Indian Institute of Science

Office of Laboratory Safety and Environmental Health

OLSEH/PPE(CHEM)/25-08/2.0

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Personal Protective Equipment (PPE) Guidelines for Chemical Safety

1. This document lists the mandatory PPE for various categories of 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.

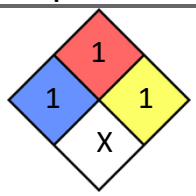
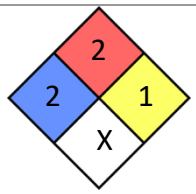
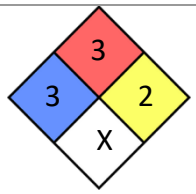
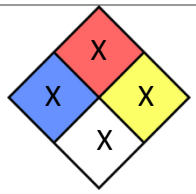
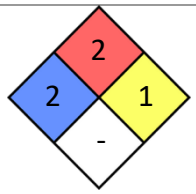
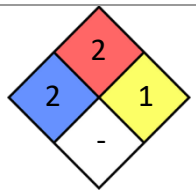
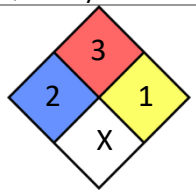
1 Minimum PPE

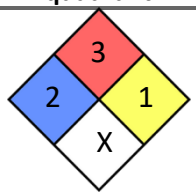
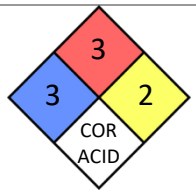
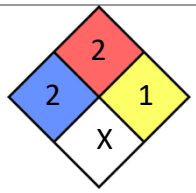
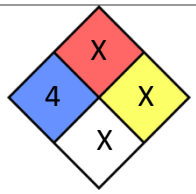
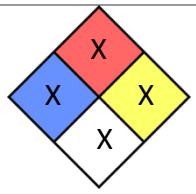
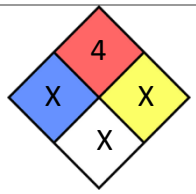
Users are expected to wear **Minimum PPE** while working with chemicals with an NFPA rating of 1 or above.

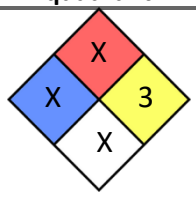
i. **Eyes:** Safety Glasses. This requirement may be waived if the lab works with sealed sources only, there is no sample preparation, and no danger of a chemical spill, even if a sample drops.
ii. **Hands:** Disposable thin-nitrile gloves. Avoid latex since it is permeable and allergenic.
iii. **Body:** Long pants or equivalent leg covering (no shorts). Synthetic clothing **is not** allowed when working with any fire hazard.
iv. **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 in-lab footwear is provided.**
v. **Tied hair:** No loose long hair. All long beards and hair should be properly tied or covered.

2 Specialised PPE

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

	Category	Maximum Limits in a quadrant	Hazard	Additional PPE
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.***

3 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.

4 Annexure A: Visual Reference of PPE

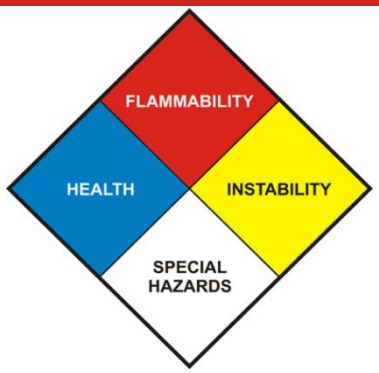
Protection Area	PPE Item	Reference Image
Body	Lab Coat (Full Sleeves)	
	Chemical-Resistant Apron	
Hands	Thin Nitrile Gloves	
	Thick Acid-Resistant Gloves	

Eyes	Safety Glasses	
	Safety Goggles	
Face	Face Shield	
Lung	Face Mask / Respirator	

5 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
W	: Reacts dangerously with water
	: Radiation hazard