. Electrical apparatus is equipped with ground plugs or is properly grounded.
3. Make sure that live terminals are not exposed to direct or indirect touching in all switches and outlets.
4. Ground fault circuit breakers are used as needed.
5. Two-pin appliances (un-grounded) are not within a 5-foot radius, or located directly above flammable materials or sinks.
6. All current transmitting parts of electrical devices are enclosed.
7. Electrical connections are not handled with wet hands or when standing in or near water.
8. Safety devices (e.g. fuses) on electrical equipment are not bypassed.
9. Electrical equipment is disconnected from electrical outlets or circuits when being adjusted, lubricated, moved, or cleaned.
10. Electrical plugs, cords, and extension cords are maintained in good condition.

11. Extension cords use is kept to a minimum and cords are as short as possible.
12. Cords are placed in areas where they are not exposed to physical damage. They are not run through doorways or ceilings, or placed under carpets.
13. Don't splice extension cords or electrical cords without properly insulating the junction with insulation tapes.
14. Extension cords, multiple outlet surge protectors are plugged directly into a wall outlet.
15. Multiple outlet surge protectors are not used in place of permanently installed receptacles. If additional receptacles are required, they are installed by an electrician.
16. Always make sure that you don't overload an electrical outlet (e.g. don't connect a 15A device to a 5A socket). If an outlet is overloaded it may lead to fire in that circuit.
17. Never try to extinguish an electrical fire with water (this can result in electric shock if the burning wires are still live); use only the proper fire extinguisher.

5.3 CLASSIFICATION OF FIRES AND METHODS OF EXTINGUISHMENT

Type of Fire	Material	Class	Method to Extinguish
Ordinary combustible material	Wood, paper, textiles, etc.	A	Water, Foam spray, ABC powder, Wet Chemical
Flammable liquids	Oils, solvents, grease, paint, etc	B	Foam spray, ABC powder, Carbon Dioxide
Flammable gasses	SiH4, GeH4, organic vapors, etc	C	ABC powder
Metal	Magnesium, Aluminum, Sodium, Potassium, Zirconium, Titanium etc.	Metal	Special metal extinguishers. DO NOT use ordinary extinguishers found in the building or else a violent reaction may result.
Electrical	Short circuit, Hot electrical components, lightening discharge etc	-	Powder type, Carbon dioxide

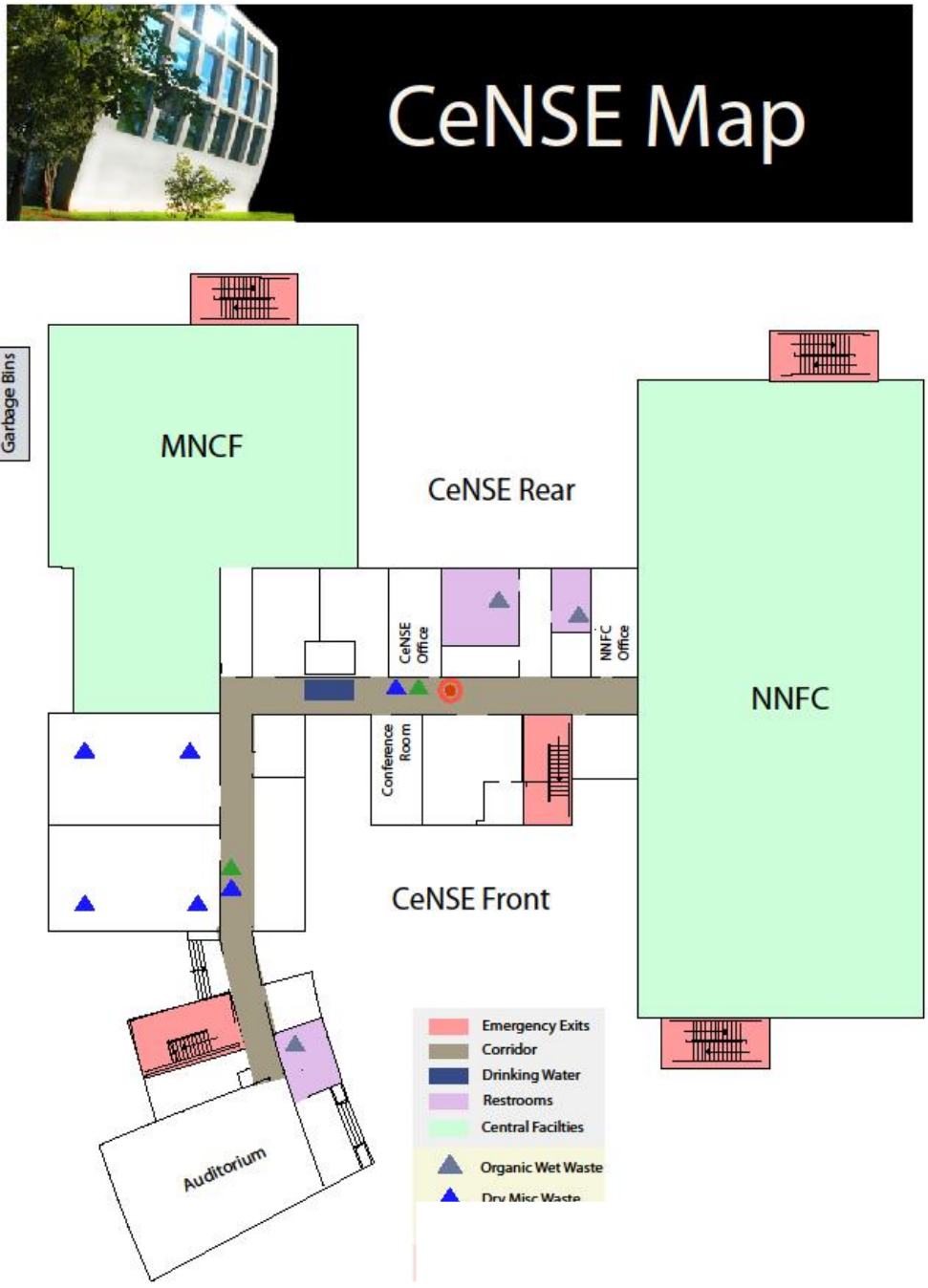
Following illustration shows different sources of fire and the right type of extinguisher to be used (http://www.vcmfiresafety.com/images/)

Symbol found on Fire Extinguishers and what they mean	Water	Foam Spray	ABC Powder	Carbon dioxide	Wet Chemical
Wood, Paper & Textiles	✓	✓	✓	✗	✓
Flammable Liquids	✗	✓	✓	✓	✗
Flammable Gases	✗	✗	✓	✗	✗
Electrical Contact	✗	✗	✓	✓	✗
Cooking Oils & Fats	✗	✗	✗	✗	✓

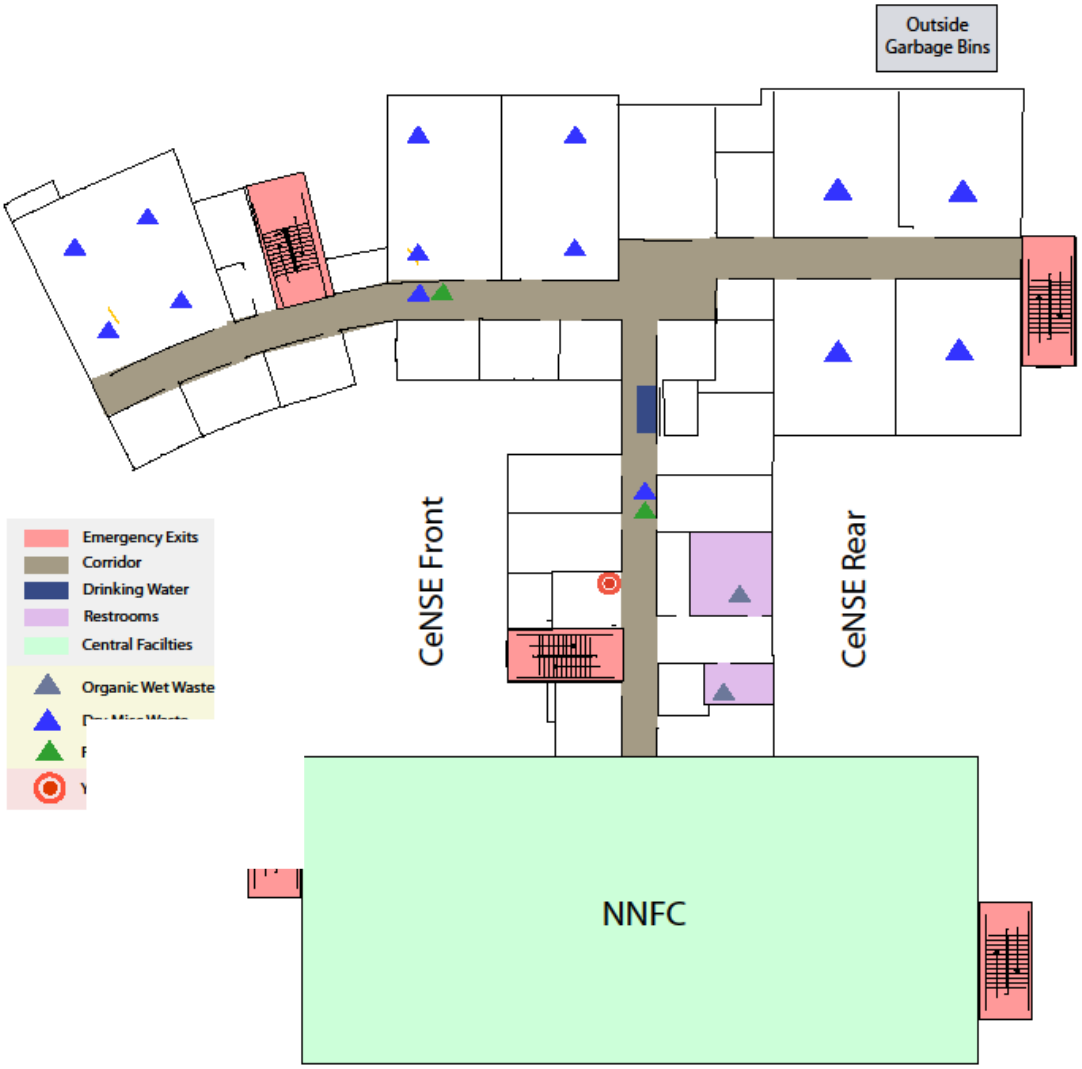
5.4 CeNSE BUILDING PLAN:

The following maps show building plan of CeNSE. Take note of emergency exits, building wings and assembly points during fire evacuation.

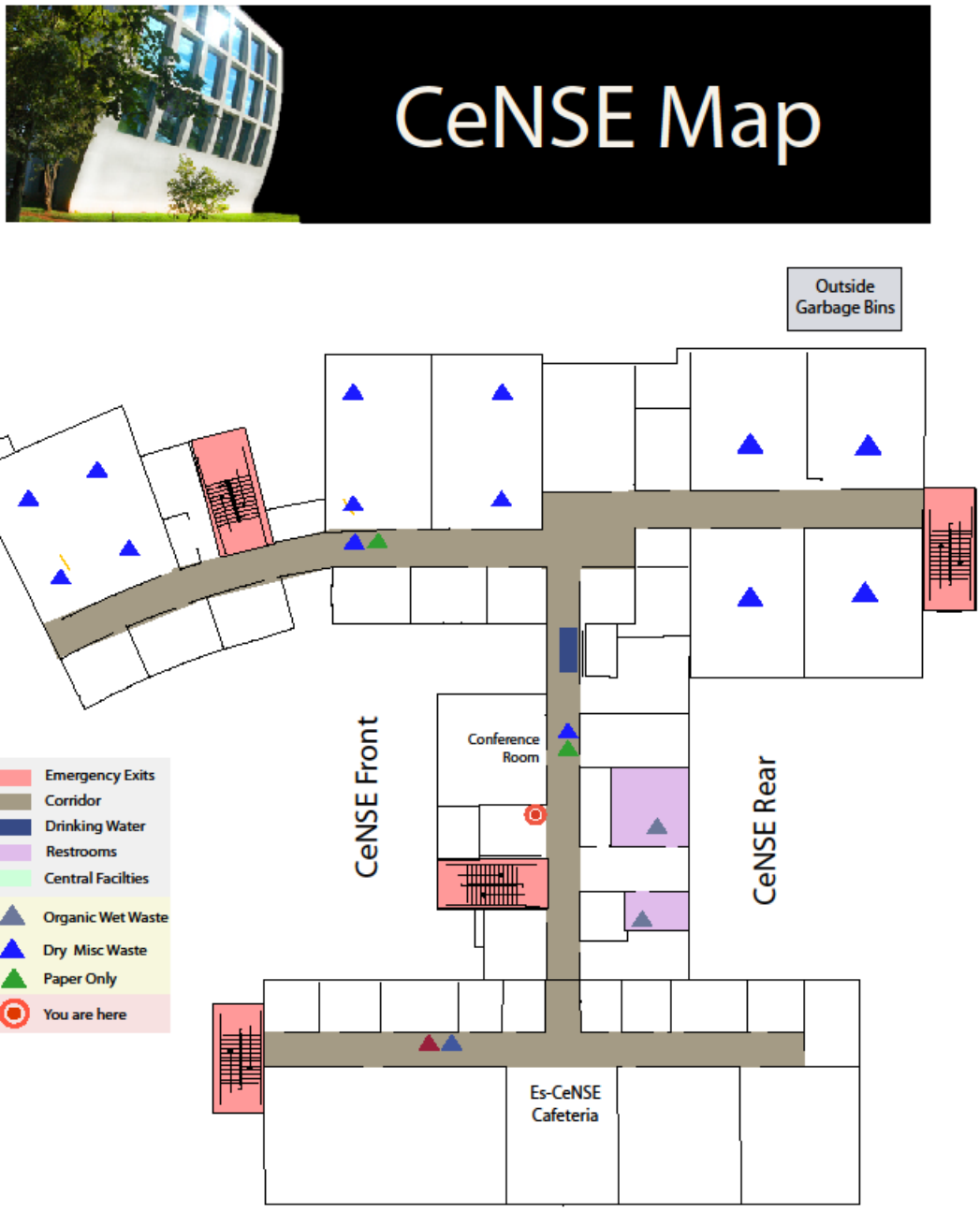
5.4.1 Ground floor



5.4.2 First floor



5.4.3 Second Floor



6 LASER & RADIATION SAFETY

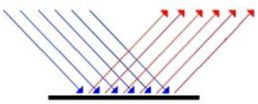
6.1 LASER SAFETY

LASER is an acronym for Light Amplification by Stimulated Emission of Radiation. A laser produces an intense, highly directional beam of light. High power lasers can cause damage to eyes and skin and in extreme cases cause blindness and burns (see Fig).

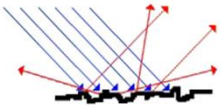
Damage caused to eyes (retina and cornea) and skin by high-power lasers.

6.1.1 Exposure to Laser

1. **Primary beam:** Direct hit/exposure from primary beam. This is the most hazardous.
2. **Specular reflection:** Exposure from laser hitting a shiny/smooth surface. This can be as hazardous as the primary beam.
3. **Diffuse reflection:** Exposure from a rough object. Typically, this is less serious but also hard to detect and hence dangerous.



Specular Reflection
(smooth surfaces)



Diffuse Reflection
(rough surfaces)

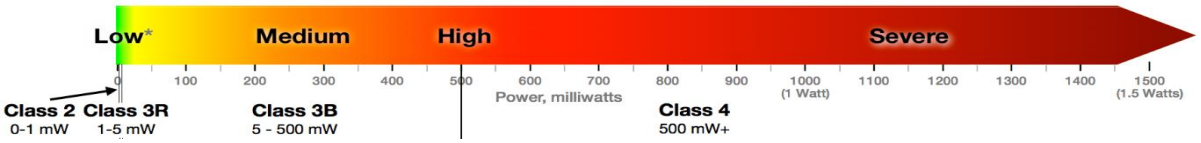
6.1.2 Laser Classification

Lasers can be classified based on power and wavelength. For details please see
http://www.rli.com/resources/articles/classification.aspx

http://www.lasersafetyfacts.com/laserclasses.html

Visible lasers (400-700 nm)

Based on their hazard, laser sources are categorized into classes. Modern ANSI/IEC classification is preferred (See table below) over older FDA Roman numeral classification. (Class I-IV). Class 1 lasers have the lowest hazard while Class 4 lasers create the greatest hazard. Exposure is typically expected to be <0.25 s. It is expected that the user will have a aversion response, which will prevent longer exposures.



Class	Procedure	Training	Eye Exam	Energy	Hazard
1	Not Required	Not Required	Not Required		Typically, when laser is not accessible. Non-hazardous to eye
1M	Not Required*	Not Required*	Not Required		Hazardous with collecting optics, e.g. with microscopes.
2	Not Required	Not Required	Not Required	0 – 1 mW	Hazardous only when person overcomes aversion response

2M	Not Required*	Not Required*	Not Required		Hazardous with collecting optics and/ Class 2 hazard
3R	Not Required	Not Required	Not Required	1 – 5 mW	Hazardous when person overcomes aversion response or uses optics
3B	Required	Required	Suggested	5 – 500 mW	Direct beam eye hazard. No serious injury from diffuse reflection to eye or to skin
4	Required	Required	Suggested	> 500 mW	Hazard to eye & skin from direct, specular or diffuse reflection. Fire hazard

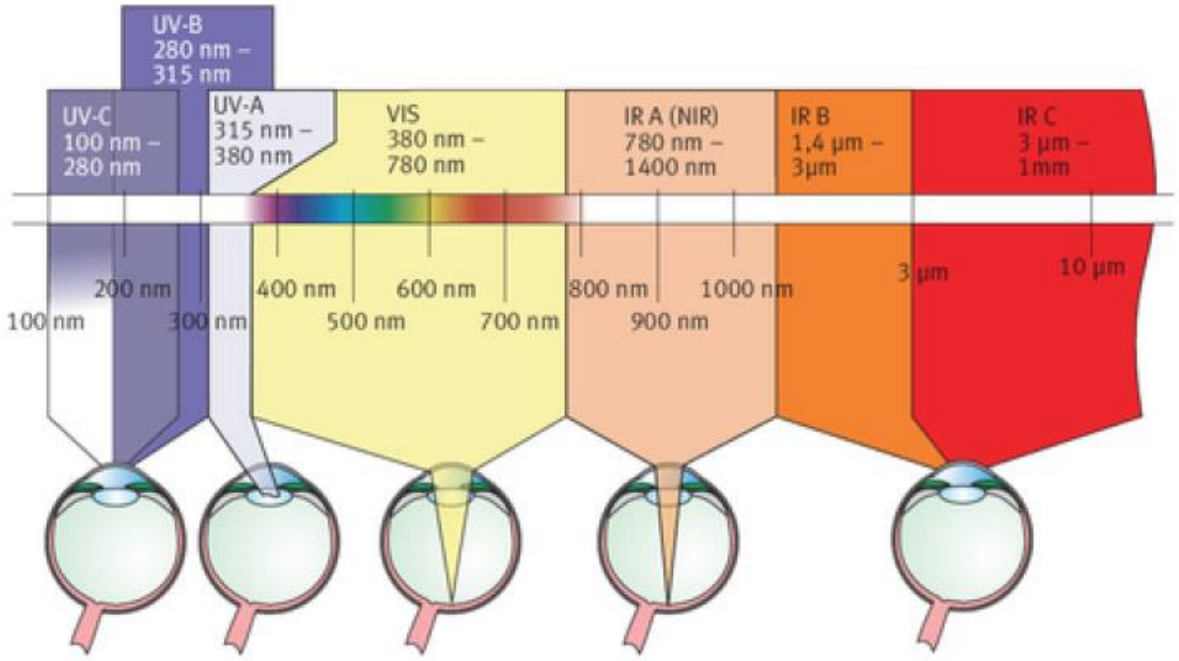
In general, we should never come in the way of laser light. Calculations have been done to estimate distance at which lasers with typical beam-spread are very dangerous. Calculations for some typical lasers are given in the table below. However, please remember that lasers are still dangerous beyond these distances. Do not stare at a laser, ever.

Laser	**Eye hazard distance or Nominal Ocular Hazard Distance (NOHD)** at which beam power <2.5 mW/cm2	**Flash blindness distance** at which beam power <100 µW/cm2	**Skin burn distance**	**Fire hazard distance**
Class 2: 0.99 mW 532 nm	14 m	67 m	0.9 m	0.6 m
Class 3R: 4.99 mW 532 nm	32 m	149 m	2.1 m	1.4 m
Class 3B: 499 mW 532 nm	158 m	747 m	10.5 m	7.0 m
Class 4: 5W 532 nm	250 m	1182 m	16.6 m	11.0 m

Non-Visible lasers (>700 nm)

Non-visible laser do not generate any aversion reflex. This significantly increases the possible of longer exposure which can be very dangerous. Even at lower powers there is a significant risk of losing eyesight.

The damage to the eye, depends on the laser wavelengths (see Fig below). Wavelengths between 380-1400 nm are transmitted by the cornea and absorbed in the retina. On the other hand, wavelengths longer than 1400 nm are strongly absorbed in the cornea and do not reach the retina for low exposures. Absorption in cornea also does damage, but since damage to retina is often irreparable, lasers from 380-1400 nm are considered more dangerous. Non-visible laser (700-1400 nm) are even more dangerous because there is no aversion response.



6.1.3 Laser Protection

Appropriate laser eye protection and other personal protective equipment must be worn while working around lasers, especially for Class III and IV lasers. The type of protective equipment will be based on the class and wavelength of the laser involved.

Laser safety glasses have lens that reduce the intensity of an incident laser beam. Glasses are commonly rated based on transmittance, which is specified in terms of optical density (OD). Higher OD = higher level of protection. Select appropriate OD level based on the power level of the laser.

OD	Transmittance	OD	Transmittance
0.0	**100%**	**5.0**	**0.001%**
1.0	**10%**	**6.0**	**0.0001%**
2.0	**1%**	**7.0**	**0.00001%**
3.0	**0.1%**	**8.0**	**0.000001%**
4.0	**0.01%**	**9.0**	**0.0000001%**

$$OD = \log_{10}\frac{1}{T}$$

$$\Rightarrow 10^{-OD}$$

OD = Optical Density
T = Transmittance (decimal)

Unfortunately, the correct choice of laser safety eyewear depends upon many local factors other than power that cannot be evaluated remotely, including the beam path, laser parameters, and lab environment, we can't recommend a specific eyewear for your application. Always, discuss your needs with your supervisor. Commonly used standards are the ANSI Z136 and EN 207 Standard. Recommended tutorial:

https://www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=762&gclid=CjwKCAjwxZnYBRAVEiwANMTRX43hAarpf9593iJz1XDNc0r9f8tDevT-VHrvm4JbxGZ1XAEcZRMAYBoC-vYQAvD_BwE

6.1.4 Best Practices

1. Never look directly at the laser beam or light-pump source.
2. Do not allow any object which could cause reflections in or along the beam, such as spherical buttons, screw heads, or jewelry, in the working area.
3. Keep a high general illumination level where lasers are in operation to cause contraction of pupils and reduced hazard.
4. Post warning signs on laser equipment and on the doors of labs/rooms that have laser equipment.
5. Always wear personal protective glasses whenever lasers are in the same room, irrespective of whether you are using that laser or not.
6. High-power lasers must be partitioned into separate work-spaces, with wall-to-floor partitions. No safety eyewear works for all wavelengths, so simultaneously using lasers with different wavelengths in the same work-area is dangerous.
7. Good quality laser protection goggles often have relevant protection levels listed on them. Before using a laser equipment, always check if the protection is adequate.

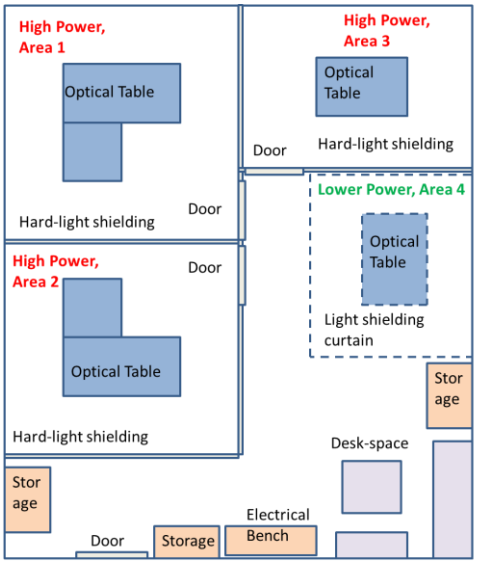


Fig: Layout of the high-power laser lab at CeNSE, showing separate workspaces. Courtesy Prof. Supradeepa

Fig: Safety goggles with safety rating

6.2 Ultraviolet Safety

1. All radiation of wavelengths shorter than 350 nanometers should be considered dangerous.
2. Protective safety glasses with UV absorbing lenses should be worn when there is even a chance of accidental eye exposure.
3. Skin exposed to strong UV radiation can receive painful burns, analogous to sunburns. So be completely clothed while working with UV radiation.
4. UV lights are often used to sterilize the room/area. In such cases please make sure the room had tinted/plastic windows, such that UV light does not escape.

6.3 X-Ray Safety

1. Laboratories with X-ray sources should have notices posted outside the door.
2. According to GoI policy, all X-ray equipment must be registered with the AERB.
3. All X-ray sources are expected to be shielded by safety enclosures so that no users are exposed to X-rays.
4. There should be automatic interlocks that shut off the sources when the safety enclosures are open.
5. Disabling or dismantling the interlocks is expressly forbidden.

6.4 Acknowledgement

We thank Ms. Roopa Prakash (PhD) for authoring the section on laser safety.

7 CRYOGENIC SAFETY

Cryogenic liquids are liquefied gases that are maintained at very low temperatures. These liquids are gases at normal temperatures and pressures. Since these liquids are extremely cold and can expand to very large volumes of gases they are a safety hazard. The following guidelines should be followed while working with cryogenic liquids.

Liquid Oxygen	-297.3 °F (-183 °C)
Liquid Nitrogen	-320.4 °F (-195.8 °C)
Liquid Argon	-302.6 °F (-185.9 °C)
Sublimation Point	
Liquid CO_2	-109.3 °F (-78.5 °C)

7.1 TYPES OF CRYOGENIC LIQUIDS

1. **Inert Gases:** Inert gases do not react chemically to any great extent. They do not burn or support combustion. Examples of this group are nitrogen, helium, neon, argon and krypton.
2. **Flammable Gases**: Some cryogenic liquids produce a gas that can burn in air. The most common examples are hydrogen, methane and liquefied natural gas.
3. **Oxygen**: Many materials considered as non-combustible can burn in the presence of liquid oxygen. Organic materials can react explosively with liquid oxygen. The hazards and handling precautions of liquid oxygen must therefore be considered separately from other cryogenic liquids.

7.2 TYPES OF CRYOGENIC LIQUIDS CONTAINER

Cryogenic liquids are shipped and used in thermally insulated containers. These cryogenic liquid containers are specifically designed to withstand rapid temperature changes and extreme differences in temperature.

1. **Liquid Dewar Flasks:** Liquid Dewar flasks are non-pressurized, vacuum-jacketed vessels, somewhat like a "Thermos bottle". They should have a loose fitting cap or plug that prevents air and moisture from entering, yet allows excess pressure to vent. Flasks containing helium, hydrogen and other low- boiling liquids have an outer vessel of liquid nitrogen for insulation.
2. **Laboratory Liquid Dewar Flasks:** Laboratory liquid Dewars have wide-mouthed openings and do not have lids or covers. These small containers are primarily used in laboratories for temporary storage.

Fig: (left) Liquid dewar flasks of different sizes. (right) laboratory liquid dewar flask

3. **Liquid Cylinders:** Liquid cylinders are pressurized containers specifically designed for cryogenic liquids. This type of container has valves for filling and dispensing the cryogenic liquid, a pressure-

relief valve with a frangible (bursting) disk as backup protection. Never remove/disable the safety valves, otherwise the tank can explode with disastrous consequences. Please read: http://blogs.sciencemag.org/pipeline/archives/2006/03/08/how_not_to_do_it_liquid_nitrogen_tanks

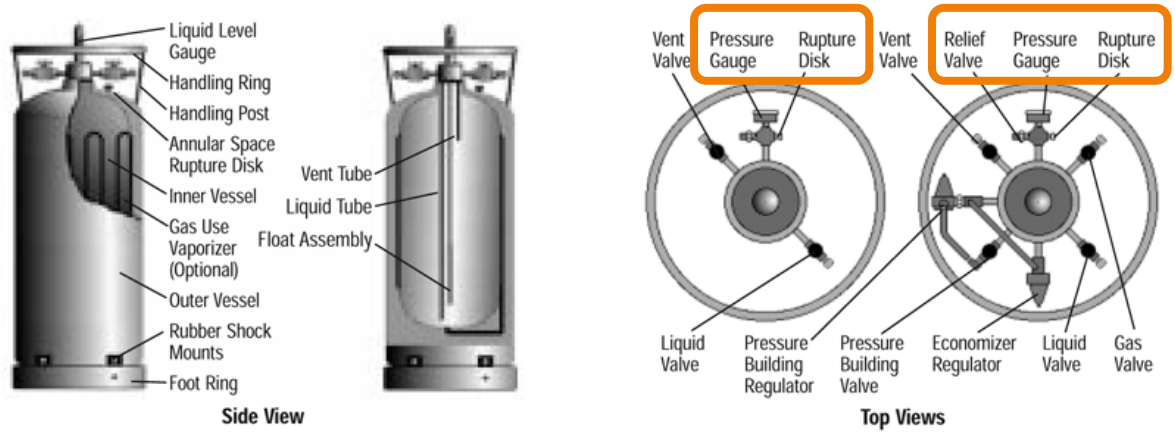


Fig: (left) cros-section liquid cylinders. (right) top view of the liquid cylinders showing the safety relief valve and rupture disks

7.3 HEALTH HAZARDS OF CRYOGENIC LIQUIDS

There are three groups of health hazards associated with cryogenic liquids: extreme cold, asphyxiation, and toxicity.

Fig: Required personal protective equipment for handling cryogenic liquids

1. **Extreme Cold Hazard:** Cryogenic liquids and their associated cold vapors and gases can produce effects on the skin similar to a thermal burn. Brief exposures that would not affect skin on the face or hands can damage delicate tissues such as the eyes. Prolonged exposure of the skin or contact with cold surfaces can cause frostbite. The skin appears waxy yellow. There is no initial pain, but there is intense pain when frozen tissue thaws. Unprotected skin can stick to metal that is cooled by cryogenic liquids. The skin can then tear when pulled away. Even non-metallic materials are dangerous to touch at low temperatures. Prolonged breathing of extremely cold air may damage the lungs. Always handle the cryo liquids with personal protective equipment: face-shield, gloves and apron.
2. **Asphyxiation Hazard:** When cryogenic liquids form a gas, the gas is very cold and usually heavier than air. This cold, heavy gas does not disperse very well and can accumulate near the floor. Even if the gas is non-toxic, it displaces air. When there is not enough air or oxygen, asphyxiation and death can occur. Oxygen deficiency is a serious hazard in enclosed or confined spaces. Small amounts of liquid can evaporate into very large volumes of gas. For example, one litre of liquid nitrogen vapourizes to 695 litres of nitrogen gas when warmed to room temperature (21°C).
3. **Toxic Hazards:** Each gas can cause specific health effects. For example, liquid carbon monoxide can release large quantities of carbon monoxide gas, which can cause death almost immediately. Refer to the material safety data sheet for information about the toxic hazards of a particular cryogen.

7.4 Flammability Hazard of Cryogenic Liquids

Several types of situations exist that may result in a flammability hazard including: fire, oxygen-enriched air, liquid oxygen, and explosion due to rapid expansion.

1. **Fire Hazard:** Flammable gases such as hydrogen, methane, liquefied natural gas and carbon monoxide can burn or explode. Hydrogen is particularly hazardous. It forms flammable mixtures with air over a wide range of concentration (4 percent to 75 percent by volume). It is also very easily ignited.
2. **Oxygen-Enriched Air:** Liquid hydrogen and liquid helium are both so cold that they can liquefy the air they contact. For example, liquid air can condense on a surface cooled by liquid hydrogen or helium. Nitrogen evaporates more rapidly than oxygen from the liquid air. This action leaves behind a liquid air mixture which, when evaporated, gives a high concentration of oxygen. This oxygen-enriched air now presents all of the same hazards as oxygen.
3. **Liquid Oxygen Hazard:** Liquid oxygen contains 4,000 times more oxygen by volume than normal air. Materials that are usually considered non-combustible, (such as carbon and stainless steels, cast iron, aluminum, zinc and Teflon (PTFE),) may burn in the presence of liquid oxygen. Many organic materials can react explosively, especially if a flammable mixture is produced. Clothing splashed or soaked with liquid oxygen can remain highly flammable for hours.
4. **Explosion Due to Rapid Expansion:** Without adequate venting or pressure-relief devices on the containers, enormous pressures can build up. The pressure can cause an explosion called a "boiling liquid expanding vapour explosion" (BLEVE). Unusual or accidental conditions such as an external fire, or a break in the vacuum which provides thermal insulation, may cause a very rapid pressure rise. The pressure relief valve may not be able to handle this increased pressure. Therefore, the containers must also have another backup device such as a frangible (bursting) disc.

7.5 General Rules

1. Always use cryo rated gloves, face-shield, and apron when handling cryo liquids. Cryo liquids should not be handled without open-toed shoes.
2. Handle the cryo liquids safely. This means use of both hands to hold dewar and duct.
3. Never store, transport cryogenic liquids in non-rated containers.
4. Never store cryo liquids above eye level, i.e. above 5 ft.
5. If a safety valve blows up. Please investigate. There is a reason it blew up
6. Never disable, replace or weld shut a safety valve. As irritating as they might be, they keep us all safe

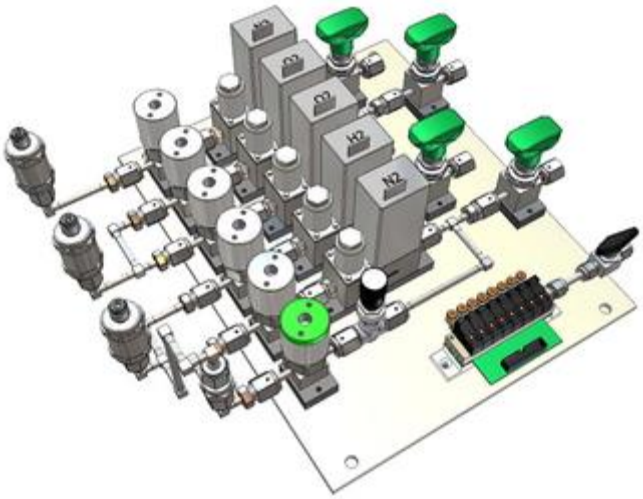
Fig: The correct usage with proper protective equipment + use of both hands to hold the tank and tube.

8 HIGH-PRESSURE SAFETY

If pressure equipment fails in use, it can seriously injure or kill people nearby and cause serious damage to property. In addition, sometimes the gases are chemically active. The addition of chemical energy makes the tank ticking time bombs that must be safely handled. Please treat gas with due respect.

8.1 EXAMPLES OF PRESSURE SYSTEMS AND EQUIPMENT

1. Compressed air systems (fixed and portable)
2. Pipework and hoses
3. Gas cylinders



8.2 GENERAL RULES

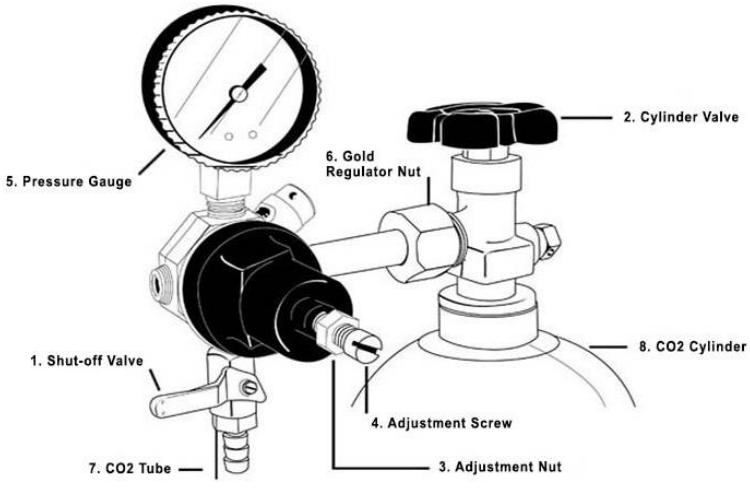
1. During storage and use, all cylinders need to be clearly labelled. Flammable, toxic, pyrophoric gasses must be distinguished by the color of the tags, and stored in segregated areas. Please see the appendix for examples.

Fig: (left) How to store cylinders in long term. (right) correct way of storing cylinders during use.

2. All gas cylinder need to be chained to the wall. The chain must either be at half height or two chains at 1/3 and 2/3 height. This ensures that the cylinder stays vertical in the event of cylinder valve failure, preventing it from flying through the walls like a missile.
3. Cylinders must always be moved on carts. Do not roll them horizontally. If handling a gas cylinder manually, you must two people holding the cylinder.

Fig: Proper method to transport cylinders. (left) using tank carts (b) two people holding a cylinder upright.

4. Please ensure the fitting/regulators being used are rated for the pressure they are being subjected to.
5. The cylinders come with a valve guard. This protects the cylinder valve in case the cylinder falls. Please keep it on if the cylinder is not being used.
6. Always install the cylinder with an output pressure gauge and shit-off valve. The former makes sure an unsafe pressure is not maintained in the line. The latter is useful in an emergency where the gas supply needs to be turned off.



Typical parts of a safely connected gas cylinder: Cylinder valve, regulator, output pressure gauge, & shut-off valve.

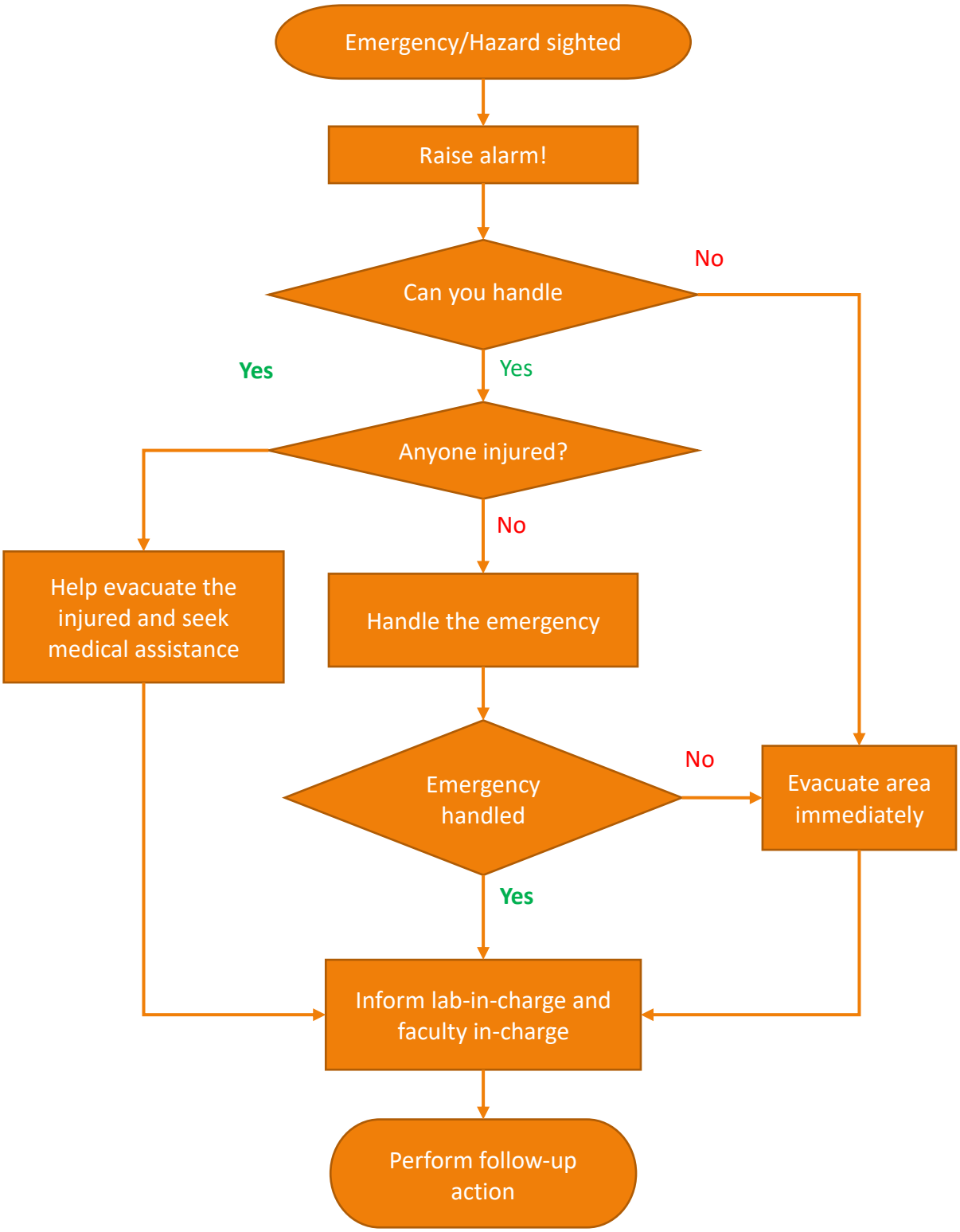
Valve guard (installed)

Valve guards (removed)

7. Dangerous gasses need a gas cabinet to be operated safely. Gas cabinet shut off the gas flow in case of alarms or gas leaks. The gas cabinets may be completely automatic or semi-

automatic. The need of gas cabinet must be decided on a case to case basis. In general, highly toxic and/or pyrophoric gasses require a gas cabinet.

9 EMERGENCY RESPONSE AND EVACUATION



9.1 CHEMICAL SPILL RESPONSE

1. Based on the chemicals stored and used in the laboratory, lab in charges must anticipate the types of spills that can occur in their respective laboratories. It is their responsibility to

obtain the necessary equipment (spill kits, personal protective equipment, and disinfection materials if biological materials are present in the laboratory) to respond to a spill prior to it happening.

2. In case of a spill first attend to injured or contaminated personnel and remove them from exposure. Alert people in the laboratory to evacuate. If the spilled material is flammable, turn off ignition and heat sources. Spill kits should only be used to clean up minor spills of chemicals with whose clean up procedure you are familiar.
3. If the spill is too large, highly toxic, is of an aggressive chemical, or just scary, please call for assistance and follow approved procedures. In the case of highly toxic spills, evacuate the room, post a notice warning people to not enter and then leave to get help.
4. The following compounds are considered very hazardous. You should not clean them up yourself: aromatic amines, hydrazine, bromine, organic Halides, hexamethylphosphoramide (HMPA), carbon disulfide, cyanides, ethers, nitro compounds and nitriles.
5. While cleaning up the spill, alert people in the immediate area of the spill and make sure that you are aware of the hazards associated with the material spilled.
6. While cleaning up the spill have adequate ventilation (open windows, fume hoods on) and proper protective equipment (minimum: gloves, splash goggles, and apron/lab-coat).
7. In case of a mercury spill use mechanical means or a portable pipette vacuum, do not use house vacuum or a vacuum cleaner. Cover small droplets in inaccessible areas with powdered sulfur. Place the residue in a labeled container and dispose it separately.
8. To cleanup alkali metal spills, smother with anhydrous sodium carbonate, calcium carbonate, powdered graphite or sand.

9.2 Fire Response

1. If you observe a fire breaking out, immediately raise an alarm and alert people around you. Activate one of the networked fire alarms if possible.
2. Evaluate if you are in immediate danger. If you are, exit the building immediately. Please refer to the CeNSE maps given below identify emergency exits and assembly points. From the assembly point call the lab in charge and the faculty in charge. Inform them of any hazardous conditions (presence of inflammable/toxic chemicals or gases).
3. If the fire is small, try to contain the fire using a fire extinguisher. If you can't try to call/find someone who can.
4. If you are completely helpless call the lab in charge and faculty in charge. The emergency numbers must be near the landline. Give your name, location, nature of the emergency and telephone number. Inform them of any hazardous conditions (presence of inflammable/toxic chemicals or gases).
5. If you are not in immediate danger, try to any assist injured people around you. If there any injured people who are in immediate danger, try to remove them away from the danger.
6. If the injured people are not in danger, do not move them. Try to keep them calm and awake. Call the medical emergency personal. Inform them about the nature of the medical emergency. Help in any way you can.
7. Assist physically impaired individuals, if any.
8. Ensure all personnel are out of the area of emergency. If lab is empty close all doors and windows while evacuating.
9. Do not use the elevators. Elevators may lose power during a fire.
10. Stay low. If confronted with smoke, keep near the floor. Smoke, heat and toxic gases will normally rise to the ceiling.

11. Stay away from the building until it is safe to return. Do not re-enter the building until advised to do so by the authorities.
12. When first responder arrive Inform them of any hazardous conditions (presence of inflammable/toxic chemicals or gases).

9.3 FIRST AID

9.3.1 General

1. It is the responsibility of uninjured laboratory occupants nearby to initiate first aid treatment to the victim if trained or qualified to do so, and to arrange for notification of medical personnel when a laboratory accident occurs.
2. If an individual is contaminated or exposed to a hazardous material in the laboratory, do what is necessary to protect his/her life without compromising your own. If you can do so safely, determine the nature of the hazardous material and communicate this information to the attending medical personnel.
3. Do not move an injured person unless he/she is in further danger from inhalation or further skin exposure. Keep the victim warm and awkae.
4. If the person is in contact with a live electrical circuit, do not touch him/her. Disconnect the power first by turning off circuit breakers or by dislocating the live wire with a non-conducting object.
5. In the case of severe bleeding, place a paper pad or cloth on the cut and apply firm pressure to control the bleeding.
6. Immediately seek medical help by calling the emergency numbers.
7. Call the lab in charge and faculty in change.

9.3.2 Burn Victims

8. If clothes are on fire, immediately deluge the victim with water under a safety shower. Water not only extinguished the fire but also cools down the body by transporting the heat away, preventing further burns.
9. Blankets are not the best method to extinguish flames because even after the flames die down the body continues to suffer damage due to all the trapped heat.
10. Do not use a fire extinguisher on a person whose clothing is burning.
11. Once the fire is put out, immerse the burned area in very cold or ice water until pain not only is relieved but also does not return when the burned area is removed from the water. If the burn cannot be immersed, apply ice cold compresses.
12. After ice treatment, cover the victim with a blanket to keep him/her warm to prevent hypothermia.
13. If the burns are extensive there is a high probability of victim going into a shock, so try to keep the patient awake and calm.
14. Be careful not to contaminate the burned area. Cover the burned area with sterile gauze or a sheet. Do not apply oily ointments, lotions or cleanser to the burned area.
15. Immediately seek medical help by calling the emergency numbers.
16. Call the lab in charge and faculty in change.

9.3.3 Chemical Spills on the Body

17. Remove the victim from contact with the chemical as promptly as possible.
18. Remove the clothing contaminated with chemicals but do not remove clothing that has burned onto the skin.

19. Affected areas of the skin should be thoroughly flushed with water (at least 15 minutes) by shower. Do not apply neutralizing or buffering agents. During flushing, goggles should be left on the victim until his head and face have been washed.
20. For fluoride acid spills, use calcium gluconate after washing with water to neutralize the fluoride ions.
21. In case of eye exposure, wash the eyes with water for at least 15 minutes.
22. In the case of contact with hydrogen fluoride, immediately remove contaminated clothing under a shower and wash all areas thoroughly. Only in the event of a delay, gently apply the calcium gluconate ointment to the affected area.
23. Alkali metals (e.g., lithium, sodium, and potassium) are also extremely caustic to all tissue. Any particles of metal that fall onto the skin should be rapidly removed with a cloth, paper towel or tweezers followed by flushing of the skin with water. If any metal on the skin ignites on contact with water, immediately deluge it with cold water.
24. Immediately seek medical help by calling the emergency numbers.
25. Call the lab in charge and faculty in change.

9.3.4 Eye Injuries

26. Loose, unattached foreign matter in the eye can often be safely removed with a wet piece of clean cotton on an applicator or clean with clean water.
27. However, if the particle is on the cornea or is embedded in the eye, do not touch it. Contact a physician or ophthalmologist as soon as possible.
28. For splashes of chemicals in the eye or exposure of the eye to corrosive vapors, remove contact lenses if necessary and flush the eye thoroughly with water from an eye wash fountain for at least fifteen minutes. Eyelids should be forcibly held apart so that the entire surface of the eye may be washed.
29. Transfer the victim to a physician or ophthalmologist. Never apply a neutralizing solution as first aid.

9.3.5 Fainting

30. An individual who feels faint should be made to lie down or to sit quietly with their head lowered below the level of their knees until the period of faintness passes.
31. If loss of consciousness occurs, place the victim in a reclining position, loosen any tight clothing, maintain an open airway and treat any injury that may have been sustained in the fall.
32. Bathe the face with cool water but do not give any liquid by mouth until consciousness returns.

9.3.6 Ingestion of Chemicals

33. Provide the ambulance crew and physician with the chemical name and other relevant information. If possible, send the container, and/or a label along with an MSDS with the victim to the nearby health center.

9.3.7 Inhalation of Chemicals

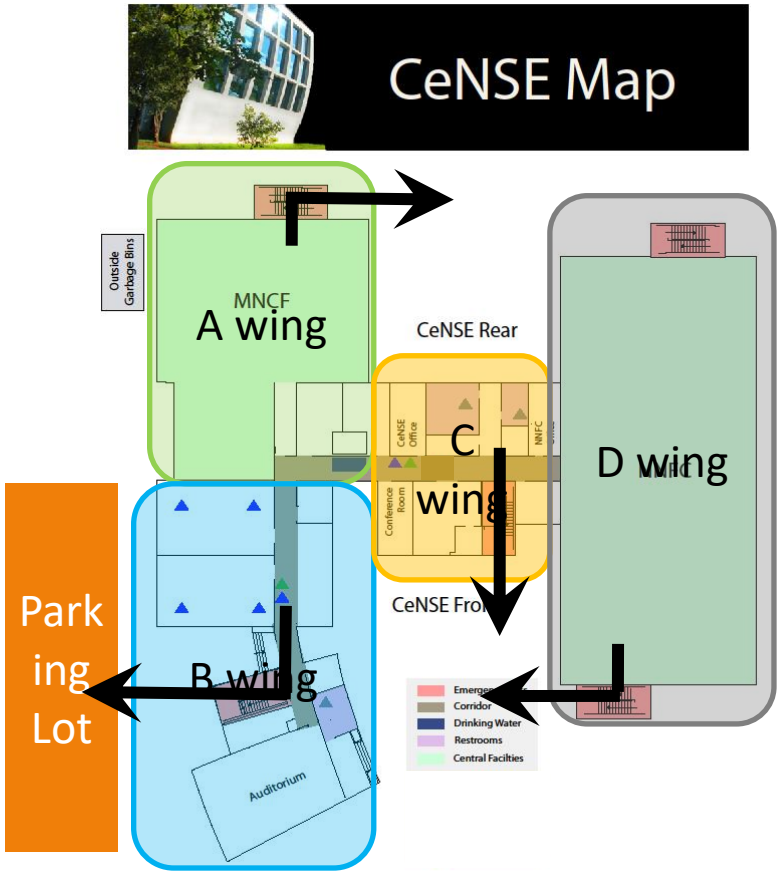
34. Remove the victim from the contaminated atmosphere and move into the fresh air as quickly as possible.
35. If possible, identify the substance to which the victim was exposed.
36. Do not enter the area if you expect oxygen depletion, explosive vapors or toxic gases.

37. Special equipment have to be worn by the rescue party.

9.3.8 Biological Materials

38. In the event of a biological materials spill you should decontaminate the area.
39. Decontamination can be accomplished by using a number of disinfectants, which include bleach (1:10 dilution), 70% ethyl alcohol, Lysol, and other commercially available products. Use protective clothing and equipment which should at least include safety glasses, rubber utility gloves, and a lab coat.

9.4 EVACUATION PLAN AND ASSEMBLY POINTS



Wing	Constituent labs/rooms	Assembly point
A	MNCF and labs /rooms above	CeNSE Rear
B	CoNE, Auditorium, Research Scholars' rooms, faculty rooms above	Parking Lot
C	CeNSE office and faculty rooms above	CeNSE front space through main entrance
D	NNFC,	CeNSE front space through emergency exit

10 PENALTIES

Consistent violation of safety protocols or willful neglect of safety would result in strict penalties that include probations, fines, and in extreme cases permanent expulsion from CeNSE.

1. There shall be a yearly safety audit of each lab by the safety committee. If any safety violation are found the audit committee will issue a detailed report, listing the violation, the severity of the violation and an appropriate time frame for fixing the violation.
2. The lab in charges are required to fix the problems within the specified time frame, and revert back to the safety committee with a written response.
3. Failing to fix the problem or explain the reason of the failure will attract a penalty up to **5000/-** to be paid by the research group.
4. If the safety violation is egregious enough, the safety committee can also levy a fine upto **5000/-** on the laboratory during the audit itself.
5. Lab in charges can report the students not following the lab rules to the safety committee. Repeat offenders will be put on probation or have their biometric access revoked. In extreme cases safety committee will initiate disciplinary action against the user as per IISc norms.

11 APPENDIX

11.1 NO FOOD LABEL FOR LAB REFRIGERATORS

11.2 CHEMICAL LABEL

To be added in the next version.

11.3 CHEMICAL WASTE LABEL

To be added in the next version.

11.4 LABORATORY HAZARD SHEET

1. Make a lab layout using some software and save it as an image file. Insert it in the 'Room floor plan' box.
2. Ensure that you include (in the floor plan)
    a. ALL windows and doors
    b. Location of wet benches, fume hoods, laser assembly, chemical storage, High-Voltage equipment, compressed cylinders and biological hazards
    c. Location of lab telephone and fire extinguishers and preferably light switches
3. Make use of the personal protective equipment table to specify protective gear like 'Nitrile gloves', 'Laser safety glasses -xyz wavelength' etc. Please be specific with the type of protective gear.
4. Use the 'Description of Lab Hazards' column to indicate hazardous substances. Reference symbols have been provided with this template document. Next to the symbol, specify the hazard as accurately as feasible. Eg: Laser- Class 4; Compressed cylinder-Silane; Acids - HF acid etc.
5. Prepare a new document once in 6 months or every time you make major changes such as shifting of equipment or addition of hazards in your lab.

Room No.: Click here to enter text.

Lab Name: Click here to enter text.

Review & Initials (every 6 months)

Date				
Initials				

Emergency Contact	Name	Office	Telephone
Safety In-charge 1	Click here to enter text.	Click here to enter text.	Click here to enter text.
Safety In-charge 2	Click here to enter text.	Click here to enter text.	Click here to enter text.
Faculty	Click here to enter text.	Click here to enter text.	Click here to enter text.

Room Floor Plan:

Description of Hazards	
	Click here to enter text.
	Click here to enter text.
	Click here to enter text.
	Click here to enter text.
	Click here to enter text.
	Click here to enter text.
	Click here to enter text.

Reference symbols of hazards

 Compressed gas	 Flammable	 Toxic	 Corrosive
 Laser	 High voltage	 Radioactive	 Bio-hazard

Protective equipment	
1	Click here to enter text.
2	Click here to enter text.
3	Click here to enter text.
4	Click here to enter text.
5	Click here to enter text.

Gas Tag Examples: