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IITBNF Safety Manual

I. Introduction

IITBNF is a state of the art nanofabrication facility catering to a large set of members. The members not only come from various departments within IITB, but also from a large number of universities across the country. Personal safety of all the members is of utmost importance at IITBNF, and to this end a safety committee was constituted. The safety committee comprises of a group of individuals who strive hard to make the lab a safe place to work. The objectives of the safety committee can be summarized as “Educate, Equip and Emergency response (EEE)”

EEE’s of Safety at IITBNF:

1. Educate

No place can be safe until he/she realizes what are the potential hazards and safety practices put in place. To this end safety committee undertakes the following actions:

- New users to lab are given a formal overview of the various safety hazards in lab and are advised on the safe working protocols before granting them access to the lab.
- Mandatory refresher seminars are carried out periodically to ensure that the users are clearly aware of hazards and the safety practices in place.
- Training of Facility team members/staff on safe working procedures and are also trained to tackle hazardous situations ranging from chemical spills to firefighting to toxic gas leaks.
- Comprehensive policy for introducing new materials (gases, chemicals) ensuring that all users are aware of the potential hazards before introducing the same inside the lab.

2. Equip

Tackling emergencies would need adequate safety equipment and apparels in place. To that end safety committee takes stock of the various safety requirements and plugs in the various gaps. To this end the major onus has been on gas, fire and chemical safety.

- A gas leak detection system with alarms and auto shut off valves in case of a gas leak has been put in place.
- Fire suppression system, fire extinguishers and fire alarms have been installed and are monitored at periodic intervals.
- Chemical spill kits, chemical resistant gowns, shoes, goggles, first aid kits and eye/body shower along with a policy for usage is in place.

3. Emergency Response

No matter how good a safety system you have in place, it would not help, if one does not know how to respond to emergencies. Safety committee stresses on this aspect and as a result the following activities are carried out.
- Policy outlining how to respond to an emergency clearly earmarking the role of users/staff/faculty
- Tops line emergency response on standby 24x7x365
- Periodic mock drills carried out to ensure that users are well and truly aware of their roles in case of an emergency.

Remember, you are responsible for your own safety, and that of others around you. IITBNF provides you with information, recommendations, and necessary resources for you to be able to do your work safely. It is up to you to ensure that you take appropriate precautions for your safety and your fellow lab members.

- Introduction by Sandeep S. S. Ex Ph.D student.
II. Material Safety

Liquid chemicals, solid chemicals, targets, gases, precursors, resist and developers

1. Where to Find Material Safety Information

1.1 Chemical Labels
Chemicals in their original containers will have a label, provided by the manufacturer, which in addition to composition contains the following precautionary information:

- A signal word, which is one of the following: “Caution”, “Warning” or “Danger”, indicating potential for hazard (in order of increasing potential hazard.)
- First Aid or other information (this may not always be present on the label).
- Chemicals that have been dispensed for use or into other containers may not have this information. As a qualified user, it is your responsibility to know the chemicals being used at your station, and the hazards posed by each.

1.2 Materials Safety Data Sheet (MSDS)
The MSDS contains information on general composition, physical and chemical properties, and toxicology, storage and handling recommendations of each chemical. MSDS documents for all the chemicals that IITBNF routinely stocks can be found in the labs where the chemical is used and online on IITBNF website.

It is highly recommended that you read the MSDS information for all the chemicals that you use in the lab. You will be expected to know the main hazards, handling requirements, and disposal methods for any chemical you use in the lab.

2. Liquid Chemicals

IITBNF Liquid Chemical Hazard Classes
At IITBNF we categorize liquid chemical hazards into six general chemical hazard classes: corrosive, oxidizer, air/water reactive, flammable, toxic/poison, and non-toxic. Many chemicals fall into more than one class. It is essential that you recognize the chemical hazard class of all the chemicals you are using and understand the appropriate measures required for safe use. The following are the usual safety measures for handling any liquid chemical:

- Know the main hazards and proper disposal method of the chemical you are using.
- Use protective gear (safety goggles and face shield, tested and resistant gloves, chemical apron) to prevent direct contact with the chemical.
- Work only in an appropriately exhausted hood area to prevent inhalation.
- Know the location of the nearest safety shower and eyewash station.

2.1 Liquid chemical classification

2.1.1. Corrosive

A corrosive (or "caustic") chemical destroys or permanently damages living tissue. On contact, corrosives can destroy skin and underlying tissues. Splashes in the eyes can cause blindness. Inhalation of vapors can destroy lung tissue. Corrosives in the lab include acids and bases. In case of localized external exposure, promptly flush the affected area with plenty of water, for at least 15 minutes. For more general external exposure, use a safety shower. Remove clothing while under the shower and flush for at least 15 minutes. Exposure of corrosives to the eyes is extremely serious; flush immediately, either with a spray gun from the eye and body shower or the nearest eyewash station. Eyes should be rolled up and down, and from side to side, continuously, to allow clean water to flush behind the eyeball. For any exposure to corrosives, get help. The victim should be taken to the emergency center for evaluation and treatment.

2.1.2 Oxidizer

An oxidizer is a chemical compound that has a pair of electrons to donate to an electron-accepting, reducing agent. Often, they contain reactive oxygen. When mixed with compounds that can act as reducing agents, the result is often a violent reaction, possibly an explosion. Oxidizers should not be stored or mixed with solvents, which generally make excellent reducing agents. At IITBNF, oxidizers are stored in the chemicals storage room through. One oxidizer is hydrogen peroxide (H2O2). Nitric acid (HNO3) is an oxidizer as well as a corrosive. In the lab, the main principle behind segregation of chemicals is to keep oxidizers away from flammable chemicals (namely, solvents) and any combustible materials (some chemicals, materials like lab wipes).

2.1.3 Water reactive

Water reactive describes compounds which very quickly generate heat and/or gas upon mixing with water. These are often concentrated acids or bases. The primary hazard presented by water-reactive compounds is incomplete mixing, which can lead to superheating and explosion. Thus, water-reactive mixtures should never be poured directly into a sink drain. Aspirating water reactive mixtures at the wet benches is standard practice; the high dilution factor and rapid mixing dissipates heat and prevents superheating. Concentrated sulfuric acid and piranha clean are water reactive chemicals.

2.1.4 Flammable

Flammables include most solvents, such as acetone, iso-propanol, and methanol. The “flash point” of flammable is the concentration in air above which the vapors from a flammable can ignite and explode. The source of ignition may be heat (such as a hot plate) or a spark (such as from an electrical
tool). Because the vapors can travel over considerable distances, the source of ignition can be far away from the flammables container itself.

To minimize hazards, always work well within the exhausted area of the appropriate bench. The air pulled into the exhaust area will keep the concentration of vapors below the flash point. Where possible, minimize the quantities of flammables used. Before working with flammables, always note the location of the nearest safety shower and fire extinguisher. Flammables should be stored in the designated flammables cabinet. Flammables must be kept away from oxidizers.

2.1.5 Toxic/Poison

A toxic material is one that has poisonous or harmful effects. There are formal, quantifiable definitions as to what comprises a toxic material and to what degree it is toxic. These definitions are based on lethal dosages for lab animals when administered orally or through inhalation.

2.1.6 Non-toxic

A non-toxic material is one that is not likely to result in harmful effects with normal use. This designation is used sparingly. Pure water is considered non-toxic.

2.2 Liquid Chemical Storage

To prevent accidental mixing of incompatible materials, every chemical in the lab must be stored in the designated area appropriate for its hazard class. Each storage area is designed for safe storage of chemicals of a particular set of hazard classes (i.e., they are appropriately ventilated, chemically resistant, and built against the main physical hazards presented by the chemicals to be stored there.) Thus, it is a safety imperative that all chemicals in the lab be stored appropriately in one of these designated storage areas. No chemicals may be kept in personal storage bins. No chemicals may be stored at any wet benches.
Fig. 1: Chemical storage of fresh and used chemicals
3. New Material Procurement process

All process chemicals and materials used in the lab must be approved by the IITBNF Safety Committee and further by the FOC (faculty oversight committee) before use.

IITBNF is required to maintain an up-to-date list of the names of all chemicals and materials in the lab (bulk materials and user specific materials).

Link for bulk materials

http://www.iitbnf.iitb.ac.in/iitbnf/index.php/for-members?layout=edit&id=12&type=bulk-chemical

Link for user specific material


If a new material needs to be used that is not listed on the website, the below mentioned procedure should be followed;

A new material procurement form available online is to be filled with all the details, such as, a safe place to store , safe way to use ,safe method to dispose material and its byproducts and also a way to prevent cross-contamination of equipment groups.

http://www.cen.iitb.ac.in/chemical_approval/index.php

New chemicals and materials are approved for a given process, on a case-by-case basis; use of chemicals/materials for another process will require safety committee approval.

Approved materials will be listed under user specific materials.

‘User specific materials ’must be appropriately labeled (with identification of owner, contents, and other safety information)

Please take time to carefully consider the process flow of your experiment and how it might affect other lab members and other downstream processes. If you have any concerns, contact the IITBNF Safety Committee, who will help with your questions.

4. Working at Wet Benches

Chemicals may be used only at wet benches. The exception is squeeze or spray bottles containing mild solvents for cleaning (see below). Wet benches are designed for the safe use of chemicals; only designated chemicals or classes of chemicals may be used at each wet station. Every wet bench has an exhaust.
- There are two general types of wet benches in the lab: those used for “Standard” processing (RCA processes) and those used for “Non-standard” processing (wet etching, lift off, litho solvents etc). To use a wet bench, you must be trained and qualified in its safe use.
- Each Standard wet bench has dedicated lab ware, in order to avoid cross-contamination (do not use lab ware from one bench at another bench.)
- Lab ware should be chosen taking into consideration contamination and safety.
- No chemical containers may be stored at wet benches.
- For any wet chemical processes use appropriate lab ware. HF should always be used in Teflon lab ware. HF is an etchant for silicon dioxide, hence glass and quartz ware should not be used.
- Work under a fume hood with proper exhaust to avoid any inhalation of chemical fumes.

Fig.2: Working at Wet Benches
4.1 Chemical warning form

Beakers and other chemical containers may be used at wet benches, but only if accompanied by the appropriate chemical warning form. Blank forms are available at each non-standard wet bench and in the wet Chemistry room.

The information required on the Chemical warning form is as follows:

- Date
- Your contact info (name, phone, e-mail ID)
- Name of the chemical (no acronyms or abbreviations)
- Approximate time the chemical would be kept on the wet bench.

Use of Chemical warning forms is strictly enforced; failure to abide by this is considered a gross violation of IITBNF safety policy and will be dealt with accordingly. Please remember, this is a shared facility and communication of lab activities that pose potential safety concerns is absolutely critical.

![Chemical Warning Form](image)

Fig.3: Chemical Warning Form

4.2 Squeeze or spray bottles

Bottles containing mild solvents (acetone, isopropanol, or methanol) are the only chemicals that may be used outside of wet benches. They must be properly labeled. They should be used only very sparingly outside of wet benches, because of their low vapor pressure, and they should never be used at standard RCA wet benches nor near any electrical equipment.
4.3 Protecting yourself

Before you start working with chemicals make sure you are properly protected. Personal protective equipment (PPE) is required whenever handling or transporting chemicals in the lab.

- Wear chemical resistant gown, chemical resistant gloves, chemical resistant shoes, safety goggles or face shield while working with chemicals
- Work with chemicals under fume hoods in the lab
- Remember that the clean room gloves you put on when you enter the lab are to prevent particulate contamination, and are NOT sufficient to protect against chemical burns. They are also soluble in some solvents. Use the chemical resistant gloves provided at wet bench for handling chemicals (put these chemical gloves over your clean room gloves).

**NOTE:** If gloves, aprons, chemical resistant shoes, face masks or face shields are not readily available, contact IITBNF staff and necessary items will be provided to you.
4.4 Handling chemicals
When measuring out chemicals, if taken in excess, never pour a chemical back into its original bottle. This can contaminate the chemical and damage the user’s devices. When removing dry chemicals, tap gently and pour them out if possible. Scoop only when necessary and use freshly cleaned spatulas.
4.4.1 Spill kit

While handling chemicals in case there is a chemical spill on the wet bench or on the floor, IITBNF staff needs to be contacted.

IITBNF staff members will use spill kit to take care of the chemical spill.

Spill kit contain neutralizers for all chemicals (acids, bases and organics)

Fig. 7: Spill Kit
4.5 Handling liquid nitrogen

Safe handling of liquid nitrogen (LN\(_2\))

LN\(_2\) is extremely cold. At atmospheric pressure, liquid nitrogen boils at -196°C. One liter of liquid nitrogen vaporizes into almost 0.7 m\(^3\) of nitrogen gas. Either of these two properties can produce personal injury or property damage.

Do not allow objects cooled by liquid nitrogen to touch your bare skin. Contact with the skin may cause serious frostbite. Because it is extremely cold, it can freeze human flesh almost instantaneously.

4.5.1 Protective clothing can reduce the hazards of handling liquid nitrogen.

Insulated or heavy leather gloves should always be worn when handling any object that has been in contact with liquid nitrogen. Loose fitting gloves are recommended so that they may be discarded quickly in the event that any liquid nitrogen splashes into them. If you are working with open containers of liquid nitrogen, boots should be worn and trousers should not be tucked into the boots, but worn outside.

4.5.2 Liquid nitrogen container specifications

- Liquid nitrogen storage containers are specifically designed and constructed to withstand the extreme temperature variances involved in handling liquid nitrogen. These special containers should be filled slowly to avoid the expansion stress that occurs as a result of the rapid cooling. Too much stress can damage the container.
- Liquid nitrogen storage containers are designed to function with little or no internal pressure. The use of any tight-fitting stopper or plug that prevents the adequate venting of gas builds up pressure that could severely damage or even burst the container. Even icing or accumulated frost can interfere with proper venting and containers should be checked for such obstructions. To assure safe operations, only the original neck tube core or approved accessories for closing the neck tube should be used.
- Containers should always be stored in an upright position. Tipping the container or letting it lie on its side can result in spillage and may damage the container or the materials stored in it. Dropping the container or subjecting it to severe vibrations may damage the vacuum insulation system. Walking or dragging containers could result in a partial or complete vacuum loss. For containers that cannot be easily and safely carried, a roller base can provide safe and easy movement of containers.
- Store containers in clean, dry areas
- Wash containers with plain water or mild detergent solution and then wipe dry

4.5.3 Transfer liquid nitrogen with care

- The primary hazards of transferring liquid nitrogen from one container to another are spilling and splashing. Special funnels (with the top partially covered) will reduce splashing.
- Because of the extremely low temperature of liquid nitrogen, plastic measuring devices
tend to become very brittle or even shatter. NEVER use hollow rods or tubes; the gasification and expansion of the rapidly cooling liquid inside the tube will force liquid to spurt from the top of the tube. Always wear insulated or heavy gloves when measuring.

4.5.4 Nitrogen gas is colorless, odorless, tasteless ... and deadly!

- Liquid nitrogen must always be stored and used ONLY in areas that are fully ventilated. As liquid nitrogen evaporates, the resulting nitrogen gas displaces the normal air-and breathing air that is less than 18% oxygen may cause dizziness, unconsciousness and even death.
- Nitrogen gas is extremely cold. The eyes can be damaged by exposure to this gas even when the contact is too brief to affect the skin.
- Nitrogen gas is invisible. When liquid nitrogen is exposed to the air, the cloudy vapors that you see is condensed moisture, not nitrogen gas. The gas itself is invisible.

4.5.5 First aid for liquid nitrogen burns

- If anyone working with liquid nitrogen becomes dizzy or loses consciousness, move him to a fully ventilated area at once and call a doctor. If he appears to have difficulty breathing, administer oxygen. Where breathing has stopped, apply artificial respiration immediately and then give oxygen. Keep the person warm and as calm as possible until the doctor arrives.
- If a person is exposed to liquid nitrogen or gas, the affected tissue should be restored to normal body temperature as quickly as possible. Remove or loosen any clothing, belts, collars, etc., that might restrict circulation to the affected area, and bathe or immerse the area in water heated to 42°C.
- DO NOT heat water above 45°C. Protect the injured tissue from further damage or infection and call a doctor. DO NOT rub the affected area in an attempt to improve circulation.
Fig. 8: Cryogenic gloves for LN2 handling

Fig. 9: LN2 can for handling liquid nitrogen at equipments
4.6 Mixing and/or Heating chemicals
Chemicals can behave very differently when heated or mixed with other chemicals and present completely different risks. You are performing a non-standard process if you are heating a chemical which is not normally heated, or mixing chemicals that are not normally mixed even if the chemicals are normally stocked in the lab.

4.7 The following hazard classes must never be mixed together:
- Corrosives + Flammables = Explosion/fire
- Corrosives + Poisons = Poison gas
- Flammables + Oxidizers = Explosion/fire
- Acids + Bases = Corrosive fumes/heat

4.8 Chemical burns
If you are exposed to chemicals, immediately remove the affected clothing and flush the area with large volumes of water for over 15 minutes; NOT LESS. Use the emergency shower and/or eye shower if necessary. Hands can be rinsed in a wet bench using a water spray gun. Know where they are located. Contact a staff member as soon as possible. After sufficient flushing seek medical attention, as damage may not occur for several hours, and HF burns are particularly hazardous. An insidious aspect of HF burns is that there may not be any discomfort until long after exposure. These burns are extremely serious and result in massive tissue damage.

**Calcium gluconate gel is antidote for HF burns.** After rinsing affected area with water for 15 minutes apply calcium gluconate gel. DO NOT use it for eye injury. First Aid for HF is placed at every lab where HF is available.

![Image of Eye Body Shower](image_url)

**Fig.10: Eye Body Shower**
4.9 Transporting chemicals in the Lab
No chemical bottles are to be transported through the lab by hand. All chemicals are to be moved using appropriate transfer carts (white polypropylene bottle carriers). Individual bottle carriers are available in the wet chemistry room. You need to return it back to the chemistry room once the work is complete.

4.9.1 How to shift chemicals from one lab to another lab

- Wearing chemical resistant gloves, covered shoes and facemask is compulsory.
- Liquid chemicals should not be transferred using passenger lift, equipment lift should be used.
- User specific solid secondary substrates/samples/targets in enclosed boxes can be transferred using passenger lift.
- 5-500 ml: Taken into container (non-Buddy).

![Fig.11: Shifting of single chemical bottles - Bucket (Non Buddy)](image)

- Buddy is needed when large quantities of chemicals are transferred. Chemical transfer trolleys to be used to transfer chemicals which do not fit in buckets or if you have more than one chemical to be transferred.
5. Material Waste Disposal

5.1 Liquid chemical waste

Disposing of chemical waste in a safe manner is everyone’s responsibility. Improper disposal of waste could result in explosion and injury. Violations of proper waste disposal laws may even result in shutdown of our lab. Take time to consider waste disposal in your experimental plans.

1. After every experiment, residual chemicals should be poured into appropriate ‘Used chemical’ bottle.
2. Used chemicals should never be filed up to the brim.
3. Vented caps have to be used for ‘Used chemical’ bottles which contain chemical mixtures that would cause gas generation or pressurization. Please go through the vented caps usage policy given below:

5.1.1 Vented Caps Usage Policy

Vented caps: Caps having a small hole at the center of the cap for free movement of any gas produced in the bottle

- Vented cap is used to prevent the primary hazard that can be caused from the storage of mixtures containing Hydrogen peroxide (H2O2). It has a potential for gas generation and over pressurization of the container.
In order to transfer and store chemical mixtures having H2O2 the steps given below should be followed:

- Solution should be left in open condition after process under a fume hood in order to cool
- After cooling, solution should be transferred under fume hood to an existing waste bottle containing exactly the same waste solution or take a new waste bottle and label it with same name as solution
- Cap the bottle with vented caps
- Store above used chemical bottles [with vented caps] in chemical storage.

Vented caps to be used in the following solutions at IITBNF
- RCA1 (NH4OH + H2O2)
- RCA2 (HCl + H2O2)
- Piranha (H2O2 + H2SO4)
- GaAs etchant
- Any other solution that contains Hydrogen Peroxide

Vented caps are placed in chemical racks in a labeled box.

Vented caps will be replaced by normal caps prior to disposal. This will be done by authorized chemical safety personnel. [Neha R, Jaya R, Shraboni, Mani N]

Fig.13: Vented caps
5.2 Solid chemical waste

- Chemically contaminated objects are considered solid hazardous waste. These include gloves, used resist droppers, used lint free, swabs, syringes, syringe filters. Chemically contaminated solid waste should be disposed in designated dustbins.
- Sharp objects that can cut or puncture skin as silicon, silicon germanium wafers, broken glass beakers, razors, knives /scalpels, or hypodermic needles must be thrown into designated dustbins.

Local Collection—All chemicals used at IITBNF are collected, located and separated from other kinds of waste. These bottles are packed into corrugated boxes and labeled as, ‘Used Acids’, ‘Used Bases’ and ‘Used Organics’. They are picked up by a local body.

6. First Aid

6.1 First aid boxes are available in all labs

![First Aid Box](image)

**Fig.14: First Aid Box**

6.2 First aid for HF Acid

- Eye Contact
  Remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15-30 minutes. Cold water may be used. Keep the eyelids apart and away from the eyeballs. Do not use oily drops or ointment or HF skin burn treatments on the eyes. Get medical attention immediately, preferably an eye specialist.
- **Skin Contact**
  In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cold water may be used. Get medical attention immediately. Massage Calcium Gluconate Cream into the affected area until there is a cessation of pain (available in refrigerator of labs).

---

Fig.15: Calcium Gluconate Cream – First aid for HF – only for skin application

- **Inhalation**
  If inhaled, remove to fresh air. Get medical attention immediately

- **Ingestion**
  If swallowed, do not induce vomiting. Never give anything by mouth to an unconscious person. Loosen tight clothing. Get medical attention immediately.
III. Fire Safety

Not all fires are the same. Different fuels create different fires and require different types of fire extinguishing agents.

**Types of fire and extinguishing procedures**

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Class of fire</th>
<th>Source of fire</th>
<th>Modes of extinguishing fire</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>Wood, paper, plastic, rubber, cloth</td>
<td>Adding water, put a lid on it, limit material burning, Use a fire extinguisher</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>Hydrocarbon and alcohol based liquids and gases that will support combustion.</td>
<td>Put a lid on it, limit material burning, Use a fire extinguisher - Use a BC or ABC fire extinguisher</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td>All fires involving electrical equipment</td>
<td>Shut off the power - May still have A or B fire remaining Use a fire extinguisher - Use a BC or ABC fire extinguisher</td>
</tr>
<tr>
<td>4</td>
<td>D</td>
<td>Combustible metals like potassium, magnesium, sodium, alloy type metals etc. They are usually started by a Class A-B-C fire, and will burn at extremely high temperatures.</td>
<td>Shovel away all materials that can be ignite by the high heat generated - Unsure if ABC extinguisher will put out - Unsure of dangerous by-product from the reaction of the chemicals - Attempt to isolate the fire by covering with sand or rock dust</td>
</tr>
</tbody>
</table>
2.1 Never fight a Fire if you don’t know what is burning
If you don't know what is burning, you don't know what type of extinguisher to use. Even if you have an ABC extinguisher, there may be something in the fire which is going to explode or produce highly toxic smoke.

2.2 Never fight a Fire if the fire is spreading rapidly beyond the spot where it started
The time to use an extinguisher is in the incipient, or beginning, stages of a fire. If the fire is already spreading quickly, it is best to simply evacuate the building, closing doors and windows behind you as you leave. Call the fire bridge or the emergence response expert.

2.3 Never fight a fire if you don't have adequate or appropriate equipment
If you don't have the correct type or large enough extinguisher, it is best not to try to fight the fire.

2.4 Never fight a fire if you might inhale toxic smoke
If the fire is producing large amounts of smoke that you would have to breathe in order to fight it, it is best not to try. Gases from manmade materials can be fatal in very small amounts.

2.5 Never fight a fire if your instincts tell you not to
If you are uncomfortable with the situation for any reason, just let the fire department do their job.

2.6 The final rule is to always position yourself with an exit or means of escape at your back before you attempt to use an extinguisher to put out a fire
In case the extinguisher malfunctions, or something unexpected happens, you need to be able to get out quickly, and you don't want to become trapped. Just remember; always keep an exit at your back.
3. Attention trained IITBNF staff members

3.1 Information about fire extinguishers

3.1.1 Quick check - is it ready to use

- Check the gauge. The pressure indicator should be in the green zone.
- (CO₂ extinguishers do not have pressure gauges.)
- The extinguisher should have a current inspection tag.
- The pin and handle should be secured with a plastic tab seal.
- The extinguisher and hose should be free of any visible damage.

3.1.2 Making the “Right” Decision to use a Fire Extinguisher

- You are trained in the use of extinguishers.
- You know what is burning.
- Fire is not spreading rapidly.
- Smoke and heat has not filled the area.
- You have a clear path of escape.
- Follow your instincts.

Fig.16: Fire Extinguishers
3.1.3 Pull, aim, squeeze and sweep

- Pull the Pin.
- Aim at the base of the fire.
  If you aim at the flames, the extinguishing agent will fly right through and do no good. You want to hit the fuel
- Squeeze the top handle or lever.
  This will release the pressurized extinguishing agent in the extinguisher into the fire.
- Sweep from side to side until the fire is completely out.
- *It is important that you should attend an actual “hands on” fire extinguisher class to be proficient in their use.*

![Diagram](image)

**Use ‘Pass’ system**

*Fig.17: Pass System*
Attention IITBNF lab members

Fire Safety Evacuation Procedure

- In case of a fire in the lab/service corridor, the smoke detectors would invoke the fire alarm. On hearing the fire alarm, users are requested to evacuate the building as soon as possible. The following procedure needs to be followed in case of a fire emergency.
- **Activate Fire Alarm**: On spotting a fire inside the lab or service corridors, activate the hooters manually by manual call point.
- **Evacuate the building**: Once the fire alarm is heard, all the occupants should move out of the building in an orderly manner without rushing and pushing.
- **Choose the nearest emergency exit**
- **Do not use elevators**: In case of fire, do not use elevators. Use stair case.
- **Inform any IITBNF staff members**
- **Assist IITBNF staff members while taking care of injured people**
- **Do not enter the building until advised by the safety team**
- **Report Hazards**: Inform any IITBNF staff members about any immediate hazard, which may arise due to your ongoing experiments, when the fire alarm was activated. Turn off the tools (if possible) using the emergency stop switch before leaving the lab.
- Proceed to the assembly point (in front of the Nano E Building), for head count.
Fig. 19: Fire Safety Equipment
IV. Gas safety

1. Attention IITBNF Lab Members
   - If you hear an alarm, then walk out of the lab through nearest emergency exit.
   - If you see/ hear/smell some gas leak in the lab and there is no alarm, then activate the alarm manually (manual call point) and walk out calmly.
   - If you are running a tool which you suspect is causing the alarm for e.g. gas line burst open inside the gas pod or Gas Leak Detector near the tool is showing red LED glow or some ppm then Press EMO (emergency off) / power off and exit immediately.
   - Proceed to the assembly point (in front of the Nano E Building), for head count.
   - Report Hazards, if any.
   - Stay away from the building until it is safe to return.

2. Attention trained IITBNF staff members
   - Finding location from the GLD panel.
   - Ensuring all auto shut off valves got activated from the panel.
   - Look at the TLV (threshold limit value) reading.
   - Wait till reading falls less than TLV and then two staff will go with SCBA to close cylinders and general site inspection.
   - If everything is ok, and no hazard is identified, alarm may be shutoff manually at this stage.
   - If TLV not coming down or any other situations it will be handled by the ERT (Emergency Response Team) involved.
   - If site inspection appears ok and GLD detects ‘0’ reading, then Technical team will inform communicating team that situation is taken care of and except for the affected lab, rest of the labs/area and offices can be open for usage and members can go in.
   - Affected Lab/area is handed over to Safety Team Members to troubleshoot the cause. Lab is shutdown till safety committee approves it to be ok to use.
Fig. 20: Gas safety

Auto Shutt Off Valve  Breathing Apparatus
3. Scrubbers for toxic gases

We at IITBNF use scrubbers for toxic gases. Toxic gases released from various sources are sent through scrubbers before letting in atmosphere to control air pollution.

Fig.21: Gas Leak Detection Panel
V. Electrical Safety

Safety points to be noted

- Keep a good quality fire extinguisher – suitable to put out electrical fires nearby at all times. An ABC Type fire extinguisher is good enough.
- Avoid the use of test lamps (bulbs) for checking electrical circuits and instead use a good quality multi-meter.
- In case a multi-meter is not available, check the voltage rating of the supply – for which testing needs to be done as follows:
  - For Three Phase System – Voltage (Line to Line) is 440 Volts & 2 lamps in series need to be connected.
  - For Single Phase System – Voltage (Line to Neutral) is 230 Volts & 1 test lamp can be used for checking.
- Always wear shock proof rubber gloves before starting any electrical work.
- In UPS & Battery rooms always wear eye goggles. This will ensure eyes are protected in case a faulty battery suddenly vents out.
- Always put off supply to Direct On Line (DOL) & Star Delta starters before attempting to screw back the front cover.
- Stay focused; maintain presence of mind on the job.
- Using the right tools for the right job – Always use tools with insulated handles.
- Check the tools are properly rated for the voltage level at which the work has to be carried out.
- Avoid, reduce & eliminate all conditions of loose contacts that can lead to sparking and overheating.
- Always use PPE while working with electrical equipment.
- Use only a wooden or FRP (Fibre Reinforced Plastic) ladder for electrical related work.
- Understand the importance of arc flash and the conditions that can lead to it.
- Knowledge of Step & Touch Potentials is a must to avoid life threatening accidents.
- Always follow a Standard Operating Procedure (SOP) for doing Lock out Tag out (LOTO). Simply Locking Out is not enough to avoid an accident. Tagging (Putting a Notice with the reason) is just as important.
- Knowing CPR (Cardio Pulmonary Respiration) Basics can mean the difference between life and death for a victim.
- Avoid working alone. Always work in a team or with a buddy.
- Always put a shock proof rubber mat at the place where electrical work is going to be carried out.
- Illuminate areas of low light intensity inside panels with a torch/light before attempting to do any work or touch any circuit breaker.
2. Attention trained IITBNF staff members

Safe Working Principles

DON’T ASSUME ANYTHING!!! Always check if voltages and/or currents are present with a multi-meter before starting to do any work.

Electrical safety rules no 1:
First of all – isolate /put off the power supply of the system to be worked on.

Electrical safety rules no 2:
Before disconnecting any wires, always make a drawing of all the wiring and label the wires so that at the time of reconnection risk of wrong connections is minimized.

Electrical safety rules no 3:
Double/Cross check all electrical connections with the drawing at least twice or even more times before switching on the power supply. Have someone else in your team also to check to pick up any mistakes and rectify then and there. Only when you are very sure then apply the power.
VI. Manual call point

Manual call points are emergency buttons which can be triggered to alert evacuation of building. We have fire manual call points and gas manual call points. In case of emergency you can trigger any one irrespective of any emergency.

Fig. 22: Manual call Point
VII. Work Permit Form Policy

Work permit needs to be taken for any work which is to be carried out by an outsider at IITBNF. The work can commence only after the approval is received from IITBNF safety team through work permit form. Below is the link for the work permit form:

http://cen.iitb.ac.in/safety/

The following are the steps of approval:

- The request is sent to buddy for approval.
- Buddy needs to confirm his/her presence when external vendor is working at IITBNF (Approve/ Disapprove).
- After Buddy approval, request is sent for site approval.
- Site approval is done by LM / Asst LM / Facility-in charge/EMT -in charge. While giving the site approval, there will be two check points which mention the following:
  - Site has been inspected thoroughly.
  - Safety precautions have been taken to the best of our knowledge.
- After this, the request is considered as approved. An approval mail is sent to requester, buddy, LM, Asst LM, Facility-in charge, EMT –in charge, safety faculty-in charges.
- If a request gets disapproved at any level, it is not sent to next level for approval.
- A notification mail is sent to relevant and authorized members at each and every level.
- Requester needs to ‘close’ the request after the completion of the work by submitting his request.
- Requester can ‘cancel’ a request if the work gets cancelled for some reason
  - At any point of time during the approval process before the request is finally approved.
  - If the approvals have already been taken at all stages, requester can then ‘close’ the request giving reasons for the actual cancellation of the work.
VIII. Lockout & Tag out usage protocol

Whenever there is a maintenance of either equipment or facilities being carried out in the lab, to ensure safety of the equipments/facilities and personnel, lock out tag out system needs to be followed.

To lock out or tag out devices

- Perform a job Hazard Analysis & conduct a briefing with all involved and affected personnel.
- Identify all the devices (switch, valves, MCB etc) on which lock or tag needs to be applied.
- Inform all affected users that the system will be down and if possible, estimate the shutdown period (email intimation needs to be all IITBNF user)
- Turn off the equipment.
- Lockout all the devices that will accept lock. Use Tag only if lock cannot be used.
- The IITBNF trained staff member must write his/her name and the date on the lock or tag.
- Before any work begins, the disconnected system should be tested in some way to confirm that the equipment will not operate.

Removal of lock out or tag out devices and re-energize equipment

- When the job is complete and equipment is ready for testing, ensure all workers are clear of the work area.
- Verify equipment power controls are off or in a neutral position.
- Remove the lock out or tag out device.
- Re-energize equipment.
- The ‘IITBNF staff member’ who locks/tags out any equipment or facility, is the only ‘authorized person’ who can remove the lock/tag
NOTE

- Failure to follow any steps of lockout/tag out program will be viewed as a serious safety violation and may be subject to disciplinary action.
- Failure to make use of locks or tags, bypassing, ignoring or otherwise defeating a tag, or any other deviation from the established program will be considered a serious violation.
- The backside of each tag will bear the warnings "Do Not Remove This Tag"

IX. Buddy system policy

Buddy policy is implemented at IITBNF labs after office hours and during holidays for your safety.

Kindly ref.


X. Emergency Exits

Emergency exit plan diagrams are being made available at individual labs.