NNFC Safety training

National Nanofabrication Centre(NNFC)

Centre for Nano Science and Engineering (CeNSE)

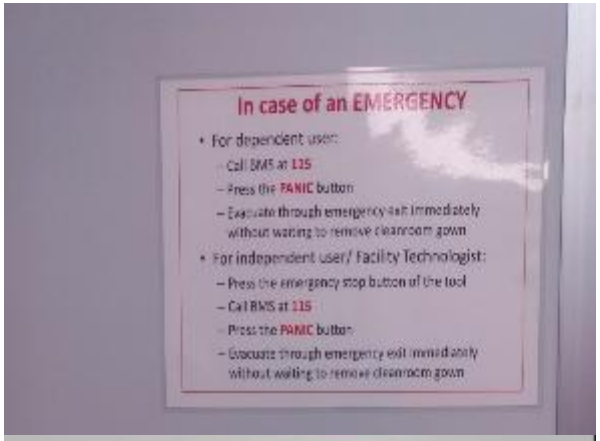
Emergency: Call 115

General Instruction during an Emergency situation

- When facility emergency alarms ring, please evacuate through the nearest exit immediately, DO NOT wait for any announcements
- Do not wait to remove the gown and PPE during the evacuation
- Do not waste time collecting your belongings like phone, notepad, laptop, etc;
- Call BMS: “115” if you need any emergency assistance

Emergency response in case of an incident

- Two facility staff members will always be present in the BMS Control Room.
- BMS personnel are trained on the Emergency Shutdown of the tool
- Posters are kept in each bay detailing the emergency evacuation procedure, and the panic button is clearly marked
- Document detailing emergency shutdown of tools – one copy in BMS, one at the bay
- <u>Evacuate from the cleanroom if power does not restore after 2 minutes as circulation also stops</u>



Note: Panic Button are to be pressed only for Facility Emergency and not for personnel emergency.

Alarm Response

- **If you hear Fire and Smoke alarm**

  Emergency Action:

  – **Evacuate through the nearest exit without wasting time and wait near the Assembly for the headcount**

- **Gas alarms**

  – **Specific to equipment, mainly LPCVD and Diffusion furnace,**

  – **NEED TO INFORM BMS SINCE IT IS ONLY A TOOL ALARM AND NOT CONNECTED WITH BMS**

  Emergency Action:

  – **Evacuate immediately through the 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 any incident

- **During Non-office Hours, if you see fire or smoke inside the cleanroom**

  -Press the Panic button nearby

  -Evacuate through the nearest exit and wait near the Assembly for the head count

- **During Non-office Hours, if you see fire or smoke in the Tool.**

  -Press the EMO of the Tool.

  -Press Panic button nearby

  - Evacuate through the nearest exit

  - Inform BMS

  -Wait near the Safe Assembly point which is right front of the CeNSE building for the head count

  -Inform FT/ Technology Manager through email/FOM

  -Update Tool down message in user group.

Response for Neutralization Tank Alarm/Beep

- When fluids drain down the wet benches, they are directed into a neutralization tank.
- The neutralization tank has an active neutralization system that measures the pH and supplies a 50% concentrated Sodium Hydroxide solution to the tank in a programmed cycle to neutralize the acid.
- When the fluid level rises to 90% of the tank capacity, one will hear the beep sound in the Wet etch area.

➢ **Response: Inform the BMS by calling 115. And follow the instructions from the Facility Engineer.**

Button to cease the Neutralization alarm after informing BMS

To Summarize…!!

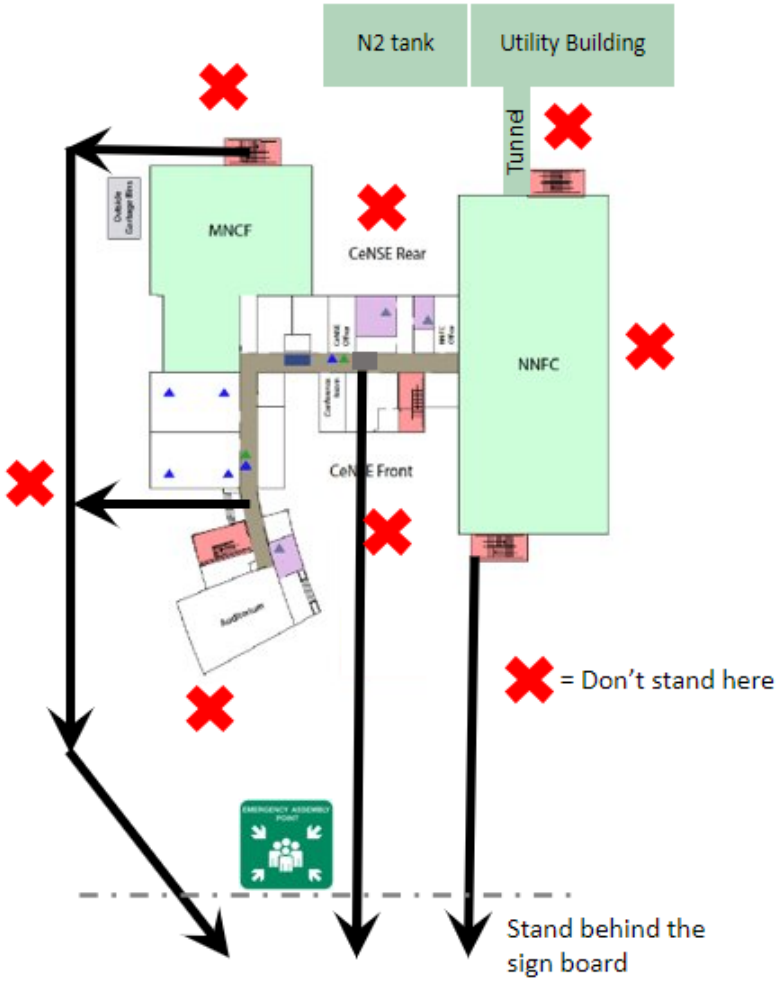
In case of an Emergency

Trigger the alarm

Evacuate through the nearest emergency exit

Go to Assembly Point at the front. Stay there.

Re-enter only when ERT issues “all-clear”

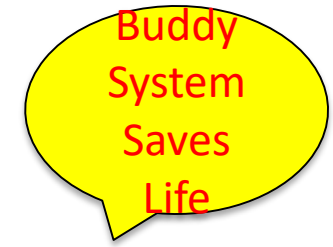


In case of tool break down-Tool issues

- Inform BMS immediately if it is a safety concerns
- 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*



Chemical Safety training

- Working in fume hoods and chemical wet benches always requires special attention...!!!–Follow fume hood guidelines of OLSEH, IISc.
- Choose the appropriate wet benches based on the contamination policy or levels
- Refer to the wet bench user document to identify which types of processes are feasible on a particular wet bench. (Under Wet bench Specifications-User document)

Wet benches are the only safe places for chemicals

Fume hood guidelines of OLSEH

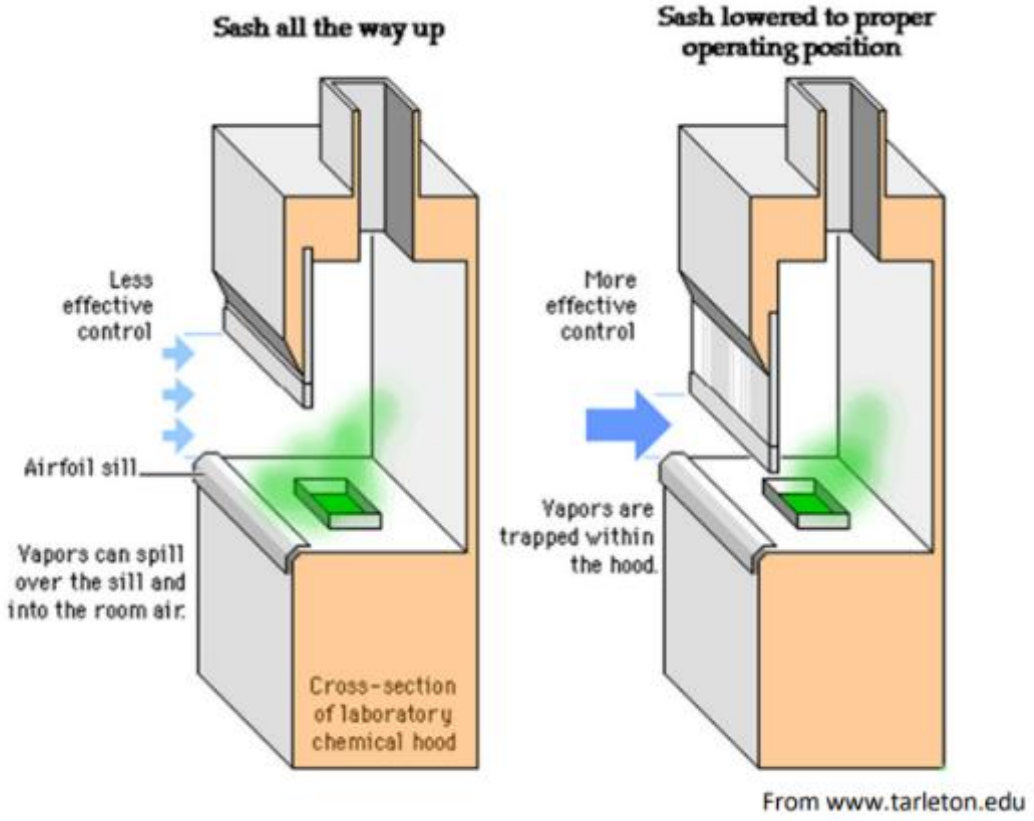


Figure 10: Good practices to follow while working with fume hoods. Never put your head inside. Don't use hoods as storage. Keep sash as low as possible.

- ✓ Keep the sash of hood as low as possible to prevent chemical vapors from back-flowing.
- ✓ Chemicals must be placed at least 6 inches inside the face of the hood.
- ✓ The user should always remain outside the hood. Never peer inside.

Chemical Safety training

- All chemicals in the fab are hazardous. Ensure that you have read the SDS of the chemical before use. SDS sheets are available with BMS or at the cleanroom corridor or the respective bay.

- ***Always use appropriate amount of chemicals…Do not waste the expensive MOS grade chemicals…!***

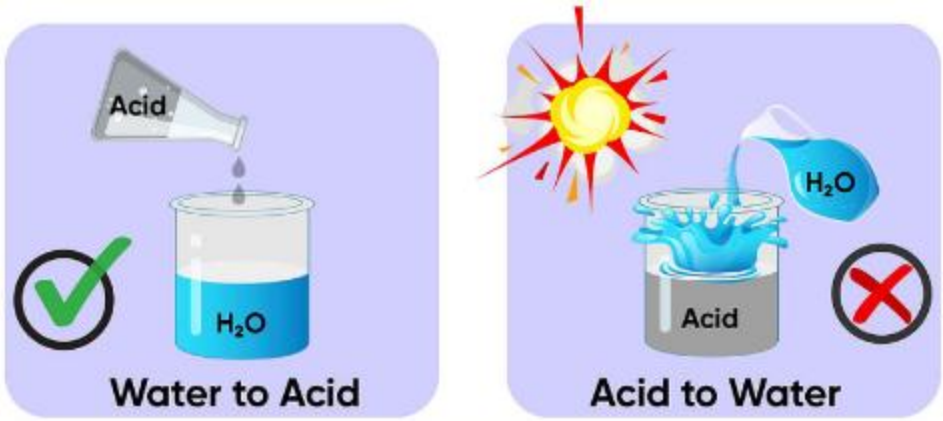
- ***Never rub in your eyes or face with your hands or gloves.***

- ***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!

Chemical Safety



- Never work together with **Flammables and Oxidizers..!!**

FLAMMABLES  **OXIDIZERS**

Acetone **Peroxide**

Wet Bench Protocol-PPE's available in wet Etch

- While working on wet bench, it is mandatory to
  - Chemical resistant Aprons
  - Wear chemical resistant sleeves
  - Wear safety glasses & face shield
  - Wear appropriate chemical resistant gloves
  - Make sure the exhaust is functioning by checking the Magnehelic gauge readings

Use of gloves

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

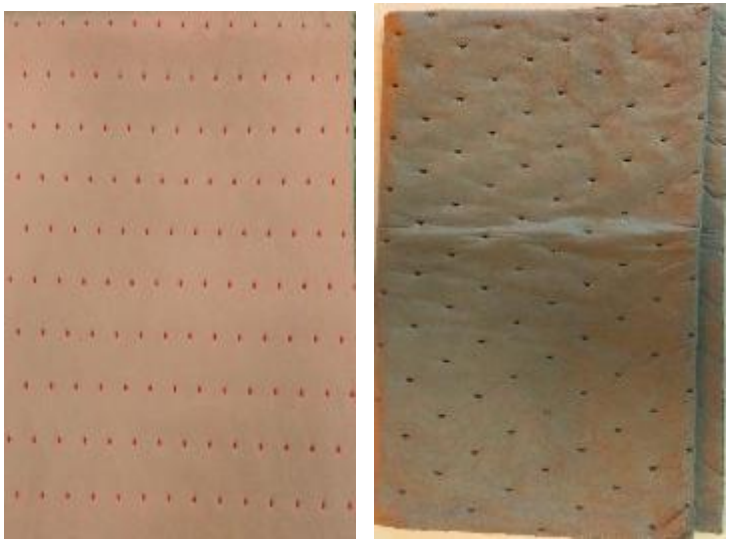
- **TRIONIC (MAPA)**
  - Thick chemical resistant gloves : used for cleaning up leaks
  - Nevertheless don’t put your hands in liquid chemicals!

- **F-Telon Gloves**
  - Thick special nitrile gloves, resistant against HF, Sulphuric acid aqua regia etc.;

Use of gloves

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 : F-telon gloves need to be worn while using HF/BHF-any etchants containing Hydrofluoric acid

Gowning protocol for Hydrofluoric acid

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 in place
- Goggles incase
- Apron

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

What is an SDS?

- What is an **S**afety **D**ata **S**heet
  - Tells what chemicals are in the product,
  - What the hazards of the chemicals are
  - How to protect yourself from the hazards.
- Where to get S.D.S
  - Manufacturer websites, or
  - Google search “SDS + name of chemical product” MUST READ !!
  - In Every bay with particular chemical details…you can ask cleanroom staff.

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 Transportation

- Chemicals should be used only in the fume hoods
- Do not carry chemicals by hand Use bottle carriers (Secondary Containers) when transporting bottles.
- Do not transport chemicals that are incompatible. Never transport acids with solvents or bases
- All chemicals in the bay need to be labeled
- Solutions left for cooling/later use need to be indentified using identification chit
- Wear nitrile / acid resistant glove depending on your experiment.

NO CHEMICALS INCLUDING WATER SHALL BE USED IN THE FAB WITHOUT PROPER LABELING

Chemical Storage

- Chemicals are stored in the properly designated areas with appropriate labels underneath the chemical wet benches
- Signs are posted next to the chemical storage
- All the chemicals for easy usage have been transferred to small bottles
- Use them judiciously as they are of MOS Grade..!!!

NNFC Disposal Protocol

- **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

Use of glassware

- **Fluoride solutions to be used only in plastic beakers-PP / 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**

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 running water (minimum 15min)
- 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 in Fab..!!

- **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.**

Penalty points for violatons
(nx times for second violation)

- Follow all the cleanroom and safety rules of NNFC
- Any deviation from this will be considered as violation and will result in appropriate disciplinary action based on the discretion of the NNFC management, it might include the suspension of your access to cleanroom.

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**

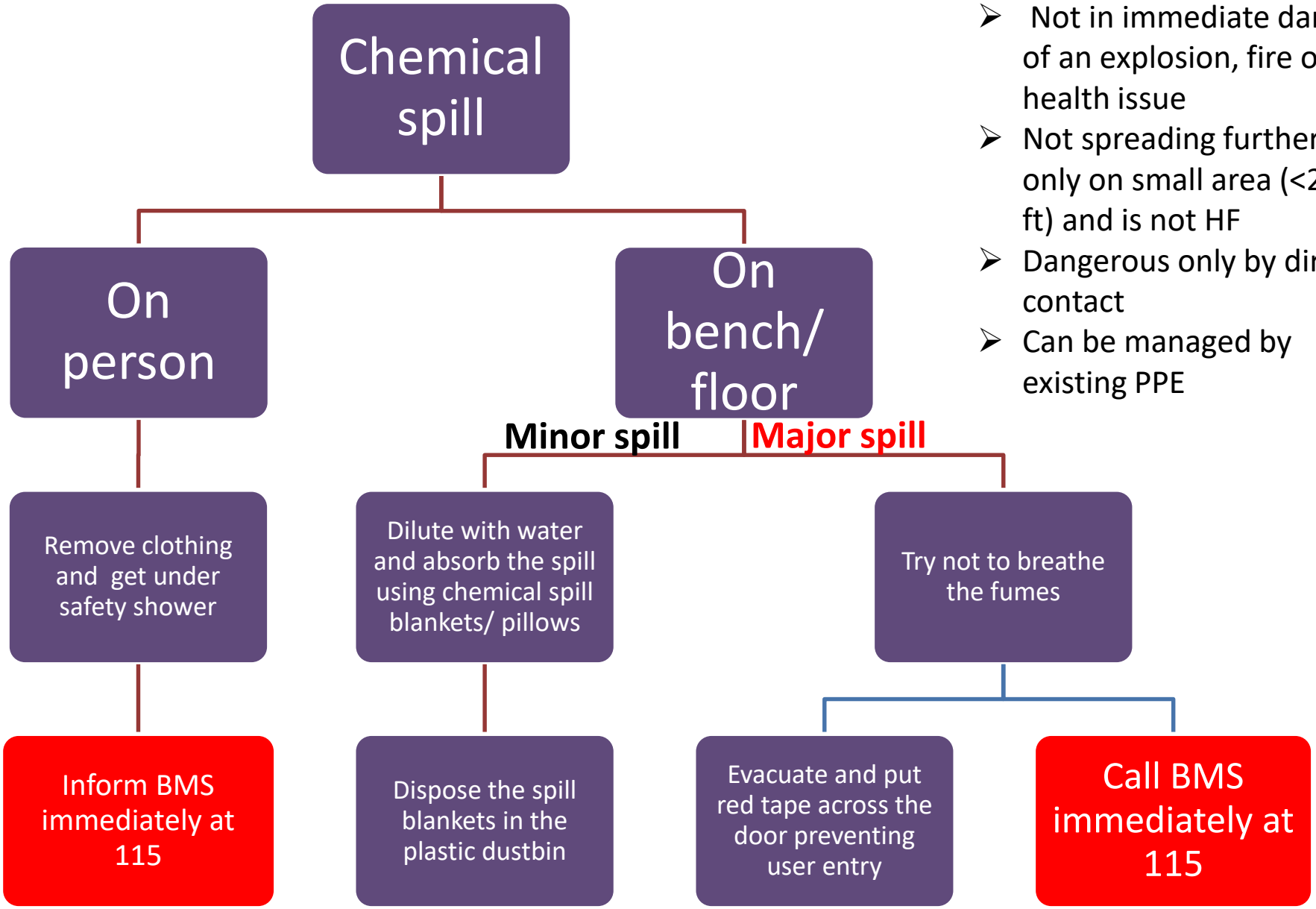
On skin contact , wash with large amounts of running water (minimum 15 minutes) and contact BMS. PPE's mandatory at developing stations

Photoresist /Developer Handling Protocols

- *Its mandatory to wear two set of gloves inside the Litho Bay along with chemical resistant sleeves.*
- *Ensure photoresist/developer contaminated gloves and wipes are disposed in the dedicated bin, which is located inside the spin coater work station under exhaust.*
- *Do not touch the tools, computer, face shield or any other object or document with photo resist contaminated glove, failing which lead to penalty.*
- ***Never keep the PR containers near the HOT Plate!!!***
- ***Never displace the resist from its designated place.***
- ***Do not leave developer/Resist bottle open….!!!!***

Responsibilities: Independent user

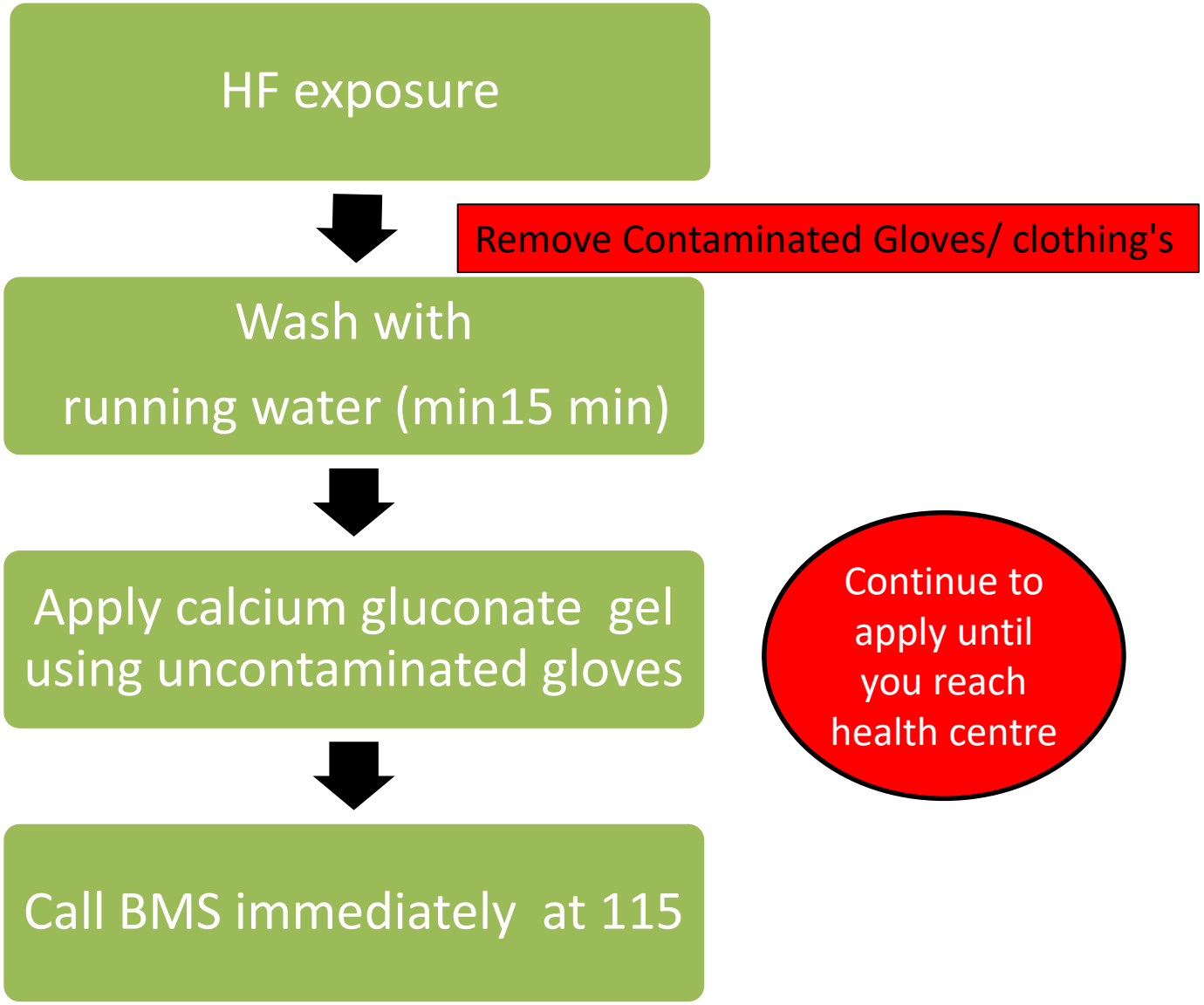
- Independent user is responsible for the tool during non-office hours
- <u>Undergo Re-orientation every year.</u>



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 spill on Body



List of emergency personnel and Local officials

	Contact	Number
IISc	ERT Team	EPABX: 115 P: 080-23229333-24
	Engineering	EPABX: 128/114/113 P: 8971118917, 9535550474, 9901011042, 7795385941
	IISc safety control room	5555, (080-22935555)
	IISc Security	080-22932400/080-22932225 CSO: 9845450888
	ICU on Wheels (IISc)	8147665421
	OLSEH Office	080-22933199
	IISc Health center/Ambulance	080-22932390/080-22932227 CMO: 9845109752 MO-9448430922
	CCMD	2345, 2206
	Electrical Engineer	9448697395, 9663071172
	Estate officer	9845376377
Outside	Yeshwanthpur fire station	080-101, 080-22971544
	Sadashivanagara police station	080-100, 080-22942589
	Ambulance	080-102 080-108
	Mallya Hospital	080-22242325
	M. S. Ramaiah Hospital	080-23608888
	Manipal Hospital	080-25211200
	Columbia Asia	080-39898969
	Narayana Hrudayalaya	080-27835000-18


THANK YOU


BE ALERT
DON'T GET HURT