Indian Institute of Science

Office of Laboratory Safety and Environmental Health

OLSEH/PPE/GUI/22-01

General Guidance on Personal Protective Equipment

1 Some Common Hazard Classes

This document provides generic guidelines for the use of personal protective equipment (PPE) when working in laboratories at IISc with one or more of the following occupational hazards.

a. Chemical hazards such as labs having chemicals or gases with NFPA rating >0;
b. Laser radiation hazard;
c. Electrical hazards such as high-voltages;
d. Radiation hazards such as X-rays and/or radio-active material.
e. Biological hazards such as infectious molecules/organisms, blood samples, etc.
f. Mechanical hazards such as in a mechanical workshop that involves material machining processes including turning, milling, drilling, etc.

2 Minimum Laboratory PPE

When working In laboratories with at least one of the hazards listed in Section 1, OLSEH recommends that the following minimum PPE be worn at all times.

1. **Eyes:** Safety Glasses. This requirement may be waived if the lab works with sealed sources only, there is no sample preparation, and no danger of a chemical spill, even if a sample drops.
2. **Hands:** Disposable thin-nitrile gloves. Avoid latex since it is permeable and allergic.
3. **Body:** Long pants or equivalent leg covering (no shorts). Synthetic clothing **not** allowed when working with any fire hazard.
4. **Close-toed shoes**: Laboratory footwear should fully cover the feet. **No sandals or flip flops**. **The common practice of removing footwear outside the lab is not allowed unless lab-specific footwear is provided.**
5. **Tied hair:** No loose long-hair anytime. All long beard and hair should be properly tied or covered.

3 Additional PPE for Specialized Laboratories

In sections 4 to 10, PPE for specialized laboratories and/or situations are listed out with respect to certain common tasks expected in laboratories at IISc. The PPE prescribed in sections 4 to 10 is in addition to the minimum PPE suggested in section 2. Any task that is not listed here does not necessarily mean that it is safe to perform without PPE. When in doubt, users are encouraged to use their judgement and follow best practices. Always err on more PPE!

4 PPE for General Safety

	Task	Potential Consequence	AdditionalPPE
1.	Working with equipment that directly exposes the user topressures>2 bar or 14 psig or a vacuum of <400 mm of Hg. Examples include working with pressurized gas nozzles.	1. Skin damage 2. Eye damage 3. Implosion	1. Face: Face shield if no other implosion/explosion barrier exists. (also see section 7 on compressed gas safety for more specific guidelines)
2.	Working with high temperature equipment or objects	1. Burns 2. Fire 3. Splash	1. Hands: Gloves that are suitable for the working temperature. 2. Extra set of thermal gloves are required when directly handling hot objects at temperatures >50 °C. 3. Body: Lab coat or apron suitable for the working temperature
3.	Working with inert cryogens (He, N2, etc.)	1. Frostbite 2. Eye damage 3. Hypoxia in confined spaces	**For ≤ 10Liters** 1. Body: Lab coat or apron 2. Eyes: Safety goggles 3. Hands: Inner disposable nitrile gloves + outerinsulated cryogenic gloves, when directly handling objects exposed to cryogens. **For ≥ 10 liters** 4. Eyes: Safety goggles 5. Face: Face shield 6. Hands: Inner disposable nitrile gloves + outerinsulated cryogenic gloves 7. Body: Lab coat or cryogenic apron. 8. Note: Use only in well-ventilated area.
4.	Woriking with reactive cryogens (H2, O2, etc.)	1. Frostbite 2. Eye damage 3. Hypoxia in confined spaces	**Talk to OLSEH. Special permission and protocols required.**
5.	Working at elevated locations such as for example loading samples in an overhead sample loading dock.	1. Fall and subsequent injury	**≤ 3m** 1. Use ladders with a stable base. Adhocplatforms, stools and chairs are not allowed. **> 3m** 1. Safety harness 2. Hard safety hat.

			Hard-toed safety shoes
6.	Possibility of falling objects such as in construction sites	1. Serious or fatal injuries to head and other body parts.	1. Hard safety hat. 2. Hard-toed safety shoes
7.	High-speed machinery	1. Entangled hair. 2. Possibility of flying scrap or high speed particles	1. Tie long hair in a bun or use hair-nets. 2. Hard-toed safety shoes 3. Eyes: Safety Goggles

5 PPE for Biosafety

	Task	**Potential Consequence**	**Additional PPE**
1.	Working with human blood, body fluids, cell lines (primary or established), tissues, or blood borne pathogens (BBP).	1. Exposure to infectious material	1. Face: Face mask or sheild 2. Body: Lab coat or disposable gown/apron
2.	Working with animal and/or human specimens preserved in fixative (such as formalin or Para formaldehyde solution) Preserving animal and/or human specimens with fixative (such as formalin or Paraformaldehyde solution)	2. Exposure to fixative used to preserve the specimen. 3. If tissue is fixed, there is no longer exposure to infectious material.	1. Eye: Safety goggles 2. Hand: Impermeable glove for preserved specimens that is chemical-resistant to fixative use 3. Face: Face mask 4. Body: Lab coat or Disposable gown

3.	Working with radioactive human blood, body fluids, or blood borne pathogens (BBP).	1. Exposure to infectious material 2. Cell damage 3. The potential spread of radioactive contaminants.	1. Eye: Safety googles 2. Face: Face mask +Face shield 3. Body: Lab coat or disposable gown
4.	Manipulation of recombinant DNA, cell lines, viruses, bacteria, or other organisms classified as Risk Group 2 and requiring Biosafety Level 2 (BSL-2). Perform aerosol-generating procedure: Vortex, sonicate, pipette, tissue harvest.	Biological agents that pose a moderate potential for infection by injection, skin exposure, ingestion, or inhalation.	1. Eye: Safety googles 2. Hand: Nitrile gloves 3. Face: Face mask 4. Body: Lab coat orDisposable gown
5.	Manipulation of infectious materials classified as Risk Group 3 but manipulated in a BSL 2 facility with BSL-3 practices (BSL 2+).	Biological agents that pose a moderate/ serious potential for infection by injection, skin exposure, ingestion, or inhalation.	1. Eye: Safety goggles 2. Hands: Nitrile gloves (double) 3. Body: Lab coat + disposable gown that ties in back 4. Inhalation: Respiratory protection like N95 mask
6.	Manipulation of infectious materials classified as Risk Group 3 and requiring Biosafety Level 3 (BLS-3) containment.	Biological agents that pose a serious or lethal potential for infection via injection, skin exposure, ingestion, or inhalation.	1. Eye: Safety goggles 2. Hands: Nitrile gloves (double) 3. Body: Full disposable coverall suit + headcover 4. Foot: Shoe cover 5. Face: N95or other triple-layered mask + Face shield.

7.	Working with live animals, e.g.mice and rats& chicken eggs:	1. Animal bites. 2. Exposure to animal allergens. 3. PotentialStaph &Strep exposure.	1. Animal bites: Restraints or bite-resistant gloves 2. Animal allergen: N95 respirator. 3. Eye: Safety goggles 4. Body: Lab coat or apron, Hair bonnet + gown 5. Foot: Shoe covers

6 PPE for Radiation Hazards

Radiation safety is managed by AERB, a governmental regulatory agency. AERB appoints safety officers (outside OLSEH). All radiation-realted work must be done under rules of AERB and with permission from AERBsafety officers.

	Task	**Potential Consequence**	**Additional PPE**
1.	Working with sealed sources	1. Exposure	1. Minimum PPE unless the dosage is above safe limits 2. TLD badges, if mandated by AERB safety officer
2.	Working with solid radioactive material or solid radioactive waste.	1. Cell damage 2. The potential spread of radioactive	1. Hands: Disposable nitrile or other impermeable gloves (double) 2. Face: N95 mask 3. Body: Lab coat or apron 4. TLD badges, if mandated by AERB safety officer
3.	Working with liquid radioactive material (in corrosives, flammables, aqueous liquids – including liquid radioactive waste) or radioactive powders.	1. Cell damage 2. The potential spread of radioactive contamination 3. Hazards presented by the specific chemical	1. Eyes: Safety goggles 2. Hands: Disposable nitrile or other impermeable gloves (double) 3. Face: N95 mask 4. Body: Lab coat or apron 5. TLD badges, if mandated by AERB safety officer
4.	Usage of open-beam X-ray sources that are not enclosed or interlocked	1. Cell damage 2. The potential spread of radioactive contamination 3. Hazards presented by the specific chemical	Talk to OLSEH. Special permission and protocols required.

7 PPE for Lasers and Intense Light Sources

	Task	Potential Consequence	AddtionalPPE
1.	Using an open-beam	1. Eye damage	1. Eye: Appropriate laser safety
	Task	**Potential Consequence**	**AddtionalPPE**
	laser of Class 3 or above in a setup that is not fully contained or interlocked.	2. Skin damage	goggles/glasses with optical density based on individual beam parameters. 2. Skin: Fully covered arms and feet. Flame-resistance clothing. Avoid synthetics. 3. Avoid reflective jewelry.
3.	Troubleshooting or maintenance of a laser system in a way that defeats the interlock(s) of a laser of Class 3 and exposes optical cavity.	1. Eye damage 2. Explosionof glass components 3. Electrocution	1. Eye: Appropriate laser safety goggles/glasses with optical density based on individual beam parameters. 2. Skin: Fully covered arms and feet. Flame-resistance clothing. Avoid synthetics. 3. Hands: Electrically Insulated gloves 4. Avoid reflective jewelry. This is a specialized activity. PPE above assumesthe personel is trained.
4.	Working with intenselight sources, infrared-emitting equipment, UV sources (<400 nm)	1. Eye damage 2. Skin-burn	1. Eye: Appropriate laser safety goggles/glasses with optical density based on individual beam parameters. 2. Skin: Fully covered arms and feet. Flame-resistance clothing. Avoid synthetics.

8 PPE for Compressed Gas Cylinders& Cryogens

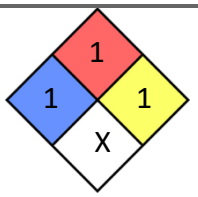
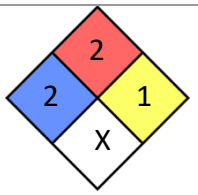
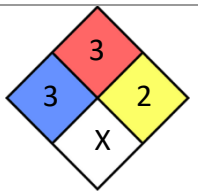
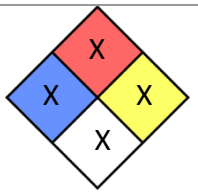
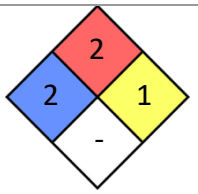
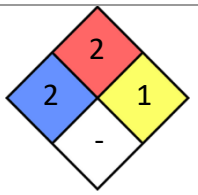
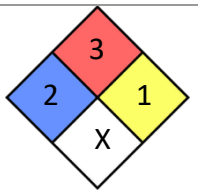
	Task	Potential Consequences	Additional PPE
1.	Transport or handling of inert gas cylinders (NFPA 704 rating of <2 in all quadrants)	1. Cylinder falling over 2. Breaking off the valves	1. Hand: Wear mechanically resistant-gloves when handling cylinders. 2. Foot: Closed-toed shoes
2.	Transport of handling of flammable gases with NFPA 704 flammability rating of ≥3	1. Cylinder falling over 2. Breaking off the valves 3. Fire or explosion due to a sudden release	1. Skin: Flame resistant antistatic safety clothing. 2. Hand: Wear mechanically resistant-gloves when handling cylinders 3. Foot: Closed-toed shoes.
3.	Toxic gases with NFPA 704 health rating of ≥3	1. Cylinder falling over 2. Breaking off the valves 3. Poisoning	Respiratory protection-Toxic gas mask or self-contained breathing apparatus

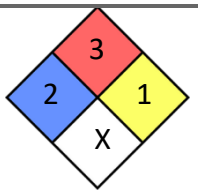
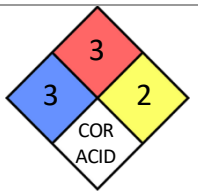
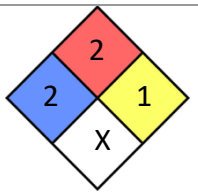
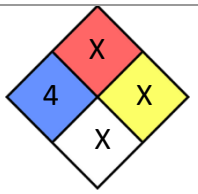
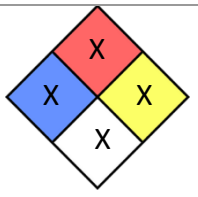
9 PPE for Electrical Safety

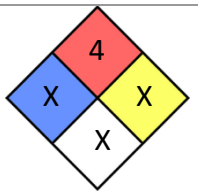
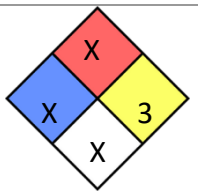
	Tasks	Potential Hazards	Additional PPE
1.	Maintenance and repairing electrically powered equipment	1. Electrocution	1. Hands: Insulated electrical gloves. 2. Foot: Electrical safety shoes. 3. Electric works to be undertaken by trained electrical technicians ONLY.
2.	High Voltage (> 400 V)	1. Electrocution 2. Arc flash	1. Body: Arc flash clothing. Switching suits available from low level to high-level protection. Arc clothing is made from flame-resistant material such as a cotton and nylon blend. 2. Electrical rated gloves and steel toe cap boots with rubber, designed for protection against high voltage. 3. Electrical-rated safety helmet. 4. To use specified Electrical standard tools, switch OFF Mains/incoming supply during maintenance/repair work.

10 PPE for Chemical Safety

1. This document lists the mandatory PPE for various categories of chemical hazards. Please scroll to Appendix A if you need a visual definition of what each PPE means.
2. This document uses NFPA 704 to categorise chemicals by hazards. Please scroll to Appendix B if you need a primer on NFPA 704.
3. **Always read the MSDS**. NFPA 704 has limitations. PPE in MSDS supersede these guidelines.
    a. NFPA 704 only captures immediate dangers.
    b. NFPA 704 does not capture damage due to long-term exposure, like carcinogens.
    c. NFPA 704 does not capture some hazards, e.g. skin permeation property of DMSO.
    d. NFPA 704 does not capture dust hazards. NFPA 652/654 covers combustible dusts.
    e. NFPA 704 does not capture environmental hazards.
    f. NFPA 704 does not capture hazards due to small impurities in mixtures.
    g. NFPA 704 does not capture the impact of dilution.
    h. NFPA does not capture contextual risk due to quantity, particle size, usage, double jeopardy, etc.
4. The mandatory PPE scales with the NFPA rating. The mandatory PPE sometimes also scales with quantity & particle size.
5. Don't suspend your judgment. When in doubt, go for a more stringent definition or talk to the PI or contact OLSEH.
6. If the PI or lab safety in charge feels that certain aspects are counterproductive, they may ask the Safety Committee for clarification or exemption. [*Note: EHS Officers don't have the right to issue exemptions.*]
7. PI and lab-in-charge can mandate a higher standard of PPE.
8. Beyond the minimum PPE, you need ***additional*** protection in the following cases. 'X' means any number & '-' means the quadrant should be 0 or empty. The highest number in any quadrant determines the PPE level.

	Category	Maximum Limits in a quadrant	Hazard	Additional PPE
1.	Low hazard solids, e.g. zinc powder, Ca metal, magnesium hydroxide.	 Particle size > 10 um	1. Eye damage 2. Skin exposure	Minimum PPE only **Fine particle of <10 um to be handled separately.**
2.	Moderate hazard solids, e.g. sulphur, magnesium & naphthalene.	 Particle size > 10 um	1. Eye damage 2. Skin exposure 3. Fire	1. Eyes: Safety goggles 2. Body: Chemical resistant apron or lab coat.
3.	High hazard solids, e.g. sodium metal, potassium metal, & white phosphorous	 Particle size > 10 um	1. Eye damage 2. Skin exposure 3. Explosible 4. Spontaneous fire	1. Eyes: Safety goggles 2. Face: Face shield 3. Hands: Chemical resistant gloves (thick) as a second layer 4. Body: Chemical resistant apron 5. Control: Use in fume hood
4.	Solids that are fine powders, like silica dust, carbon black, dry nanoparticles, & alumina polishing powder	 Particle size < 10 um	1. Inhalation 2. Explosible	In addition to PPE specified for larger particle size, 1. Face: Suitable face mask or respirator 2. Control: Use in fume hood only, if dust is explosible.
5.	Low hazard liquids in small quantity, e.g. acetic acid & ethylene glycol.	 Quantity < 100 ml	1. Eye damage 2. Skin exposure	Minimum PPE only ***Not applicable if the liquid absorbs through skin, is a long-term toxin (carcinogen, mutagen, teratogen) or is a nanoparticle solution.***
6.	Low hazard liquids, e.g. acetic acid & ethylene glycol.	 Quantity > 100 ml	1. Eye damage 2. Skin exposure 3. Splash	1. Eyes: Safety goggles 2. Hands: A second layer of thin nitrile gloves. 3. Body: Chemical resistant apron or lab coat.
7.	Moderate hazard liquids in small quantity, e.g., most alcohols (ethanol, isopropanol, methanol), acetone, xylene, chloroform, THF & DMF	 Quantity < 100 ml	1. Skin damage 2. Eye damage 3. Fire	1. Body: Chemical resistant apron or lab coat. 2. Control: Ventilated area

8.	Moderate hazard liquids, e.g., most alcohols (ethanol, isopropanol, methanol), acetone, xylene, chloroform, THF & DMF	 100 ml < Quantity < 4 litres	1. Skin damage 2. Eye damage 3. Fire 4. Splash	1. Eyes: Safety goggles 2. Hands: A second layer of thin nitrile gloves needed for permeating solvents (e.g., DMF, chloroform, THF) or prolonged contact. 3. Body: Chemical resistant apron or lab coat. 4. Control: Use in fume hood
9.	High hazard liquids, e.g. sulphuric acid, nitric acid, alkali hydroxides, & formaldehyde	 Quantity < 4 litres	1. Eye damage 2. Skin damage 3. Splash 4. Inhalation	1. Eyes: Safety goggles 2. Hands: Chemical resistant gloves (thick) as a second glove 3. Body: Chemical resistant apron or lab coat 4. Control: Use in fume hood. ***If a fume hood is not available, then chemical resistant apron is mandatory***
10.	Any hazardous liquid in large quantity	 Quantity > 4 litres	1. Splash 2. Ingestion	In addition to PPE specified for liquids 1. Eyes: Safety goggles 2. Face: Face shield with mask. Replace with respirator if fumes are very noxious. 3. Hands: Chemical resistant gloves (thick) as a second layer 4. Body: Chemical resistant apron
11.	Acutely toxic chemicals, e.g., hydrogen fluoride, hydrazine, hydrogen cyanide, chlorosulfonic acid, hydrogen sulphide at high concentration, phenol at high concentrations, nickel carbonyl & dimethylmercury		1. Eye damage 2. Skin penetration 3. Inhalation 4. Systemic toxicity 5. Lethal in small doses	Work inside a glove box **OR** 1. Eyes: Safety goggles 2. Face: Face shield. Suitable face mask if the material is noxious. 3. Hands: Two layers of appropriate gloves. Special gloves designed for that specific hazard are highly recommended. 4. Body: Chemical-resistant apron 5. Control: Use in well-ventilated fume hood or glove box with tight engineering control
12.	Special toxin that absorbs through skin, or is a long-term toxin (carcinogen, mutagen, teratogen) or is a nanoparticle solution**.** E.g. benzene, hexavalent Cr, ethidium bromide, DMSO, carbon tetrachloride, cadmium, lead, or mercury		1. Eye damage 2. Skin penetration 3. Inhalation 4. Systemic toxicity	Work inside a glove box **OR** 1. Eyes: Safety goggles 2. Hands: Two layers of appropriate resistant gloves 3. Body: Chemical-resistant apron 4. Control: Use in well-ventilated fume hood or glove box with tight engineering control

13.	Highly flammable chemicals, e.g. diethyl ether, acetaldehyde, Ethylene oxide, vinyl chloride & isopropyl ether		1. Explosible 2. Spontaneous fire 3. Flying debris	Talk to OLSEH. Need special permission and protocols. ***OLSEH inspection is mandatory.***
	Category	Maximum Limits in a quadrant	Hazard	Additional PPE
14.	Explosive chemicals, e.g. azides, hydrogen peroxide (>52%), picric acid, compressed ozone, fluorine gas, nitroglycerin, diazomethane & tetranitromethane		1. Explosible 2. Spontaneous fire 3. Flying debris	Talk to OLSEH. Need special permission and protocols. OLSEH inspection is mandatory.
15.	Radioactive chemicals		1. Radiation 2. Systemic toxicity	Talk to OLSEH. Need AERB special permission and protocols. OLSEH inspection is mandatory.

11. Things to note

i. Proper ventilation is directly linked to the effectiveness of PPE. Respirators, masks, and other protective gear can only provide adequate safety if background solvent or vapour levels are kept within safe limits, which requires fume hoods or local exhaust systems. In poorly ventilated labs, heat stress also discourages continuous use of gloves, coats, and face shields. Therefore, PPE requirements must be coupled with minimum ventilation standards: ensure adequate air changes per hour (at least 6–12 air changes per hour (ACH), use fume hoods or portable extractors for chemical work, schedule hazardous tasks only in ventilated spaces, and suspend all chemical handling if ventilation fails. This ensures PPE functions as intended as the last line of defence, not the only one.

ii. PPE is a consumable. Please replace it when it is worn out or torn.

iii. Laboratories with hazardous chemicals must stock PPE appropriate for the type and quantity of chemical during both handling and storage.

iv. The PPE must be within easy access of users.

12. Annexure A: Visual Reference of PPE

Protection Area	PPE Item	Reference Image
Body	Lab Coat (Full Sleeves)	
	Chemical-Resistant Apron	

Hands	Thin Nitrile Gloves	
	Thick Acid-Resistant Gloves	
Eyes	Safety Glasses	
	Safety Goggles	
Face	Face Shield	
Lung	Face Mask / Respirator	

13. Annexure B: NFPA 704 Diamond

0 : Will not burn
1 : Must be preheated to burn
2 : Ignites if moderately heated
3 : Ignites at ambient temperatures (flash point< 37 °C)
4 : Extremely flammable (gas, volatile liquids, vapors)

0 : No hazard
1 : Slightly hazardous (significant irritation
2 : Hazardous (temporary incapacitation possible)
3 : Extreme danger (serious injury likely)
4 : Deadly (very short exposure could be fatal)

0 : Stable
1 : Unstable if heated
2 : Violent chemical change possible
3 : May detonate with shock or heat
4 : May detonate readily (e.g., explosives)

OX : Oxidiser (enhances combustion)
ACID : Acidic
COR : Corrosive
: Reacts dangerously with water
: Radiation hazard