MNCF ORIENTATION PROGRAM (MNCF)

Initiator with Date	Reviewer with Date	Approver with Date	Version number
Safety in-charge, MNCF	**Technology Manager, MNCF**	**Chief Operating officer, MNCF**	**Issue 1 Revision 1**
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Centre for Nano Science and Engineering
National Nano Fabrication Centre
Micro and Nano Characterization Facility

ISO 9001:2015
ISO 45001:2018
ISO 14001:2015

Protocol to MNCF entry

Shoe cover and belongings:

Step 1

Wear the shoe cover over your footwear from the labelled bin

Step 2

Place your belongings on the rack placed in the entrance. Do not place heavy objects on the top-most shelf.

Protocol to MNCF entry

Food

1. Eating, drinking, or applying cosmetics near hazardous materials (radioactive, bio-hazardous, or chemical) is not permitted. Since all labs in IISc count as hazardous, NO FOOD/DRINK SHOULD BE ALLOWED INSIDE THE LAB.

No eating, drinking, or munching in the lab.

Protocol for inside MNCF during an emergency situation

When to Press the Emergency/ panic Button For:

1. **Fire or Explosion**
   Visible flames, smoke, or chemical explosions.

2. **Chemical Spill (Hazardous or Uncontrollable)**
   Large spill of toxic, corrosive, or highly flammable substances.
   Release of gases or vapors that could cause harm.

3. **Gas Leak**
   Smell of gas (e.g., natural gas, ammonia, or lab-specific gases).
   Hissing sound near gas cylinders or pipelines.

4. **Electrical Hazard**
   Sparking equipment, exposed wires, or electrical fire risk.

5. **Injury or Medical Emergency**
   Serious injury, unconscious person, severe bleeding, or chemical burns.

6. **Radiation Leak**
   Suspected or confirmed release of radioactive materials.

7. **Unsafe Equipment Malfunction**
   Equipment behaving dangerously or uncontrollably (e.g., centrifuges, pressure systems).

Emergency/ panic button

When NOT to Press the Emergency /panic button for

- Minor chemical spills you can clean safely.
- Non-urgent equipment malfunctions.
- Personal disputes or disciplinary issues

What to do in an emergency situation?

Emergency response in case of an incident

- Know emergency evacuation protocols thoroughly
- Please inform BMS at 115 immediately in case of any emergency
- Call someone if you cannot get BMS. (Phone numbers available in the bay near the phone)
- Press emergency/panic button
- Evacuate through the nearest exit and wait near the Assembly points.

Emergency/ panic button

How to get out/evacuate in an emergency situation?

Emergency evacuation floor plan is placed in the entrance & in the MNCF corridor

Fast walk/ run

Towards exit

In case of any alarm Evacuate through the emergency exit (follow the exit sign) and wait near the Assembly area

During exit one need not to worry/ remove the shoe cover during the evacuation process

Protocol to MNCF exit

Belongings and shoe cover:

Step 1

Take your belongings while exit along with you from the rack placed in the entrance.

Step 2

Please drop the used shoe covers in the labelled bin kept at the entrance

General Safety

Personal Care:

1. Maintain personal cleanliness, so that hazards don't affect you after you leave the lab.

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.

3. Avoid wearing dangling jewelry. These can reflect light from lasers or get caught in moving parts.

4. Avoid wrist-bands, rakhees, rings and wrist-watches, and other wrist ornaments. These may become contaminated with chemicals, react with chemicals, or be caught in the moving parts.

5. Remove laboratory coats and gloves before you leave the laboratory to prevent spreading contamination to other areas.

6. Wear closed-toe shoes inside MNCF.

Chemical Safety

What is a Chemical Hazard?

A chemical hazard is a type of occupational hazard caused by exposure to chemicals in the workplace. A description of hazards associated with MNCF is available in the Hazard Identification and Risk Assessment (HIRA).

What should you know?

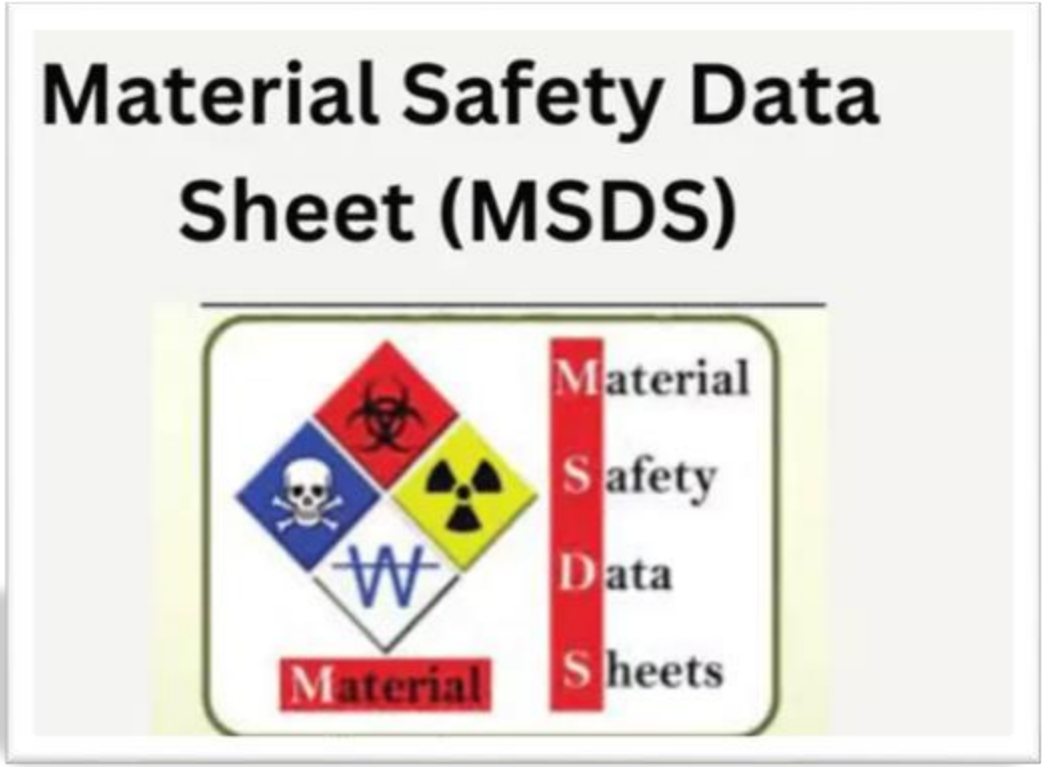
- **Identify and understand the hazards associated with chemicals that you may use**
- **Identify suitable ways of storing hazardous chemicals**
- **Know methods for safe handling of such hazardous chemicals**
- **Know methods of proper waste disposal**

Chemical Safety

Hazard Identification: MSDS

MSDS **A Material Safety Data Sheet (MSDS) is a multipage (for each chemical, several pages are there) document that contains the following information about a chemical.**

- **Flammability**
- **Toxicity**
- **Reactivity and Fire Hazards**
- **Mixing Hazards (with other chemicals)**
- **Emergency First Aid Procedures**
- **Spill Handling Procedures**
- **Disposal Procedures**



Chemical Safety

INHALATION

1. Remove the victim from the contaminated area
2. Keep the victim warm in a reclined position with head and shoulders elevated
3. Give artificial respiration, if necessary
4. Call emergency personnel or a physician immediately

SKIN CONTACT

1. Shower victim, removing all contaminated clothing
2. Wash the affected area with soap and water

EYE CONTACT

1. Irrigate eyes with water for 15 minutes, holding eye lids wide apart
2. Call emergency personnel or a physician immediately
3. Irrigate for second 15-minute period if emergency personnel or a physician is not immediately available

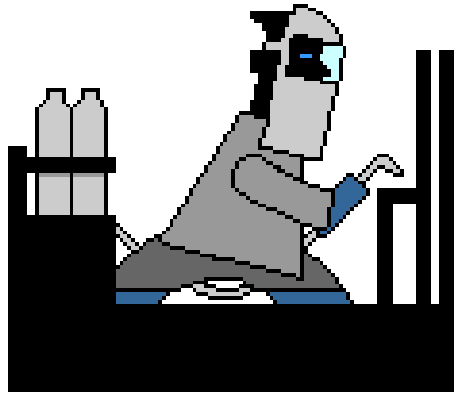
Chemical Safety

Chemicals used in MNCF:

S.No	Bay	Chemicals used
1	Electrical bay	IPA, Acetone, Silver paste, GE-varnish
2	Mechanical bay	Acetone, IPA, Silver paste
3	Material bay	IPA, Silver paste
4	Anti TEM room	Acetone, IPA, ethanol, methanol
5	Optical bay	Acetone, IPA, Ethanol, Potassium bromide, Barium sulphate, Aluminium oxide, Benzoic acid

Gas Safety

Gas is a type of matter that has no defined shape or volume. Gases can be made up of a single element, such as hydrogen gas (H_2), a compound, such as carbon dioxide (CO_2), or a mixture of several gases, such as air.



Types of gases

- Oxidizing gases (oxygen and oxygen rich gas mixtures)
- Flammable gases (acetylene, hydrogen)
- Corrosive gases (ammonia, chlorine, methyl amine)
- Toxic gases (hydrogen cyanide, Nickel Carbonyl)
- Inert gases (argon, helium)

Gas Safety

Main causes of accidents:

- Overtightening of valves
- Usage of inappropriate tools
- Inadequate training and supervision
- Faults in installation
- Supply of leaking cylinders
- Poor maintenance
- Faulty equipment and/or design (e.g badly fitting valves or regulators)
- Poor handling
- Poor storage
- Inadequately ventilated working conditions

Gas Safety

Things to keep in mind while carrying the cylinders:

- During storage and use, all cylinders need to be clearly labeled and tagged.
- All gas cylinders 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.
- Please ensure the fittings/regulators being used are rated for the pressure they are being subjected to.
- The cylinders come with a valve guard. This protects the cylinder valve in case the cylinder falls.
- Always install the cylinder with an output pressure gauge and shut-off valve
- Cylinders must always be moved on carts

Gas Safety

Gases used in MNCF:

S.No	Tool	Gas used
1	Raman, VSM, XPS	Helium
2	RF probe station, TEM, SEM, FIB, Rheometer, AFM 2, MSA	Compressed dry air
3	XPS, VSM, Raman	Argon, Nitrogen, Helium, Compressed air
4	CPD	Carbon dioxide
5	SEM, FIB,TEM, Simultaneous Thermal Analyzer (STA), DCP-1,3,4, UV spectrometer, FTIR	Nitrogen
6	Plasma cleaning	Ultra-pure Argon, Oxygen

Laser Safety

"Light Amplification by Stimulated Emission of Radiation," is a device that produces a focused, coherent beam of light by stimulating atoms or molecules to emit photons in a synchronized manner.

Laser

Exposure to laser light can cause significant damage to the skin and eyes – typically in the form of burns and direct damage to the retina.

Eye and skin damage due to laser exposure

Laser Safety

Laser Safety-Safe practices:

- Laser goggles designed for specific wavelengths should be clearly available near laser setups to protect the wearer from unintentional laser reflections.
- Laser Safety Curtains, Laser Barriers and Blackout Materials can prevent direct or reflected light from leaving the experimental setup area.
- Post appropriate warning signs or labels near laser setups or rooms.
- Turn off the laser before connecting it to or disconnecting it from another fiber. All beams should be terminated at the edge of the table, and laboratory doors should be closed whenever a laser is in use.
- Do not place laser beams at eye level.
- Carry out experiments on an optical table such that all laser beams travel horizontally.
- Remove unnecessary reflective items such as reflective jewellery (e.g., rings, watches, etc.) while working near the beam path.
- A personal dosimeter can be used to evaluate the absorbed dose in the case of a discovery of radiation exposure, radiation leakage or scattered radiation. When using the X-ray diffractometer, be sure to wear a personal dosimeter (such as a film badge, luxel badge or packet dosimeter) as directed by the equipment supervisor or other supervisory personnel.

Radiation Safety

Dose limits for occupational worker & public:

Application	Annual Dose Limit	
	Occupational	Public
Effective dose	20 mSv per year, averaged over a defined period of 5 years, with no more than 50 mSv in any single year.	1 mSv per year or 1mSv/year averaged over 5 years.
Annual equiv. Dose Individual Organs Eye Lens Skin Hands and feet	 500 mSv* 50 mSv 500 mSv**	 150 mSv 15 mSv --
Equivalent dose Pregnant Women	2 mSv for the surface of the abdomen and 0.05ALI for intake of radio nuclides after declaration of pregnancy up to the termination of pregnancy	

@ The limit prescribed by Atomic Energy Regulatory Board is 30mSv in a year.

* Averaged over areas of no more than any 1 cm^2 regardless of the area exposed. The nominal depth is 7.0 mg cm^{-2}.

** Averaged over areas of the skin not exceeding about 100 cm^2.

Every inhabitant of this planet receives an average dose = 2.4 mSv/y

Laser and Radiation Safety

Laser/ radiation used in MNCF:

S.No	Tool	Laser/radiation used	Controls
1	Raman	532 nm-785 nm-Class 3B laser 266 nm-Class 4 laser	Laser goggles, Optical enclosure, Laser warning sign, Laser safety test
2	FLS	400 nm, 375 nm, 450 nm-Class 2	Optical enclosure
3	XPS, XRD	Al K alpha, Ag L alpha, Cu K alpha	TLD badge, Optical enclosure
4	TEM	Electron and X-ray	Optical enclosure
5	SEM & FIB	Electron and X-ray	Optical enclosure
6	AFM, MSA, ZetaPALS	Class 2 650 nm, Class 2 632 nm	Laser goggles, Optical enclosure

Cryo Safety

Cryogenic liquids are liquefied gases that are kept in their liquid state at very low temperatures. Cryogenic liquids have boiling points below -150°C (- 238°F) (Carbon dioxide and nitrous oxide, which have slightly higher boiling points are sometimes included in this category). Direct contact with cryogenic liquids, uninsulated cryogenic pipes or equipment can cause freeze burns and tissue damage.

Types of Cryogenic liquid:

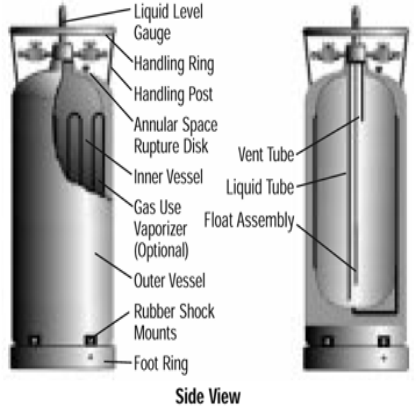
a. Inert Gases
b. Flammable gases
c. Oxygen

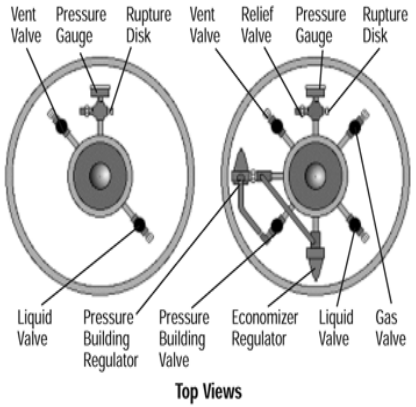
Types of Cryogenic liquids Container:

Storage should be in Double-Jacketed Dewar which has proper venting to avoid pressure build-up.

Liquid Dewar flasks

Laboratory Liquid Dewar Flasks





Liquid cylinders

Cryo Safety

First Aid:

- Where inhalation has occurred, the victim (who may be unconscious) should be removed to a well-ventilated area. Rescuers should not put themselves at risk – a contaminated area should not be entered unless considered safe. Breathing apparatus may be required but should only be used by trained personnel.

- The affected area should be doused with copious quantities of tepid water (40^{o} C) for at least 15 minutes and a sterile burn dressing applied to protect the injury until the person can be taken to receive hospital treatment. Do not use a direct source of heat such as a radiator, permit smoking or alcohol consumption and give analgesics (e.g. Paracetamol, aspirin).

Emergency contact Number: 080-22935555
Health center Contact Number : 080- 22932390

Cryo Safety

Precautions:

- **Always use cryo rated gloves, face-shield, and apron when handling cryo liquids. Cryo liquids should not be handled without closed toe shoes.**
- **Handle the cryo liquids safely. This means use of both hands to hold Dewar and duct.**
- **Never store, transport cryogenic liquids in non-rated containers.**
- **If a safety valve blows up. Please investigate there is a reason it blew up.**
- **Never disable, replace or weld shut a safety valve. As irritating as they might be , they keep us all safe.**
- **Take training before handling the cryogens.**
- **If the cap of a cryogen Dewar is iced up and is clogged, contact the IISc Safety Office and seek professional help.**

Cryo Safety

Liquid Nitrogen used in MNCF:

S.No	Tool	Amount of Liquid Nitrogen used
1	DCP 3	80 L/week
2	Raman	2 L/month
3	TEM	70 L/month
4	PIPS	30-50 ml/5 hrs
5	XRD	30 L/ day

Electrical Safety

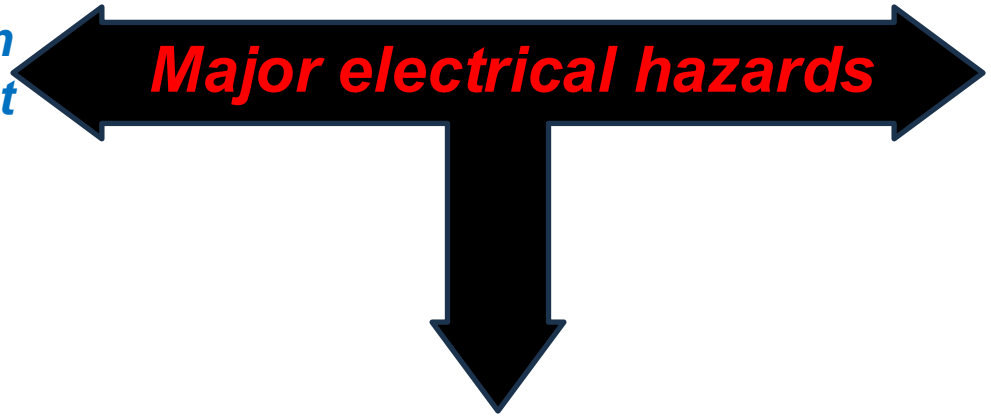
We need to use electricity regardless of the engineering discipline

Have we ever thought about how,

1. **Dangerous it could be in using electricity ?**
2. **The levels of electricity we handle at home or at workplaces?**
3. **What could go wrong in using electricity how and why that can happen**
4. **How can we prevent accidents related to electricity?**

Electrical Safety

Arc: *the light and heat released from an electrical breakdown that is due to electrical current ionizing gases in the air.*



Blast: *an explosive or rapid expansion of air with tremendous pressure and temperature, which is caused by arcs sometimes.*

Electrical shock: *A sudden physiological simulation when human body is a part of an enclosed current loop*

Electrical Safety

Normal human responses to current magnitude:

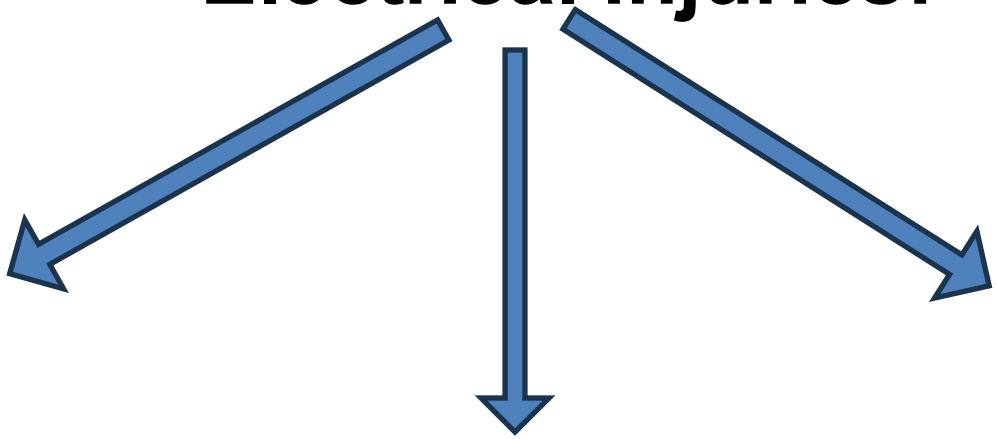
Current (50/60 HZ) rms	Physiological Phenomena	Lethal incidence
< 1mA	None	Imperceptible
1-10 mA	Perception threshold	Mild to painful sensation
10 mA	Paralysis threshold of arms	Cannot release hand grip
30 mA	Respiratory paralysis	Stoppage of breathing, frequently fatal
75 mA	Fibrillation threshold 0.5%	Heart action discoordinated (probably fatal)
250 mA	Fibrillation threshold 99.5%	Heart action discoordinated (probably fatal)
4 A	Hearing paralysis threshold	Heart stops duration of current passage
> 5A	Tissue burning	

**This data is approximate and based on a 68 kg person*

Ref: R.H.Lee, " The other Electrical Hazard: Electric Arc Blast Burns," IEEE Trans. Industrial Applications, 1A-18 (3): p246, 1982

Electrical Safety

Electrical injuries:



Electrical injuries consist of four main types:

- Electrocution (fatal)
- Electrical shock
- Electrical burns
- Falls caused as a result of contact with electrical energy

Electrical injuries may occur in various ways:

- Direct contact with electrical energy
- Injuries that occur when electricity arcs to a victim.
- Flash burns are generated by an electrical arc.
- Flame burns from the ignition of clothing or other combustible materials

The effect that electricity has no an individual depends on four factors:

- The voltage of the circuit
- Internal body resistance
- The amount of current that flows through the body
- The path electricity takes through the body

Electrical Safety

Electrical safety precautions

- Never touch both battery terminals with your bare hands at the same time.
- Remove rings, watches and dangling jewellery when working with or near batteries. The metal in the jewellery can cause a shock or burn if they contact the battery terminals.
- Only use insulated/non-conducting tools to remove cell caps. Never lay tools or other metal parts on top of a battery.
- Consider covering battery terminals and connectors if possible with an insulating blanket before overhead inspections or repairs.
- Ensure charger is turned off before connecting or disconnecting a battery to prevent arcing

Biological Safety

Biological substances encompass materials derived from or produced by living organisms, including microorganisms, human or animal products, and even certain toxic compounds.

Biological substances:

- **Animals and Plants**
- **Tissue**
- **Live cells**
- **Killed cells**
- **Large cellular components (organelles etc.)**
- **Bacteria**
- **Viruses**
- **Biomolecules (nucleic acids, proteins etc.)**

Biological safety level (BSL):

BSL-1: working with agents that are not known to consistently cause harm in humans

BSL-2: working with agents that are associated with human diseases and pose moderate risk to humans upon accidental exposure

BSL-3: working with agents that may be transmitted through air and can cause lethal infections

Please refer to MNCF Bio-wing and Safety Orientation - Bio-wing Orientation

Biological Safety

What to do in Emergency Situations

(A)

Spills

- Clean up with bleach, ethanol and water (learn technique in laboratory)
- If large quantities – seek help in clean up (call emergency services as required)

(B)

Eye Exposure

- Move away from biological agents
- Rinse eyes with copious amounts of clean water (eye faucet)
- Seek immediate medical attention (go to health centre)

(c)

Skin Exposure

- Move away from biological agents
- Wash affected area with soap+water
- Seek immediate medical attention

Waste disposal Safety

Waste is any unwanted or unusable material. It should be handled and disposed of properly to prevent harm to health and the environment.

Here are common types of waste disposable materials, categorized by their nature:

1.Organic Waste – Food scraps, garden waste, and other biodegradable materials.

2.Inorganic Waste – Plastics, glass, metals, and synthetic materials that do not decompose easily.

3.Recyclable Waste – Paper, cardboard, certain plastics, glass bottles, and metals that can be processed and reused.

5. Hazardous Waste – Batteries, chemicals, paints and medical waste that require special handling.

6. Electronic Waste (E-waste) – Old computers, electronic devices.

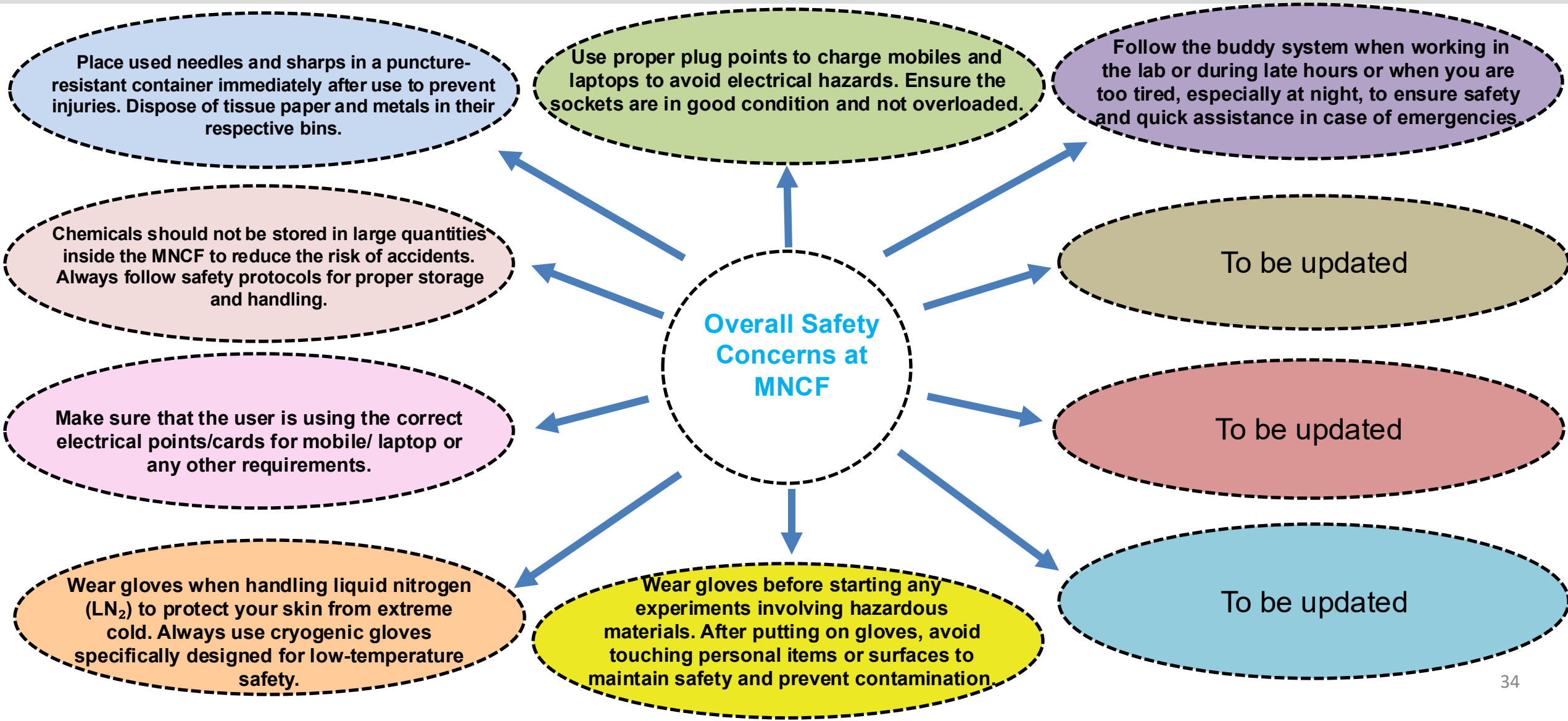
7. Biomedical Waste –syringes, bandages, and human tissues.

Waste disposal Safety

Paper waste (a), plastic waste (b), aluminium foil (c), chemical waste (d), and sharp waste (e) should be disposed of in designated, labelled biohazard containers. Refer to Sample handling and disposal SOP for more details.

(a) (b) (c) (d) (e)

MNCF waste disposal bins


Overall Safety Concerns at MNCF
Place used needles and sharps in a puncture-resistant container immediately after use to prevent injuries. Dispose of tissue paper and metals in their respective bins.
Use proper plug points to charge mobiles and laptops to avoid electrical hazards. Ensure the sockets are in good condition and not overloaded.
Follow the buddy system when working in the lab or during late hours or when you are too tired, especially at night, to ensure safety and quick assistance in case of emergencies.
Chemicals should not be stored in large quantities inside the MNCF to reduce the risk of accidents. Always follow safety protocols for proper storage and handling.
To be updated
Make sure that the user is using the correct electrical points/cards for mobile/ laptop or any other requirements.
To be updated
Wear gloves when handling liquid nitrogen (LN_2) to protect your skin from extreme cold. Always use cryogenic gloves specifically designed for low-temperature safety.
Wear gloves before starting any experiments involving hazardous materials. After putting on gloves, avoid touching personal items or surfaces to maintain safety and prevent contamination.
To be updated

Thank You