NNFC Safety training

National nanofabrication centre

Indian Institute of Science

Bangalore

Outline

- Emergency Response
  - Fire, Smoke and Gas leak alarms
  - Tool break down
- Chemical safety training
  - protocols
  - Chemical handling
  - Disposal of chemical
  - Chemical spill
  - First aid

Emergency: Call 115

General Instruction during Emergency situation

- Stop the process by pressing the emergency stop buttons of the equipments (if known)
- When facility emergency alarms ring, please evacuate through the **nearest exit** immediately, DO NOT wait for any announcements
- Immediately alert the staff concerned (phone numbers are near the door) or call BMS : “115” if you need any emergency assistance
- Do not wait to remove the gown and PPE during evacuation

NOTE: Detailed Fire, Smoke and Gas leak alarm emergency procedure is there in the following slide

Alarm Response

- **Common Alarms: Fire and Smoke**
  - **In the cleanroom corridor, outside Films room**

  Emergency Action:

  - **Evacuate through the nearest exit and wait near the Assembly for the head count**
- **Gas alarms**
  - **Specific to equipments, mainly LPCVD and Diffusion furnace,**
  - **NEED TO INFORM BMS SINCE IT IS ONLY A TOOL ALARAM AND NOT CONNECTED WITH BMS**

  Emergency Action:

  - **Evacuate immediately through emergency exit**
  - **Inform BMS by calling 115 from the cleanroom outside corridor phones**
- **Evacuate cleanroom if power does not restore in 2 min**

Emergency response in case of an incident

- **2 BMS personnel to be there at all times**
- **BMS personnel trained on tool Emergency shutdown**
- **Posters kept in each bay detailing emergency evacuation procedure and panic button clearly marked**
- **Document detailing emergency shut down of tools – one copy in BMS, one at the bay**

What user need to do?

- Know emergency evacuation protocols thoroughly
- Please inform BMS at 115 immediately in case of any emergency
- Call someone if you cannot get BMS - COO/Technology manager, Bay-in charge, tool owner (Phone numbers available in the bay near the phone)
- Press panic button, present at each bay
- Evacuate through nearest exit, without ungowning and wait near the Assembly points near the front car park or badminton court for the head count

Responsibilities: Independent user

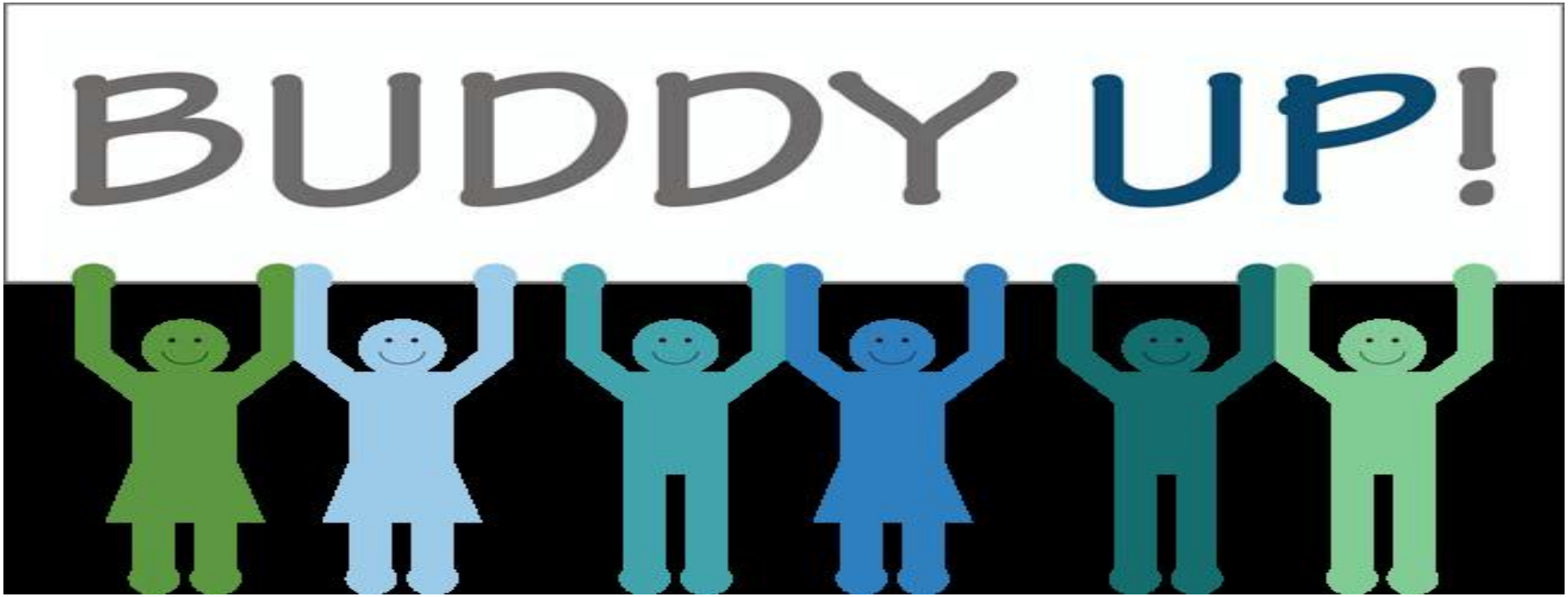
- **Independent user is responsible for the tool during non-office hours**
- **Has enough presence of mind to save lives and the facility**
- **Undergo orientation every 3 months**

In case of tool break down

- **Stop the process by pressing the emergency stop buttons of the equipments**
- **Inform BMS immediately**
- **Concerned facility technologist during fab working hours or if it is a safety issue (phone numbers available in Bay emergency contact list/ FOM)**
  - **Call from outside the fab incase of network problem**
- **Send 'Instrument problem report' to the instrument managers using FOM**
  - **Log off and press the "something wrong" button**
- **If unable to contact FT's, please put the tool down notice and send an email to the FT and technology manager, after letting the BMS know**
- **Send an email in the user group so that the next user is aware**
- **DO NOT TRY TO REPAIR BY YOURSELF**

Buddy System: *One rule not to be forgotten*

- ***Buddy system*** **need to be followed strictly at all times**
  - **Someone needs to know where you are and what your process is**
  - ***This is for your safety and this is the law***
  - *In the wet bay, the buddy need to be in the bay itself, if you are handling HF or HF based etchants*



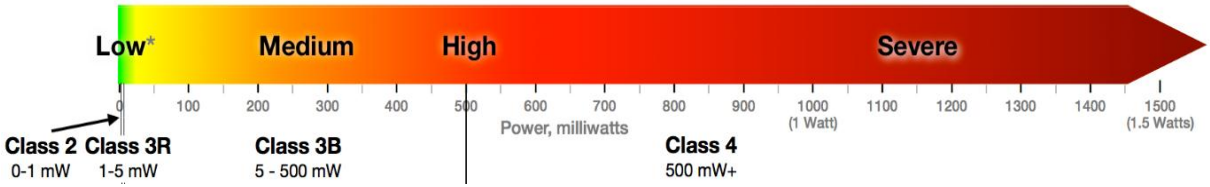
LASER SAFETY*

- **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.**

Lasers are present in PLD tool at Equipment development bay. Please use caution when entering and using tools in that bay.

*By Roopa prakash/Sushobhan Avasthi

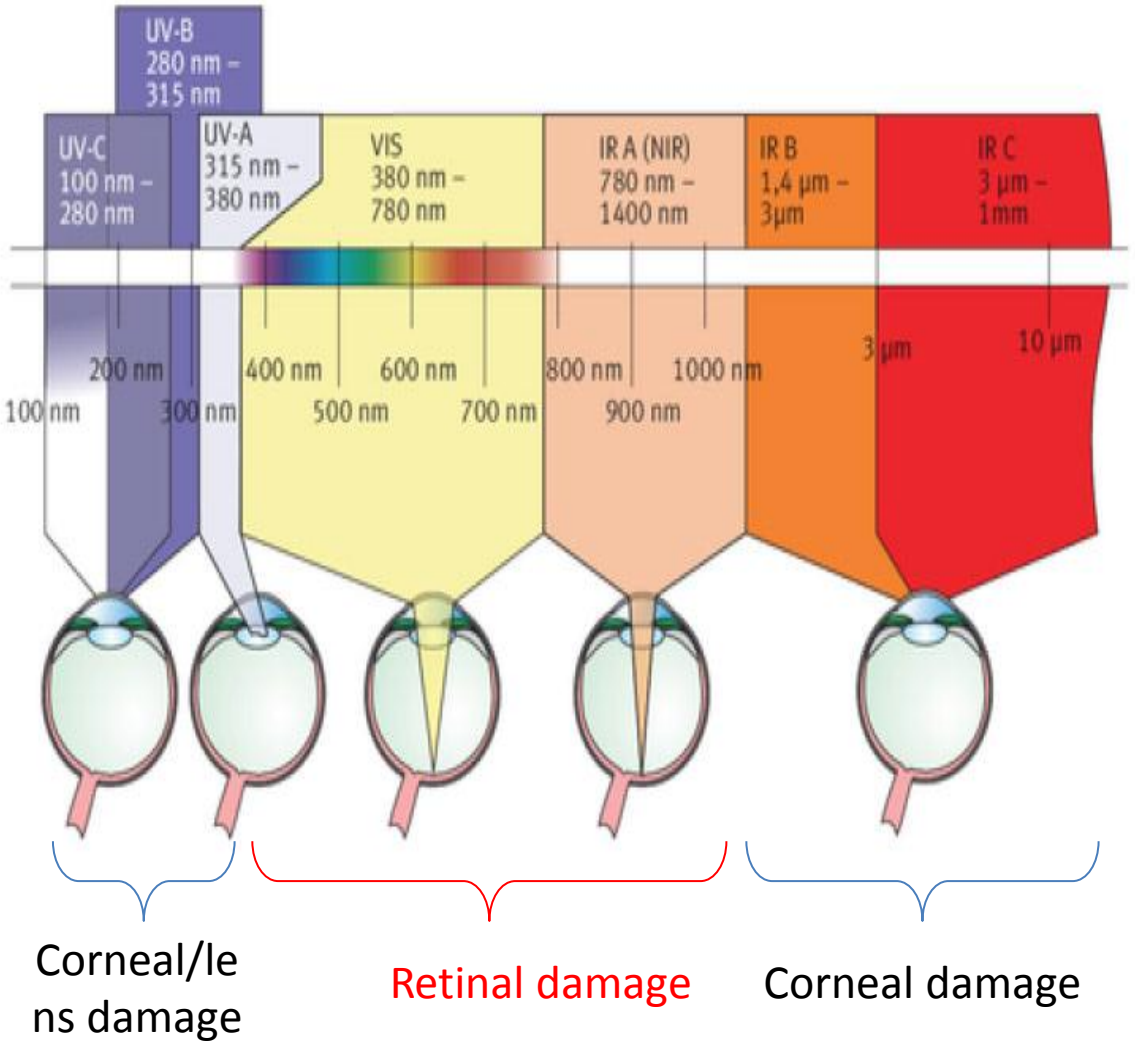
ONLY VALID FOR VISIBLE RADIATION



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

WARNING LABELS

RESPONSE OF HUMAN EYE TO DIFFERENT WAVELENGTHS OF LIGHT



Retina damage is often permanent and irreparable.

Cornea and lens damage can heal, although the injury is incredibly painful.

PERSONAL PROTECTIVE EQUIPMENT

EYE PROTECTION

- Appropriate eye protection devices must be worn when working with Class 3B and Class 4 lasers or laser systems.
- Eyewear must be specifically selected to withstand either direct or diffusely scattered beams
- Goggles are marked with the wavelength range over which protection is afforded and the minimum optical density within that range.

Chemical Safety Training

- **To ensure a safe environment for learning and research**
- **To prevent fatal Injuries and accidents**

Wet benches are the only safe places for chemicals

Wet Bench Protocol

- **While working on wet bench. it is mandatory to**
  - **Wear lab shoes**

  - **Wear Aprons**

  - **Wear safety glasses & face shield**

  - **Wear appropriate gloves**

  - **Make sure exhaust is functioning**

Gowning protocol for Hydrofluoric acid

Use of gloves

- **PVC**
  - **Are used protect wafers from particles generated by humans**
  - ***No resistance to chemicals***

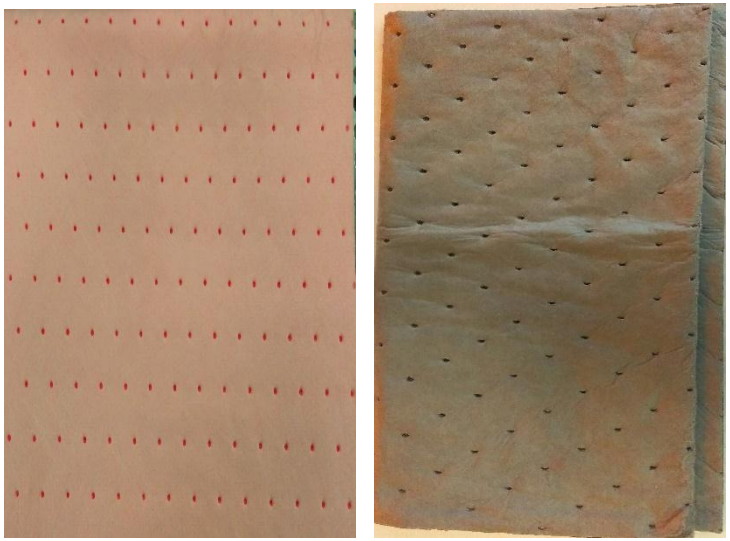
- **NITRILLE**
  - **Thin chemical resistant gloves**
  - **Strong material : used for protection against dilute acids**

- **LATEX/RUBBER**
  - **Gloves with good organic solvent protection**
  - **Could cause a skin allergy**

- **TRIONIC (MAPA)**
  - **Thick chemical resistant gloves : used for cleaning up leaks**
  - **Nevertheless don’t put your hands in liquid chemicals!**

F-telon gloves (Teflon incorporated)

TRIONIC (MAPA



Chemical spill pads for acids (pink) and organic solvents (grey)

Chemical spill pillows

PPE sequence

- **Nitrile gloves on top of the gowning gloves**
- **Aprons**
- **Sleeves**
- **Goggles**
- **Face-shield**
- **MAPA/ F-telon Gloves**

- **Please note that F-telon gloves need to be worn when using HF/BHF**

While wearing PPE

- **Do not touch with your contaminated gloves,**
  - **Face shield/Apron/sleeves**
  - **Cleanroom Gown**
  - **Mobile**
  - **Taps**
  - **Phone**
  - **Wet etch computer**

- **No walking around the fab wearing wet etch PPE**

Removing PPE

- **Removal in the order**
  - **Contaminated gloves, wash and keep in its place**
  - **Sleeves, fold and keep**
  - **Face shield**
  - **Goggles**
  - **Apron**

- **ACCESS TO THE WET ETCH WILL BE DENIED IF PPE RULES ARE VIOLATED**

Protocols

- **All chemicals in the fab are hazardous. Ensure that you have read the MSDS of the chemical before use. MSDS sheets are available with BMS or at the cleanroom corridor or the respective bay**
- ***Never rub in your eyes or face with your hands or gloves.***
- ***Never touch the phone or the taps wearing contaminated gloves***
- ***AAA principle: Always Add Acid to Water***

SOMEBODY WORKING AFTER YOU IN A LAB HAS TO TRUST EVERYTHING IS CLEAN!

What is an MSDS?

- **What is an Material Safety Data Sheet**
  - **Tells what chemicals are in the product,**
  - **What the hazards of the chemicals are**
  - **How to protect yourself from the hazards.**
- **Where to get M.S.D.S**
  - **Manufacturer websites, or**
  - **Google search "MSDS + name of chemical product" MUST READ !!**

The label on the bottle also will contain some relevant information

Hazard Symbols

Carcinogen
Mutageniciy
Reproductive Toxicity
Respiratory Sensitizer
Target Organ Toxicity
Aspiration Toxicity

Flammables
Pyrophorics
Self-Heating
Emits Flammable Gas
Self-Reactives
Organic Peroxides

Irritant (skin and eye)
Skin Sensitizer
Acute Toxicity
Narcotic Effects
Respiratory Tract Irritant
Hazardous to Ozone Layer

Skin Corrosion/Burns
Eye Damage
Corrosive to Metals

Explosives
Self-Reactives
Organic Peroxides

Gases Under Pressure

Oxidizers

Acute Toxicity (fatal or toxic)

Aquatic Toxicity

Chemical handling

- **Chemicals should be used only in the fume hoods**
- **All chemicals in the bay need to be labeled**
  - **Solutions left for cooling/later use need to be indentified using identification chit**
- **Do not randomly mix chemicals since this may result in an explosion / evolution of hazardous gases**
- **Appropriate face masks/ goggles and gloves have to be worn before starting the expt. Please note that latex gloves used for clean room entry has no chemical resistance. Wear nitrile / acid resistant glove depending on your experiment.**

Use of glassware

- **Fluoride solutions to be used only in plastic beakers / petridishes / measuring cylinders**
  - **Fluoride etches glass!**
- **Other acids to be used only in glass beakers**
- **Exchange of glassware between benches strictly not allowed**
  - **Glassware is labeled and belongs to particular benches as per contamination policy**

Disposal of Chemicals

- **Alkali's and Acids can be poured down the drain after cooling!**
- **HF and BHF solutions to be disposed in a single plastic bottle**
- **Chrome etch to be disposed into the designated plastic bottle**
- **Organic solvents (Acetone, IPA, Methanol) in a separate bottle, separate bench provided, should not be poured down the drain**
- ***Do not leave anything on the wet bench uncleaned/unclaimed after use***
- ***Si wafer/glass pieces to be discarded in the designated bin at the wet etch/dry etch***

Why is disposal procedure important?

- **Improper disposal can cause major accidents**
- **Severe accidents can result from mixing of incompatible chemicals, for eg:**
  - **Nitric acid with acetone/ ethanol/ acetic acid**
    - Results in fire and explosion
  - **Hydrogen peroxide with organic solvents**
    - Results in fire and explosion

Chemical spill On person

- **Remove contaminated clothing and get under safety shower**
- **Use eye wash for minimum of 15 min if splashed into eyes**
- **Inform BMS and seek medical attention**
- **Please note the location of safety showers and eye showers in the layout slide**

Eye Shower

Safety Shower

Chemical spill on the Floor

- **Small**

  - Contain the spill using chemical spill pillows
  - Dilute the spill with water and put spill blankets
  - Discard spill blankets and pillows in the plastic dustbin

- **Big**

  - Come out and close the door to the wet etch
  - Pull the red tape across the door to prevent further entry
  - Inform BMS immediately
  - Take precautions not to breathe in the fumes

Fluoride Solutions

- **Hydrofluoric acid and Buffered HF solution**
  - **Equally hazardous**
  - **Highly dangerous due to the internal tissue and bone damage (Decalcification) caused by contact with the colour less liquid!**
  - **Painful treatment in hospital (death possible)**

HF/BHF burns

Symptoms HF injury: HF 50%

- ***Almost immediate deep throbbing pain, burning feeling,(especially at hands and finger tips)***
- **Red discoloration with whitish blister, tissue under skin starts dying off, bone de-mineralises**
- **Need only 1% body surface area to be exposed**
- **Systemic fluoride intoxication**
- **Painful treatment in hospital (death possible)**

Symptoms of HF injury: Diluted HF solution > 20%

- **Sometimes it can take upto 24 hours before symptoms appear (pain, rash)**
- **Might result in deeper penetration and more painful burn (especially at hands and finger tips)**
- **The surface symptoms are minimal or may be absent**
- **Can cause white discolored skin, blisters seldom form**
- **HF solution >20%<49%:**
- **Symptoms sometimes just noticeable after a few hours!**
- **Treat all unlabelled, water-like solutions as HF solutions**

First Aid

- Wash with large amounts of water (minimum 5min)
- Rub in Calcium gluconate gel (make sure your hand is not contaminated) and cover the burn with plastic foil
- Seek medical attention
- **Calcium Gluconate Gel is in the First aid box at the wet etch**
- **If the spill on the eye, please wash with large amounts of water and rush to the hospital**

Most of the harm from HF exposure can be minimized if washed within minutes

Other Acids and Bases

- **Strong acids used:**
  - Sulfuric, Nitric, Hydrochloric, Phosphoric
- **Weak acid used**
  - Acetic acid
- **Bases used**
  - Potassium hydroxide, TMAH

- **The strong acids & bases are poisonous, corrosive, and will cause severe burns to body tissue.**
  - Long term exposure will cause lung and tooth damage.
  - The weak acids will cause eye, skin and mucous membrane irritation and burns.
  - Some are even carcinogenic or teratogenic.
  - TMAH and KOH causes severe eye damage and blindness
  - Exposure to 25% TMAH might cause respiratory failure

- **Acetone, Isopropyl Alcohol (IPA) and Methanol:**
  - **All solvents may cause skin and eye irritation. They are colorless & combustible, should NEVER be heated for use. Solvent vapors are toxic, use only in ventilated hoods.**

Photoresists

- Photoresists are organic polymers which change their chemical structure when exposed to ultraviolet light.
  - They are generally flammable and should be kept away from any source of heat and ignition.
  - Could be carcinogenic / irritant/ harmful / cause depression of central nervous system and damage to liver and kidneys
  - Protective gear has to be used at all times when dealing with Photoresists

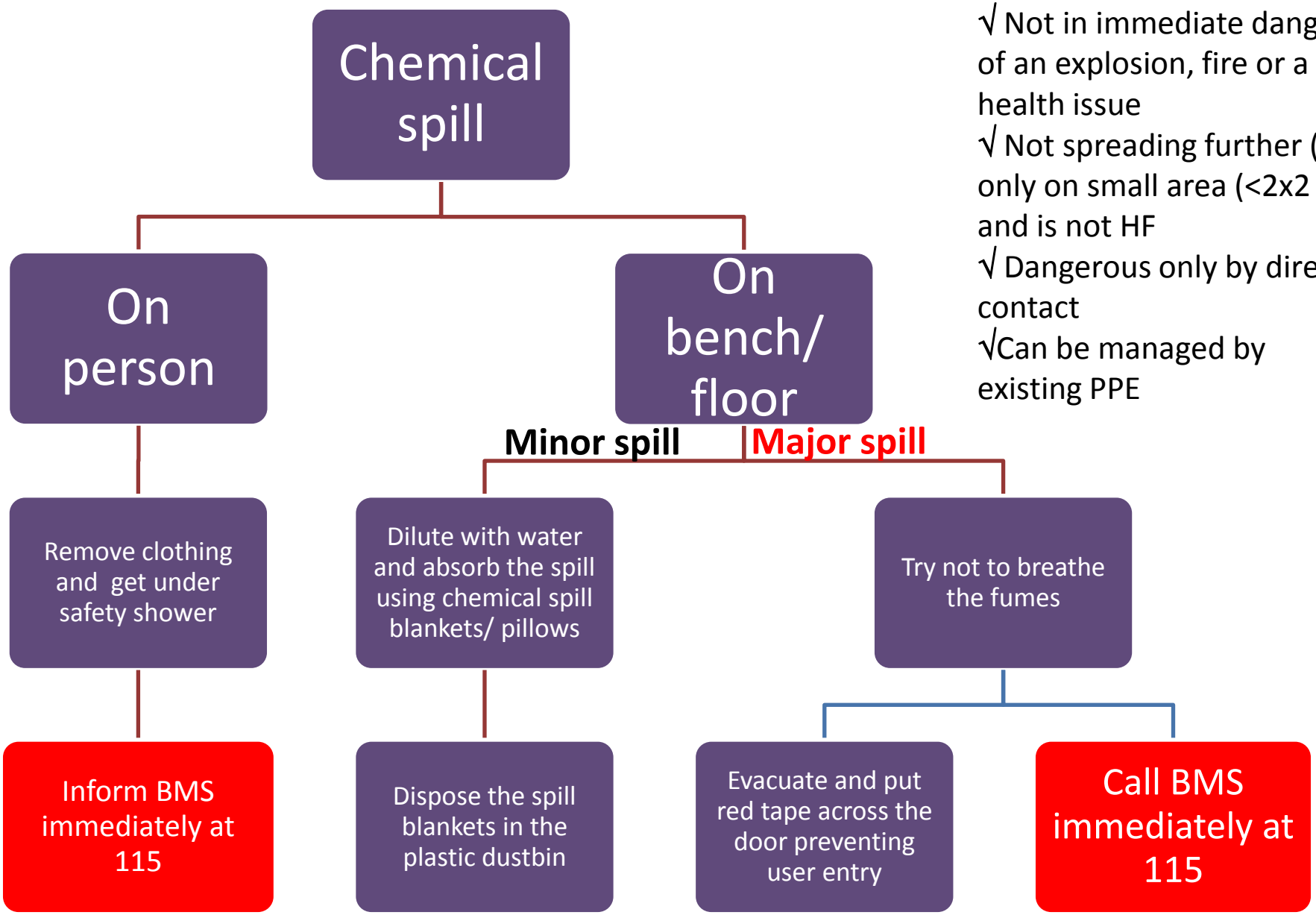
Photoresist Developers

- Mostly use TMAH (Tetra methyl ammonium hydroxide)
  - Severe eye damage might effect from exposure to TMAH
  - Could cause chemical burns on skin contact
  - Dermal exposure might also cause respiratory failure/ cardiac arrest

On skin contact , wash with large amounts of water (minimum 15 minutes) and contact BMS. PPE's mandatory at developing stations

Penalty points at the wet benches
(nx times for second violation)

- **Using without booking slots: 15 points**
- **Not wearing proper PPE (gloves/ goggles): 15 points**
- **Exchanging glassware: 15 points**
- **Leaving solutions without identification chit: 15 points**
- **Leaving bench unclean: 30 points**
- **Using cellphones near the bench: 30 points**
- **Using BHF/HF/ Vaporizer carelessly: 100 points (immediate suspension of cleanroom access)**
- **Bringing external chemicals without permission (across all the bays): 100 points**



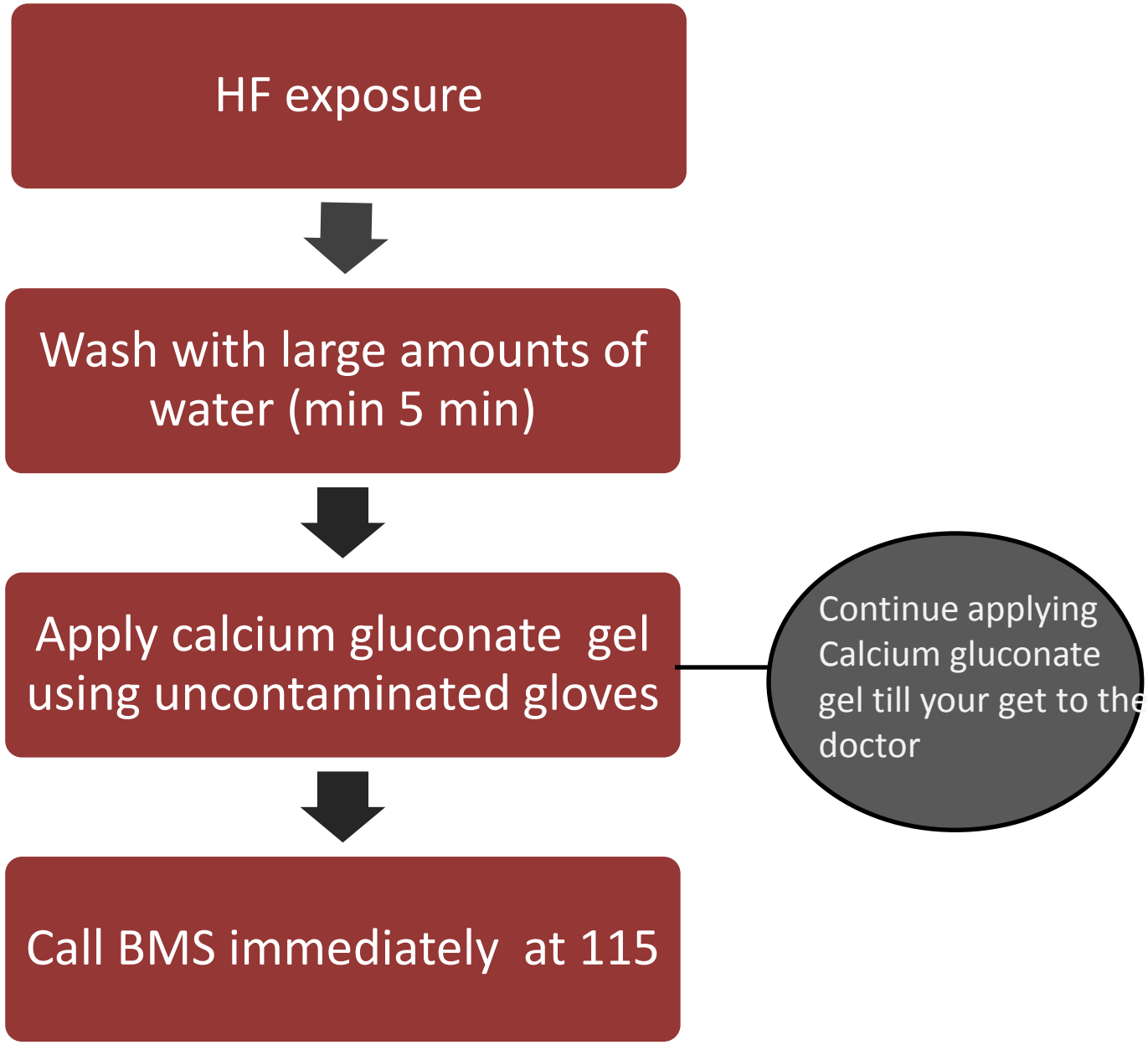
Minor Spill Criteria

√ Not in immediate danger of an explosion, fire or a health issue

√ Not spreading further (is only on small area (<2x2 ft) and is not HF

√ Dangerous only by direct contact

√Can be managed by existing PPE


HF exposure
Wash with large amounts of water (min 5 min)
Apply calcium gluconate gel using uncontaminated gloves
Continue applying Calcium gluconate gel till your get to the doctor
Call BMS immediately at 115


Thank
you