

**RIT**

**Semiconductor and  
Nanofabrication Laboratory**

# Standard Operating Procedures

**Rev. O –8/10/23**

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## I) Introduction

This RIT SNL Standard Operating Procedures document is intended to instruct users of the SNL facility on its operational and safety policies. All users are expected to have read and understood the contents this document. The SNL contains hazardous materials and sensitive equipment that is used by many people. The purpose of this document is to define policies and procedures that will enable all users to work safely without damage to themselves, others, or the equipment. As always, common sense applies. If something doesn't seem correct or you observe unsafe behavior or conditions, users are expected to bring the matter to the SNL staffs attention.

User's feedback on the facility and operation are always welcomed. You may direct your comments to any member of the SNL staff.

As always, the number one rule for working in the SNL is **"If you are unsure of what you are doing, stop and ask"**

## II) Emergency Contacts

### For all

- Emergency Chemical exposures
- Fire
- Situations where immediate medical treatment is required.
  
- Initiate the appropriate procedure and then dial **333** from any campus phone.
  - Dial 475-3333 from a cell phone.
  
- If time permits, contact
  - Thomas Grimsley – 585-314-2473

### For Facilities / Tool Issues

- Contact the appropriate Tool Engineer
- Off hours – use the Emergency Call in List
  - Found on the website at
    - [SNL Call in list](#)
  - Posted near the lab phones

### For Access / User Issues

- Contact T. Grimsley – 585-314-2473

### III) SNL Safety Policy

The Staff and Management of the RIT SNL, along with other RIT groups have put into place controls, procedures and policies to provide a safe working environment for all SNL users

It is the responsibility of the SNL users to be familiar with the information in this document and conduct themselves in a professional and safe manner at all times in the lab.

Users that violate the safety and operating rules of the SNL could be denied further access to the lab at the sole discretion of the management.

### IV) Standards

This laboratory operates under the OSHA Laboratory Standard, 29 CFR 1910.1450 ([www.osha.gov](http://www.osha.gov)). This standard establishes the rights of laboratory workers and directs laboratory management to set up training programs, monitoring, and other actions. It also requires that the lab have a Chemical Hygiene Plan. The SNL adheres to the RIT Chemical Hygiene Plan (maintained by RIT's EH&S department). This document supplements RIT's CHP.

We also operate under OSHA Laboratory Standard, 29 CFR 1910.1200 which stipulates how RIT communicates information about hazardous materials in the workplace.

- Chemical Inventory – performed by the SNL on an annual basis.
- Access to and handling of SDS
- Hazardous Chemical list – available from SNL or RIT EH&S
  - The SNL updates its Hazardous Chemical list on a yearly basis and reports the results to RIT's EH& S Department.
- Appropriate labels & warnings – “all chemicals labeled, all the time”
- Employee information and training

This document meets the requirements of the 1910.1200 and serves as the SNL's Written Hazard Communication Plan.

This document supplements and reinforces RIT's Hazard Communication found on the RIT EH&S website at

<https://www.rit.edu/ehs/>

This laboratory also conforms to the NYS Right to Know Laws. (passed in 1980) This document, along with the mandatory safety training and the available Safety Data Sheets (SDS) constitute sufficient notification and training.

- You have the right to request and receive information on the hazardous chemicals information that you might contact.
- You have the right to be informed of hazardous chemicals used in your work area.
- You have the right to have access to RIT's written Hazard Communication/Right-to-Know Program.

The Environmental Protection Agency has regulations that govern the handling of hazardous materials. The SNL makes every effort to meet these regulations and users of the facility are also expected to comply.

## V) Roles and Responsibilities

### RIT EH&S

- The RIT Environmental Health and Safety department is responsible for overall safety policies and procedures on the RIT campus. They also perform routine lab safety inspections and monitor and track the progress in addressing and deficiencies found.
- They assist the various labs around the campus in adhering to and meeting the requirements of the variety of local, state, and federal regulations.

### SNL Operations Manager – Thomas Grimsley

- The SNL Operations Manager is responsible for this document (SNL Standard Operating Procedures) and serves as the SNL's Primary Safety Officer. Once an issue has been identified, it is the SNL's Safety Officers responsibility to address and rectify the situation. Input is collected from the SNL staff on a yearly basis on needed changes to policies and procedures. These changes are then incorporated into the new version of the RIT SNL SOP. The Operations Manager is also responsible for safety training of users of the SNL. The Operations Manager reports to the KGCoe Dean and is a designated Chemical Hygiene Coordinator for the SNL and is also responsible for the SNL's yearly chemical inventory.

### SNL Staff

- All SNL staff are trained in the contents of this document and have contributed to the material contained within. All staff members are expected to be proactive in addressing any safety issues in the SNL.

## 1.0 Lab Access

### 1.1 [People in the SNL Fab](#)

Many different people use the SNL for a variety of purposes. The mission of the facility can be broken down into two main functions. The first is support the undergraduate and graduate level education that is offered a variety of programs at RIT. The second is to support research in at RIT. The following is a general breakdown of the types of people working in the SNL.

*Staff* – Full or part time employees of RIT

*Members* – People working on an approved project (or taking classes) in the SNL

*Students* - Students enrolled in an RIT program.

*Faculty* - RIT Faculty members.

*Academic Researchers* - Faculty from RIT or other educational institutions pursuing research in the SNL.

*Industrial Researchers* - Individuals from industry pursuing research in the SNL.

*Visitors* - Individuals visiting the SNL for a brief period of time and who are not associated with any SNL research project.

### 1.2 [Hours of Operation](#)

The SNL is staffed Monday through Friday, 8 am to 5 pm. The lab is available for off hour's usage Monday through Friday, 6am to 8am and 5pm to midnight, in addition to weekends, 6am to midnight. There may be times when the lab is shut down for maintenance or when there is limited access. Off hours access to the SNL requires other training and is given to those users that meet specific requirements. This is detailed in section 1.8

There are certain days when no staff might be present. These are Institute holidays such as Memorial Day, Labor Day, etc. In these cases where the Institute is officially open and no staff members are present, the SNL is then considered to be in Off-Hours mode and those rules apply.

The SNL will typically close at the end of the Spring Semester for campus wide facilities preventative maintenance. The SNL staff will also perform their yearly PM's at the same time and the lab will be closed to all users. There are other times of the year where maintenance on various facilities might be required. The staff will endeavor to give its users as much notice as possible on what systems will be affected and whether there will be a partial or full lab shutdown.

### 1.3 [Safety Training Requirements](#)

Safety training is required for all users of the SNL on a yearly basis. There are two types of training available to access the cleanroom:

- **Class Safety Training**
  - For those taking a lab in the SNL - basic safety training.
  - This level enables user to operate in the SNL under supervision of Instructor/TA/Researcher
  - No certification/login on tools.
  - Tool operation is done under the supervision of a Certified User for that tool.
- **Researcher Safety Training**
  - For those working independently in the SNL.
  - Appropriate for upper level students actively processing wafers in lab sections. *For example - MicroE students working on their senior project.*
  - Basic safety training along with SNL policies and procedures.
  - Able to be certified on tools.
- **Chemical Safety Processing**
  - Is available for those with a Researcher Badge – enables user to perform chemical processing in the Wet Etch Bays.
    - Contact T. Grimsley for a chemical use pre-test to see if you are ready
    - Users that pass this will be given a 1 hour tour of the wet etch bays and be informed on the information they will need to know to work with chemistry in the SNL Wet Etch Bays
    - Users will take a SNL chemistry test – similar in format to the researcher test.

#### Notes

- All lab users must pass a yearly safety test.
- You must have passed a safety test within the past year in order to access the facilities.
- Upon successful completion of the test, a safety badge identifying the lab user will be issued. A valid safety badge is required in the lab. It is good for one year.
- If you are found in the lab without a valid safety badge, you will be asked to leave immediately.
- Visitors will be escorted at all times by an RIT employee with a valid safety badge.

[This table sums up the types of badges and certifications in the SNL](#)

### 1.4 [Off Hours Sign In](#)

After hours lab users are required to sign in and sign out of the lab. This is to let emergency responders know who is left in the lab.

- All users who are in the lab during off hours will sign in when they entered (5pm for those who were in the lab) and sign out when they leave.
  - This includes those without Off Hours Access under the supervision of an OHS user.
  - TA's who have a lab section that extends past 5pm will take attendance for their lab section so that in the case of an emergency, they will be able to account for their students.
- The sign in book will be kept in the Gowning Vestibule of the lab.

## 1.5 [Off Hours Buddy Rule](#)

During normal operating hours (M-F, 8-5) the facility is staffed and users will not be in the lab alone.

After hours, the buddy rule is strictly enforced. Your buddy must be in the lab with you at all times and have a valid SNL safety badge. Being in the building doesn't count, neither does popping out of the lab for a quick break. If your buddy needs to leave the lab, you must also.

Your buddy doesn't necessarily have to be constantly by your side during your off hours processing. If processing in different bays, you should check on each other frequently.

The only exception to the buddy rule is the OHA or OHS with \* designation. This is covered in the section on off hour's usage.

## 1.6 [Member Communication](#)

All users of the SNL must provide a working email address. As members are certified on a particular tool, their email address is added to the distribution list for that tool.

The SNL staff will communicate with its users via the FOM software. Tool status is also updated on the FOM site. Specific news about a particular tool is generally sent to the certified users of that tool.

The main website is [www.snl.rit.edu](http://www.snl.rit.edu) Procedures, contacts and forms are generally found on our main website. Users can also find many of our documents on the SNL FOM system

## 1.7 [Visitors & Tours](#)

Visitors are welcomed but the SNL must be notified in advance. Tours are also welcome but must be arranged through SNL staff. Large groups can be disruptive in the lab and should be staged through the lab in smaller groups.

## 1.8 [Off Hours Access](#)

The SNL is only staffed from 8am to 5pm on Monday through Friday. It is recognized that users of the lab may need access to the facility outside of these hours. Everyone using the facility has received safety-training and has successfully passed a safety exam. In addition, use of any tool requires training and certification on that tool.

### Key Points

- Off hours access is a privilege granted to users at the discretion of the SNL management and is based on observations of the candidate's maturity and technical knowledge as demonstrated by their work in the SNL over an extended period. Off hours users will be expected to have a higher level of safety awareness.
- Users that do not have off hours access can find someone with OHS willing to supervise their use. It is not the responsibility of the SNL staff to do this.
- Off hours access (and the \* modifier) is granted on as needed basis – it is **not** automatic and will not be granted to persons for the sole sake of convenience.
- As off hours access is a privilege, it can be revoked at any time for procedural and/or safety violations.

There are two types of off hours access. The first is designated as OHA. The second is designated as Superuser. The difference is as follows.

OHA – Must work with buddy that has OHA or is a faculty member supervising students.

In addition – the OHA can be modified with a \*. This designation means that the member may work alone in the lab during off hours for a specific reason. No chemical usage is allowed. It is granted on an as needed basis and is given for a specific reason or scope of work. The default is to always work with a buddy off hours.

Examples of acceptable reasons for requesting to work alone in the SNL off hours - \* designation

- Use of metrology tools
- Loading a PVD run
- Loading of Furnace run
- " I can't find someone to work with" is not a valid reason for requesting the privilege to work alone.

Superuser – These are lab users with a great deal of experience on the tools and our lab operations. They are well versed in our safety procedures. Superusers have off hours access and can supervise other users without off hours. They can also certify users on tools where they have demonstrated superior knowledge of the tools operation.

## Off Hours Responsibilities & Training

Off hours users must communicate with each other about what they are doing and when they are leaving. Do not leave the lab without checking to see if you are leaving someone alone.

If you turn on a tool or use a tool, you are responsible for shutting it down or putting it in an idle state. At 5pm, the default state for tools in the lab is OFF unless a user is actively using the tool. SNL staff will do the 5pm walk through and put every tool in its idle state as defined in the tool manual.

When you and your buddy leave the lab together, a walkthrough is required if you are the last ones out of the lab. This procedure is in the lab and is also located on the SNL website. It involves turning off hotplates, chemical baths, pumps, etc throughout the lab.

The SNL lab shutdown procedure is available in gowning and is also online at [www.SNL.rit.edu](http://www.SNL.rit.edu)

### 1.8.2 Process for obtaining off hours access - OHA

1. SNL user with active project in lab. Must have worked in the SNL F on an active, consistent basis for at least one previous semester.
2. Is a Certified Operator on two "Base level" tools. (student requirement only)
3. Is a Certified operator on one "Upper level" tool. (student requirement only)
4. Letter of Recommendation from Faculty Member. (student requirement only)
  - a. Demonstrated reason for off hour's access.
  - b. Candidate has demonstrated history of safety awareness, relevant training, etc.
  - c. Faculty member attests to the candidate's responsibility and maturity.
5. Candidate has SNL Staff sponsor
  - a. Can be any member of SNL staff.
  - b. SNL Staff member attests to the candidate's responsibility and maturity.
  - c. Sponsor signs off on Letter of Recommendation
6. Consensus on candidate is reached between SNL staff.
7. Off Hours Access conferred by SNL management
  - a. Responsibilities are reviewed and signed.
  - b. Badge identifies them as having OHA.
8. User is trained in after hours procedures
  - a. Sign in & out in NW vestibule
  - b. People are signed into lab along with "buddy" responsibility
  - c. Trained in lab shutdown procedures and emergency procedures
9. Notes
  - a. OH status can be revoked for safety / procedural violations.
  - b. After hours card access to the lab.
  - c. Some requirements may be waived for relevant industrial experience

### 1.8.3 Off Hours Emergency Procedures

The following procedures are to be used by off hours users for various emergencies that might come up in the facility. All users are trained in emergency procedures but it is the expectation that the off hours users are capable of handling these emergency situations.

- Fire
  - Alarm – Exit cleanroom & meet outside NW Doors
  - Alarm – Shepherds people out of lab.
  - Actual Fire – Presence of mind to pull alarm
- Toxic Gas
  - Alarm - Exit cleanroom & meet outside NW Doors
  - Alarm – Shepherds people out of lab.
- Scrubber failure
  - Exit cleanroom & meet outside NW Doors.
  - Alarm – Shepherds people out of lab.
- Chemical Spill
  - Calls RIT Public Safety & SNL Staff Member
  - Exit cleanroom & meet outside NW Doors
- HF & Chemical exposure
  - Assists in emergency treatment of exposed area
  - Flushing & showering & applying appropriate HF treatment
  - Ensures that RIT Public Safety & SNL Staff Member is contacted
  - Meets with emergency crew & has SDS
- Chemical Reaction
  - Monitors situation & contact SNL Staff
  - Pull alarm if situation is getting worse
- Medical Emergency
  - Render aid and contact Public safety
- Power Failure
  - Puts lab/equipment in safe/idle condition when generator kicks in
  - Exit cleanroom
  - Contacts SNL Staff Member through call in list
- Loss of other facilities
  - Contacts SNL Staff Member through call in list
  - Able to go through SNL Facilities Playbook with support.

## 1.9 [Infractions](#)

Violations of SNL policies will be taken seriously and could result in loss of lab access. Please encourage proper lab usage and report any serious violations to the SNL staff. Forms for doing this are located on the website and in the SNL gowning area. The following procedure will be used by SNL management.

- Users that violate SNL safety policies will be given either a reminder or a warning.
- Upon receiving a warning, the user will be notified in writing. The user's advisor/supervisor will also be informed.

### 1.9.1 Actions that will result in a verbal reminder

- Safety glasses on top of users head.
  - Wearing open toed shoes in cleanroom – user will be asked to leave cleanroom to change footwear.
  - Forgetting to wear your badge in the cleanroom (assuming you have one).
  - Minor improper lab protocol (hood not tucked in)
  - Using lab phones for non-business purposes.
- This list is not all inclusive. A reminder may be issued for any act that is not in keeping with SNL lab policies.
  - Constant reminders to a user about a particular issue will result in a warning.

### 1.9.2 Actions that will result in a warning.

- Improper use of PPE (Not wearing any PPE while performing chemical work) leaving PPE on center table, not rinsing gloves after use, wearing PPE outside of Wet Etch Bays).
  - Improper chemical handling (not labeling chemistry, head inside hood/over heated bath, dipping/pipetting from chemical baths, improper waste disposal).
  - Major improper use of card swipe (loaning someone your card, taking/using someone else's card for the purpose of letting uncertified users on a tool or charging other projects for your time).
  - Processing with an expired safety badge or with a Visitors badge. In the case of a Visitors badge, the sponsor/host/TA will also be given a warning.
  - Improper lab protocol - in cleanroom without suit
  - Any action that results in damage or injury that was negligent in nature and not accidental.
- This list is not all inclusive. A warning may be issued for any act that has a higher potential for harm to users or equipment.

- First Warning
  - Lab user is informed in writing about the warning.
- Second Warning
  - Lab user is informed in writing about the warning.
  - Off hours privileges are lost if Lab user had OH status.
- Third Warning
  - Lab user is informed in writing about the warning.
  - Safety badge is removed.
  - Safety certification is lost. User must go through new user training.
  - Tool certifications are lost. User must go through tool certification again. SU on second certification must be different than the original.

Any serious safety violation may result in immediate loss of privileges and lab access. This is at the discretion of the SNL management.

Serious intentional safety violations may result in the permanent loss of SNL access.

## 2) Projects

### 2.1. [Project Proposal Process](#)

All use of the SNL facility must be reviewed and approved. The process is outlined below. Please determine which customer class you fall under.

#### 1. External User

This model is appropriate for commercial or external academic users that want to do their own work in the SNL. This model does not include any IP arrangements.

- Discussion of use of lab and processes to be performed.
- Quote issued for use of lab, arrangements for payment are made.
- Work performed by customer after safety and tool training.
- Charges incurred - invoice sent out on a monthly basis
- Documents required
  - SNL Quotation (signed & returned)
  - Customer Purchase Order or VISA/MC
  - Signed [SNL Visitors Agreement](#)

#### 2. Commercial Design & Fabrication Services

This model is appropriate for commercial users that wish to have SNL perform their processing. This model does not include any IP arrangements.

- Discussion of processes to be performed and agreement on specifications.
- Quote issued for use of lab, arrangements for payment are made.
- Work performed by SNL staff.
- Charges incurred - invoice sent out on a monthly basis
- Documents required
  - SNL Quotation (signed & returned)
  - Customer Purchase Order or VISA/MC

#### 3. Sponsored Research

This model is for faculty engaged in sponsored research either through funding agencies or corporate sponsored. All of this work must be set up through RIT Sponsored Research Services.

- Discussion of processes to be performed with researcher. Match scope of work with capabilities of SNL.
- Work performed by researchers after safety and tool training.
- Charges incurred - journal entries made against researcher's project on a monthly basis.
- Documents required
  - [SNL Project Form](#) (signed & returned – includes Oracle charge account)

## 4. Unfunded Work

This model is for faculty and students engaged in exploratory research, faculty development, or class development. It represents an investment on RIT's part in the researcher.

- Discussion of processes to be performed with researcher. Match scope of work with capabilities of SNL.
- Includes tool time only, supplies supplied by researcher.
- Monthly Usage Fee and safety training fees apply
- Documents required
  - [SNL Project Form](#) (signed & returned)

### 2.2. [SNL Visitors Agreement Form](#)

External lab users must fill out the [SNL Visitors Agreement](#) before they can perform any work in the lab. The form must be signed by the SNL Lab Director, the proposed lab user, and a corporate officer from the lab user's firm. This form can be found on the SNL website.

### 2.3. [Orientation & Safety Training](#)

All SNL lab users (students, external, and faculty) must go through safety training on a yearly basis. Researcher as well as Class Training is offered quarterly as well as the refresher training course for those that have gone through the Researcher Training. All users must take the safety exam and receive a passing grade before a valid safety badge is issued

### 2.4. [Project Codes & Tool Access](#)

Once your project has been approved / all needed forms signed, you will be issued a project account. For funded internal users – it will be the full Oracle 24 digit project code. Unfunded/Class and External accounts will receive a project code similar to the Oracle 24 digit project code. Subsequent tool usage in the SNL will be charged against your project.

- Users may have multiple projects. Do not mix accounts; choose the right one for the work you are performing.
- Time should only be logged against the appropriate project.
- Access to the tools is done through the SNL FOM Access system which is described in Section 4.1
- The procedure for becoming certified to use a tool is described in section 4.6.

## 3 SNL Cleanroom Procedures

### 3.1 [Entry to the Gowning area](#)

There are some simple things that must be done before entering the gowning area.

1. Footwear
  - a. No sandals or open toed shoes. Shoes with mesh tops aren't the best.
  - b. No hiking boots – do not track mud, slush, water, etc. into gowning anteroom.
  - c. Flat or low heeled shoes only.
2. Long pants should be worn under your cleanroom suit.
3. Leave all coats, backpacks, hats, cardboard boxes outside the cleanroom.
4. Once in the anteroom, put on blue shoe covers.

### 3.2 [Gowning and Appropriate Dress](#)

As people can be the primary source of contaminants in a cleanroom, proper gowning is essential.

1. If you don't already have a set of cleanroom garments, obtain a new hood and new gown from the storage cabinet in gowning.
2. Put the cleanroom hood on first, long hair should be contained in a bouffant cap. These are located near the glove containers.
  - a. Persons not engaged in instruction should wear a separate face mask if one is not integrated into the hood. This prevents spittle from getting on the users wafers while talking.
3. Place your feet into the gown and pull over your body. Do not let the gown touch the floor. When the gown is completely zipped up, your hood should be inside. Use one of the mirrors in the gowning room to check if needed.
4. Sit on the cleanroom bench and put the cleanroom boots on over your shoe covers.
5. Obtain a pair of cleanroom gloves from the storage containers and put them on. At this point, do not touch your face/exposed skin with the cleanroom gloves. You can spread skin oil / salt to the tools and wafers.
6. Cleanroom gloves are required at all times in the cleanroom. Should your gloves become torn or contaminated, replace them immediately. The gloves provide some protection from chemistry but are not used as such in the chemical bays. There are other, heavier gloves for working with chemistry.
7. Obtain a pair of safety glasses (meeting the ANSI Z87 Standard) and put them on. Safety glasses are required at all times in the cleanroom. The safety glass may be removed when using a microscope.
8. Step on the tacky mat before entering the cleanroom. Once in the cleanroom – do not open your gown

When you are done in the cleanroom,

1. Remove your cleanroom garments in the reverse order.
2. Place your garments neatly into one of the wire rack bins with your safety badge clipped to the front to identify these as your garments.
3. Do not store wafers, personal materials in the garment racks. There are other places for these.

### 3.3 [Appropriate Cleanroom Materials](#)

- Certain materials are not appropriate for the cleanroom and should not be brought into gowning or the cleanroom.
  - No Paper
  - No Cardboard
  - No Foam or packing peanuts
  - No Pencils & Erasers
- Cleanroom notebooks, cleanroom paper and laminated paper are acceptable.
- If there is any question whether something is compatible, ask an SNL Staff Member,

Items brought into the cleanroom should be wiped down with Isopropyl alcohol first. This includes cell phones and laptops. IPA and wipes are available in gowning. Dispose of the wipes in the waste solvent can.

Wafers should only be handled with tweezers or vacuum wands – not with your gloved hand.

### 3.4 [Project Storage](#)

Storage space is limited in the SNL and we ask that researchers consolidate their research materials as much as possible. Researchers will be assigned a storage space upon request. Please use only the space assigned to you and do not help yourself to other spaces you may find.

Do not store your wafers in the garment racks. These are purged at the end of each quarter.

- Classes should use the cabinet assigned to them.
- Seniors should use the cabinet for their project storage.
- Researchers should use the space allotted to them.
- Do not move other users items to make room for yours
- All of the material belonging to your research projects should be clearly labeled.
- Do not put any materials on top of the cabinets
- Make sure your materials are labeled with your project/name. Un-labeled materials will be removed for disposal or recycling.
- User specific chemistry is to be cleared through our imported chemical process before being brought into the facility (Sections 3.9 & 3.10). Chemicals are to be stored in the appropriate chemical cabinets located in the SNL, not in your gowning cubicle or your storage area.

### 3.5 [Phones](#)

There are currently several types of phones in the cleanroom.

- Intercom phones – in each processing bay near windows, only work from phone to phone, no outside line. They will not reach RIT Public Safety in case of an emergency.
- Lab Phones – There are two, both capable of calling outside the cleanroom. One is located on the wall in between WEI & WEII. The other is on the wall opposite the ion implanter.
- The Lab phones are not to be used for personal calls. They are there for staff communication and emergency use. They can be used to call SNL staff or PI's for questions.
- Cells phones are permitted in the lab with the exception of the wet etch bays. We ask that you move into the back hallway or gowning to make and receive calls. A reminder, your cell phones are a source of contamination and distraction. They should be wiped with isopropyl alcohol before bringing into the cleanroom.
- Do not open your gown to get your cell phone in the cleanroom.
- No ear buds or headphones are allowed in the cleanroom.

### 3.6 [Emergency Exits](#)

There are several emergency exit doors that lead from the cleanroom to the main building hallway. Opening these doors breaks the cleanroom seal and will let in contamination. Do not open them for any other purpose. There is an intercom phone next to the all of the windows for conversations with people in the outer hallway.

### 3.7 [Behavior](#)

Professional behavior is expected at all times from SNL users. Common sense and common courtesy will get users through most issues.

If you see something that needs to be addressed, please bring it to our attention. If chemicals are running low, let us know.

Should users observe others in the lab not following proper procedures, they should politely remind each other of the correct method. Contact the SNL staff if this does not rectify the situation or there is a disagreement on what the procedure should be.

Radios, MP3 players, etc are not allowed in the cleanroom. Listening to music on the SNL computers is also not allowed.

The use of headphones/ear buds under your cleanroom hood is also not allowed.

Laptop computers are allowed but must be wiped with Isopropyl Alcohol before bringing into the cleanroom. Do not place laptops on the benches in the wet etch bays – portable tables are available.

Users are expected to clean their area when their work is done and to put all materials/labware where it belongs.

### 3.8 [Computer Usage](#)

The computers in the cleanroom are to be used in the support of research and operation of the facility. Browsing the web and the like should be done on your own computer.

### 3.9 [Chemical Storage](#)

Chemicals used in the SNL facility have their appropriate storage areas. Chemicals are not to be stored in your project storage area.

Due to stability and performance issues – particular chemicals will be disposed of after a certain period of time.

- In general, photoresists will be disposed of 4 years past their expiration date unless a good case may be made for the materials continued storage.
- Solvents will be disposed of two years past their expiration date or if their bottles become badly deformed.
- Hydrogen peroxide will be disposed of past its labeled expiration date.
- Chloroform will be disposed of past its expiration date.
- Any chlorinated solvent purchased for a project will be disposed of once it is past its expiration date or at the completion of the project.

### 3.10 [Bringing Chemistry into the SNL](#)

The SNL has a large number of chemicals available for use in the facility. There may be times when a chemical needed for a project is not stocked in the SNL. A list of SNL chemicals can be found on the SNL website.

Before any chemical can be brought in, it must be signed off by the SNL. [This applies to all users whether they are internal or external.](#) The following is a guideline of what must be done in order for chemicals to be brought into the SNL. All of this information is contained within the [SNL Imported Chemical Form](#). Fill this out and return to the SNL before ordering.

- 1) SDS is provided to SNL.
- 2) Detailed plans of how the chemical is to be used.
  - a. Process conditions.
  - b. Handling of the chemical.
  - c. Manual or bench baths.
- 3) Storage of the chemical.
  - a. Timeline
- 4) Risk Assessment
  - a. Tools (including downstream)
  - b. Personnel
- 5) Disposal of the chemical.
  - a. Used and unused material.
  - b. RIT waste stream or other.

Only approved RIT personnel may purchase chemistry. RIT's EH&S has a process through which RIT employees become certified chemical purchasers.

The chemical will eventually need to be disposed of. This cost will be born by the user. We will periodically purge our chemical storage cabinets of imported chemicals. If you are not currently using the imported chemical, it will be disposed of.

Once the chemical and its use have been approved, the chemical shall be labeled appropriately for storage in the SNL. If the chemical is transferred to another container, that too shall be labeled with the Chemical Name, User, etc.

Chemicals should be ordered in minimum quantities as to reduce exposure and disposal costs.

Chemicals should also be transported by proper shipping methods. [Do not show up with bottle in hand!](#) An approved carrier with proper documentation should ship the materials directly to the SNL. Please refer to the US Government DOT website for shipping requirements.

Failure to follow this guideline will result in unnecessary delays. We will not make exceptions and will remove any unauthorized materials that are found in the lab. Possible suspension of lab privileges could also result.

All chemicals must be checked in by SNL personnel before being brought into the cleanroom.

## 4 Equipment Policies

### 4.1 [SNL Tool Control System](#)

The SNL FOM Access System is used to reserve and enable most of the tools in the facility.

#### 4.1.1 [Requirements](#)

- Users must be certified on the tool before use. (Section 4.6)
- You must have a current SNL safety badge. The system will automatically reject any user who has an expired safety badge. Safety badges are valid for a period of one year after they are issued. (Section 1.3)
- Users must have an active project account. (Section 2.4)
- Users will need their RIT login credentials to log into the RIT FOM system.
- [Instructions on how to set up an account in the FOM system are here.](#)

Your system screen will look similar to this below.

The screenshot displays the 'RIT - FOM - User Home' interface. On the left is a navigation sidebar with options like 'eviltom Home', 'Collaborate & Service', 'Purchase Supplies', 'Chemicals', 'Lending Items', 'Documents', 'User Report', 'My Profile', 'My Accounts', 'Contact Manager', 'Software Feedback', and 'Logout'. The main content area is titled 'Authorized Resources (Click to view schedule)'. It includes a search bar and a list of resources categorized by facility:

- SMFL**
  - Dry Etch - Room 2720
    - STS ASE (Day time user) - Available
    - Technics PE2A Etcher (Day time user) - Down
- Facility** - Room 2700
  - SMFL Facility Maintenance (View only) - Available (Note: Lab is up in limited mode - certain tools are available)
- Lith**
  - Room 2730
    - GCA Stepper (Day time user) - Available (Note: 8/8/23 - Annual PM is from 8/14 through 8/18)
  - Room 2750
    - ASML Stepper (Any time user) - Down (Note: 8/8/23 - Annual PM will be 8/21 through 8/25)
- LPCVD** - Room 2770
  - Tystar LPCVD (Day time user) - Down (Note: 8/14/23 - Install in progress - Quote received for gas line welding, quote being prepared for exhaust tube work, tech running power. Chiller to be ordered for cooling water.)
- Thermal** - Room 2770
  - AG 610 (Day time user) - Down
  - Bruce Furnace Tube 5 (Any time user) - Down
  - Bruce Furnace Tube 8 (Day time user) - Down

You should see the tools you are certified on, their status, if they are in use, and notes from staff concerning the tools.

If you click on one of your tools, it will bring up the tool calendar, you may make a reservation on the tool from any computer.

#### 4.1.2 Logging into tools and logging out

- Your reservation is good for a certain time period (15 min) before it is cancelled. Please be accurate with your reservations and arrive in the cleanroom to turn your tool on.
- You can open up the FOM system from any of the three stations in the main cleanroom hallway – you are not limited to which station you use. These are the only computers that can be used to login and logout of tools.
- Once you are logged into the FOM system – go to your reservation.
- Click on the reservation and hit the login button.
  - The tool is now enabled and you may begin processing.
- Once you are done with the tool, return to a FOM workstation, go to your reservation and log out of the tool. You may add comments to the staff at this time about the tool performance – process time corrections, etc.
- If you forget to logout, the system will do so after a certain time period has expired – it varies from tool to tool, do not just leave the tool when you are done – please log out.
- If no one is using the tool or has an upcoming reservation in the very near future – you can do an express logon and create a reservation and immediately start using the tool.
- [Detailed instructions can be found here.](#)

Some notes;

1. Tools cannot be reserved more than one week in advance without clearance.
2. Reserving tools off hours is restricted to those users that possess off hours access only.
3. Please delete your tool reservation if you are not able to use the tool.
- 4. Do not add any project accounts in the FOM system. If you do so and then use that account for charging tool time, you will be removed from the FOM system and your access to the SNL will be removed as well.**

## 4.2 [Tool Malfunctions](#)

- There are times when a tool is down due to a problem or for preventative maintenance. The tool will be marked as unavailable in the FOM system.
- If the tool is experiencing a problem – it will be marked with a “red tag”. It could be that the tool is malfunctioning or is being upgraded. This is a slip of paper entitled “Tool Down for Maintenance/Repairs” because it is printed on red paper, it is commonly referred to as a red tag.
- If the tool you are working with becomes inoperable or is not performing as expected,
  1. Fill out a red tag and place it on the tool.
  2. Please fill out all sections
  3. Make the SNL Staff aware of the problem – it will be marked down in the FOM system

Users will not operate any tool that has been marked with a red tag. Only SNL Staff can remove the red tag and release the tool for use.

## 4.3 [Lockout – Tagout – LOTO](#)

- "Lockout/Tagout (LOTO)" refers to specific practices and procedures to safeguard employees from the unexpected energization or startup of machinery and equipment, or the release of hazardous energy during service or maintenance activities.
- When an SNL tool is being repaired, it might be necessary to lock the tool down so that SNL personnel are not subjected to electrical, mechanical, chemical hazards while working on the tool.
  - An example would be when SNL staff are working on the electrical system of a tool, the power to that tool would be turned off (and locked out) at the main disconnect or breaker panel. This would prevent the staff member from an electrical hazard from either coming into contact with a live power source or having someone mistakenly turn the tool on.
- A tool that has been disabled in such a fashion to prevent injury during repair or maintenance is in a Lockout – Tagout state and will be clearly marked as such. The SNL uses a red colored padlock to prevent breakers from being turned on, valves from being turned, etc.
- Only the person that did the LOTO may remove the tool from that state. If that staff member is unavailable, the Facilities Manager may do so.
- No other personnel other than those listed above may remove the tool from its LOTO state.
- A tool with a red tag is down for repairs, it may also be under LOTO depending on the problem. In either case, only the appropriate SNL staff member may remove the red tag and/or LOTO.

## 4.4 [Tool Modifications](#)

- Users are not to modify, change or alter any of the equipment in the lab for any reason. This includes removing any covers from the tools.
- Tools are to be run as specified in the various tool operating manuals. There will be no deviation from this.
- Users should never operate a tool without its safety covers in place. If you see this situation, please bring it to the attention of the SNL staff immediately.

## 4.6 [Tool Certification & Usage](#)

- Most tools in the cleanroom require formal training through the certification process before use.
- Non-certified users may operate tools under the close supervision (nearby!) of a certified user.
  - Do not swipe an uncertified user into a tool and leave them to work alone. If you swipe the tool operational, you are responsible for its use.

### 4.6.1 [Tool Training](#)

- The SNL currently does not have the resources to provide individual "ground up" training to users. It is the responsibility of the user to become familiar with the tool and its operation. This can be accomplished in several ways.
  - Reading the tool manual – in the lab or online.
  - Observing the tool being operated by other users.
  - Operating the tool under the supervision of a certified operator for that tool.
- The tool manuals are listed in the Documents section in the FOM system.
- SNL staff and Superusers are available to help with training on tools after the user has familiarized themselves with the tool. We will answer specific questions about the tool but will not answer the question "How do you run this tool?" We expect users to make the effort to understand the tool and its' operation through the resources listed above.
- Once the user feels that they understand the tool, they will be given a lab practical exam by the tool's SNL Staff Certifier or that tool's Super User. This lab practical is based on the certification sheet for that tool. The certification sheets are available on line for each tool and serves as a guide to what the user should know about the tool.
- Users must show proficiency and knowledge in six areas.
  - They know the specific hazards of the tool they are operating.
  - They know the circumstances under which they can damage they tool.
  - They know how to operate the tool.
  - They can recover from simple errors.
  - They can demonstrate knowledge of the processes performed with that tool.
  - They understand the appropriate uses of the tool.

Users are allowed (and encouraged) to use the tool manual during certification - we are not testing your memorization skills.

#### 4.6.2 Certified User Process Checklist

- 1) Candidate studies tool documentation.
  - a. Tool Manuals available online.
  - b. Tool certification forms available online.
- 2) Candidate observes operation of tool.
  - a. Listing of certified users is available.
  - b. Online tool reservations show when tool will be in operation.
  - c. Candidate can operate tool under supervision of certified user or SNL Staff/Super User.
- 3) Candidate user contacts SNL Staff Certifier/SNL Superuser for that tool.
  - a. Certifier will certify candidate upon successful operation of tool.
  - b. Certifier will certify from a checklist developed for that tool.
- 4) Candidate becomes certified user.
  - a. Tool is added to the users FOM account.

## 5 SNL General Lab Safety Procedures

### 5.1 General Safety Practices

- 5.1.1 All persons using the SNL will be instructed in emergency procedures, safety precautions, and specific hazards related to the SNL, equipment, and operations on a yearly basis.
- 5.1.2 The best safety precaution (Most Important) is to understand exactly what you are doing and the potential dangers. If you do not understand something or have any questions, STOP AND ASK.**
- 5.1.3 Protective clothing is required when working with chemicals and certain pieces of equipment.
- The cleanroom gowns do not protect you from chemicals – they keep the cleanroom clean.
  - No sandals / open toed shoes. You will be sent out for appropriate footwear. Shorts are not recommended. Running shoes with mesh tops are not ideal for working with chemistry.
  - Contact lenses are not recommended as they may trap chemistry next to the eye and interfere with rinsing.
  - Protective eye wear with side shields meeting the ANSI Z87 standard (impact resistance, etc) is required **at all times**. (with the exception of working in front of a microscope) Prescription safety glasses must be approved by SNL.
- 5.1.4 Never work alone – on or off hours. Off hours users are required to sign in.
- Lab hours are M-F, 8am to 5 pm.
- 5.1.5 When operating any piece of equipment, carefully follow the instructions on the operation manual. **ASK FOR HELP** if you have questions. Users are required to be certified on the equipment prior to use.
- 5.1.6 Users are expected to be proactive.
- Prior to using any chemical, understand the nature of the chemical, potential safety hazards by reading the SDS.
  - Understand the particular hazards for each tool by reading the tool certification sheet
  - Know the location of the SNL safety equipment – showers, eyewashes, etc
- 5.1.7 **All chemicals** in secondary containers (storage or process) **are to be labeled**.
- Proper labeling in the SNL includes:
    - An appropriate GHS compliant label
    - the owner
    - the date created
- 5.1.8 Inform SNL staff of any safety and/or equipment problems.
- We can't help you if you don't tell us
- 5.1.9 Lab phones are located in between Wet Etch 1 & 2 by the LPCVD tool and Line Maintenance.
- Lab phones are primarily used for emergencies but users can use them to contact their PI/Instructor
- 5.1.10 No food or drink in the lab or gowning.

## 5.2 [Lab Emergencies](#)

- 1) There are eight types of emergencies that a user will be trained to respond to in the SNL.
  - 1) Fire
  - 2) Toxic Gas Leak
  - 3) Scrubber Failure
  - 4) Chemical Reaction
  - 5) Chemical Spill / Exposure
  - 6) Fluorinated Acid (HF) Spill / Exposure
  - 7) Medical Emergency
  - 8) Power Failure

### **If the building alarm sounds, all persons are to immediately leave.**

The building alarm will sound immediately if

- a fire pullbox or smoke detector is activated
- a toxic gas leak is detected
- or if the fume exhaust scrubber fails.

### **If you see a fire or hear someone talking about an ongoing fire**

- Stay calm, do not run. If you panic – it spreads to others.
- Leave the building by the nearest exit and pull the fire alarm on your way out.
- Collect and inform other lab users on your way out the building to pull the fire alarm.

### **If someone's clothes are on fire**

- Roll person around on floor to smother flame, or drench with water if safety shower is immediately available.

## 5.3 [General Emergency Procedures](#)

- 1) Stay calm – get help from others if needed.
- 2) Do not put yourself in danger.  
*Is the person soaked in chemistry? Is the person bleeding? Where is the person located?*
- 3) Initiate **Appropriate Response** to emergency such as evacuation, first aid, eyewash, shower, fire alarm pull box, etc.
- 4) Call RIT emergency number X333 (or 53333) from any internal phone. Report emergency, nature of emergency and location (building and room number). The number from an outside line (cell phone) would be 475-3333
  - a) Cleanroom phones are located in between Wet 1/Wet Etch 2 & by LPCVD tool in diffusion.
  - b) Entrance to cleanroom is Building 17 (Engineering Hall), Room 2700
- 5) Be available to meet with the RIT emergency crew and tell them what happened. If a chemical is involved, provide the SDS to the emergency crew. Assign people to wait by the cleanroom entrance and the front entrance to the IT Collaboratory to guide help in.
- 6) Contact SNL Staff.
- 7) Fill out an accident report if applicable.

#### 5.4 [Appropriate Response – Fire, Gas, Scrubber](#)

- 1) If necessary, evacuate the building by using pull boxes – near the NE and NW exits of the lab and near all exterior doors of the building.
- 2) Put down work. Leave empty handed.
- 3) Immediately leave the building through the nearest exit – go through the emergency doors on the bays in the main hallway if necessary.
- 4) Avoid the NE exit of the building. Gas Storage area is located there.
- 5) Do not stop to take off your gown
- 6) Meet at the NW exit of the building for headcount.

This same procedure holds for a large spill (1 gallon or larger) of flammable or fuming chemistry.

#### 5.5 [Appropriate Response – Chemical Reaction](#)

If your chemical bath/process begins to react in an uncontrolled fashion (runaway, excessive fuming, flashes, fire) the following steps should be taken.

- Step back from the bench
  - If the bench has a sash, make sure the sash is down.
- Leave the wet etch area telling others in the wet etch bay to come with you.
- The owner of the chemical process should stand at the entrance to the wet etch bay and monitor the situation.
- Send someone to contact the SNL Staff.
- If during this time the reaction becomes increasingly uncontrolled, leave the building by the nearest exit pulling the fire alarm as you leave. Inform and gather others on your way to the alarm.

#### 5.6 [Chemical Spills](#)

Spills can be categorized two ways – Incidental or Emergency. If the liquid is unknown, do not assume it is water.

##### Incidental

- These are spills that pose little threat to human health, property or the environment.
- Generally small in nature of a known chemical with a 0 or 1 rating for health, fire and reactivity.
- Do not require any other special precautions beyond immediate cleanup.
- Do not disrupt routine operations.
- Only personnel trained in cleanup procedures and equipment may handle incidental spills.
- Contact the SNL Staff for any incidental spill.

##### Emergency

- Small or large spills of a known chemical that pose a health, fire, or reactivity hazard, oxidizers or unknown chemicals.

If you are not sure whether the spill is incidental or an emergency – assume it is an emergency and follow the procedures in Section 5.6

## 5.7 [Appropriate Response - Emergency Chemical Spill](#)

- Inform SNL staff – they will do cleanup.
- Let other lab users know about the situation.
  - The best way to do this is to get someone to stand near the spill to warn others until SNL staff arrives.
  - If off hours – contact campus safety

## 5.8 [Chemical Exposure](#)

Chemical Exposure can be categorized in two ways - Incidental or Emergency

### Incidental

- These are exposures to chemicals that pose little threat to human health.
- Generally small in nature of a known chemical with a 0 or 1 rating for health.
- Contact the SNL Staff for any incidental exposure.
- Student will be escorted to the Student Health Center by RIT Personnel.

### Emergency

- Exposure to a known chemical that poses a threat to human health and requires immediate treatment
- Chemicals with health ratings of 3 and 4 or long exposure to a chemical with a rating of 2.
- Unknown chemicals.
- RIT Public Safety will be called for ambulance service/transport to a hospital.

If you are not sure whether the exposure is incidental or an emergency – assume it is an emergency and follow the procedures in Section 5.9

## 5.9 [Appropriate Response - Emergency Chemical Exposure](#)

- 1) Immediately provide first aid.
- 2) Eyewash/shower for at least 15 minutes. Located in main cleanroom hall in between the processing bays.
- 3) Remove contaminated clothing/jewelry after a few minutes of rinsing. Not a time for modesty, clothing/jewelry will hold the chemical next to your body.
- 4) Rinse chemistry away from other parts of the body.

Should you spill chemistry on your gown but not on yourself, consider yourself lucky. Rinse the area so you can safely remove your gown and inform SNL staff. Do not place your contaminated gown in the laundry barrel in gowning.

We do have extra clothing (scrubs and crocs) in case your clothing is contaminated/wet – see SNL staff for assistance.

## 5.10 Appropriate Response - Fluorinated Acid Exposure

- 1) IMMEDIATELY rinse the contacted skin area with copious quantities of water, being careful to wash the acid away from other parts of your body, especially finger/toe nails.
- 2) Remove all clothing/jewelry exposed to the HF while rinsing in the shower.
- 3) Continue rinsing for ~ 2 minutes. Get the HF off the skin/clothes. Do NOT dry the skin.
- 4) Squeeze the Calcium Gluconate (Calgonate) Gel on the contacted area, cover the entire area with gel. Located on top of both the flammable cabinets in the Wet Etch Bays.
- 5) Use a double gloved hand to spread the gel, and gently massage it into the skin. Take the gel with you and continue to apply fresh gel while enroute to the Emergency Room.
- 6) For burns to the hands, retain gel in a glove.
- 7) Elevate burned extremities, if possible.
- 8) Call Public Safety, remember to send someone to bring them in.
- 9) Immediately go to the nearest Emergency Room. Have SDS.
- 10) Tell them you have Hydrofluoric Acid on you. Have SDS.
- 11) Continue to apply fresh gel (and gently massage it in) while waiting.



HF SDS &  
Information

There are four safety showers / eyewash stations in the SNL

- 1) In the main cleanroom hall between Dry Etch & Lith Bay 1
- 2) In the main cleanroom hall between Lith Bay 1 & Lith Bay 2
- 3) In the main cleanroom hall between & Lith Bay 2 & Thermal
- 4) In the Northeast Vestibule near chemical storage rooms



Between Dry Etch & Lith 1



In Northeast vestibule near chemical storage

### 5.11 [Appropriate Response – Power Failure](#)

- Put work station in safe condition
- Exit the lab through gowning. Degown.
- SNL staff will inform you when you can go back into the lab.
- For Power Flicker/brownout – stop work and move to gowning. SNL staff will let you know what tools are still available

The fire detection system, the security system, phone system, emergency lights, the fume exhaust scrubber, and both ASUs will be powered by a backup generator.

## 5.12 [Medical Emergency](#)

The first aid you administer to an injured individual should be limited to procedures necessary to stabilize and protect the person from further injury.

The instructions that follow are intended as guidelines for untrained individuals who witness or are personally involved in a medical emergency.

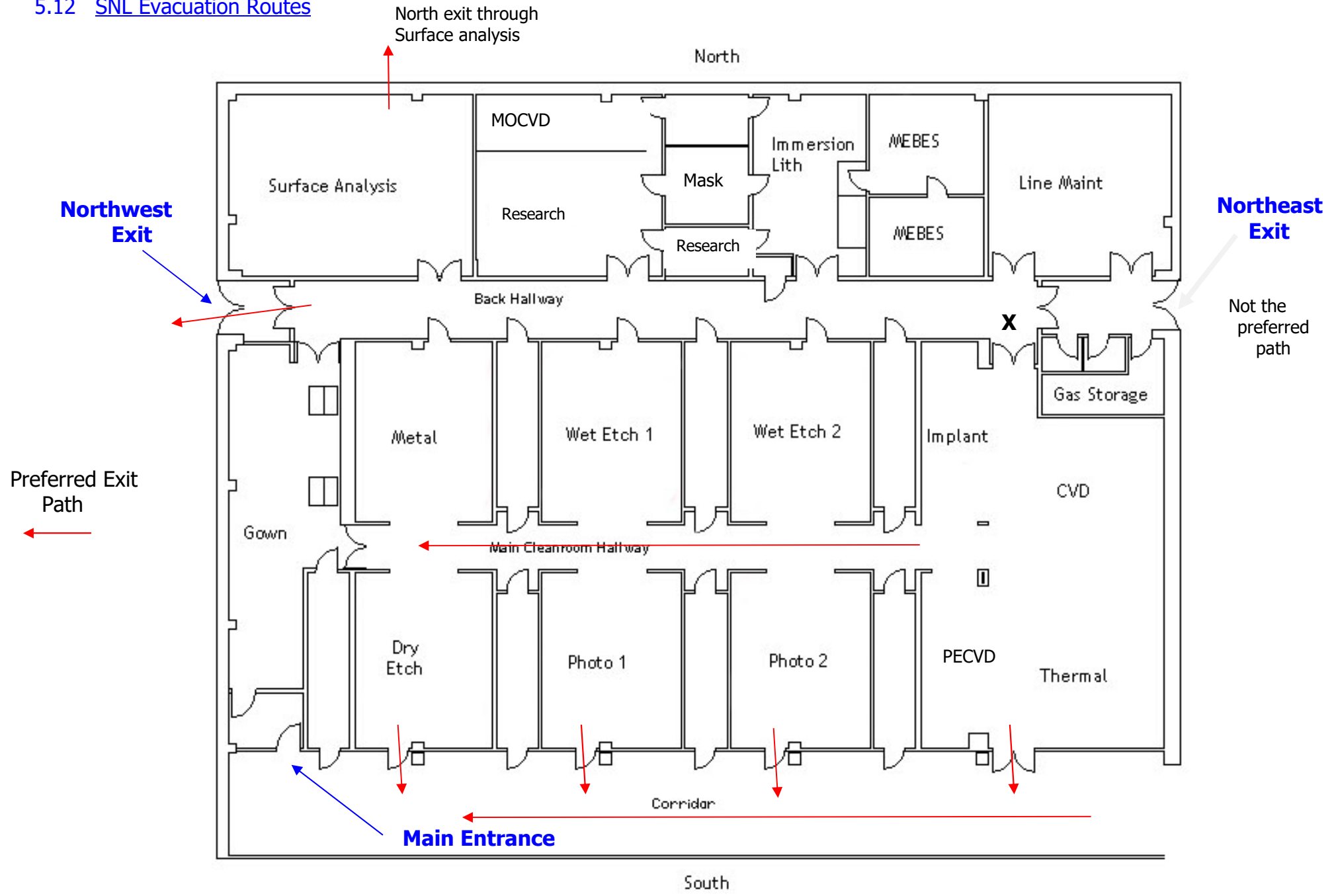
- Remain calm, when you are calm, others are more prone to be calm.
- **DANGER:** Do not put yourself at risk to help someone else. Assess the scene first. Do not help the victim or attempt a rescue unless you are **ABSOLUTELY** certain that the environment in which the victim is located is safe and does not represent a life-threatening situation for you.
- Get help from others in the cleanroom. Call for help if no one is visible. If no one responds, leave the person to call for help on a lab phone or stay with the victim and use a cell phone.
- Call the RIT Public Safety at 333 from any lab phone. (or 475-3333 from a cell phone). Briefly describe the incident, nature of the injuries and location of the injured person. Send runners to the front entrance of Gowning and the front entrance of the IT Collaboratory Building to escort the ambulance to the medical emergency site.
- Put on suitable personal protective equipment before coming in contact with the victim of a chemical exposure.
- If the victim appears to be unconscious, determine responsiveness by attempting to communicate in a loud voice. If the victim does not respond, place your hand near the victim's breathing zone to check for a sign of respiration. Do not move the person's head or neck in the process. Communicate this information to campus safety.
- If you detect the victim is not breathing and the heart is not beating - and you are properly trained in CPR - establish a clear airway and begin CPR.
- Do not move an injured person unless they are in further danger (e.g., advancing fire).

The SNL has a first aid kit located in the gowning room (red bag). It is primarily set up for bleeding injuries until medical personnel are on scene.

## 5.13 [Accident and Incident Reporting](#)

- All incidents involving injuries or chemical exposure must have an accident report filed.
  - RIT Accident Report is online and is also located in gowning.
  - For life threatening injuries (emergency chemical exposure, lacerations), RIT Public Safety will be called for ambulance service/transport to Hospital.
  - For non-life threatening accidents (incidental chemical exposure, minor cuts,etc), student will be escorted to the Student Health Center by RIT Personnel.
  - You will be asked to send a note to the SNL Operations Manager for an after action report.

## 5.12 SNL Evacuation Routes





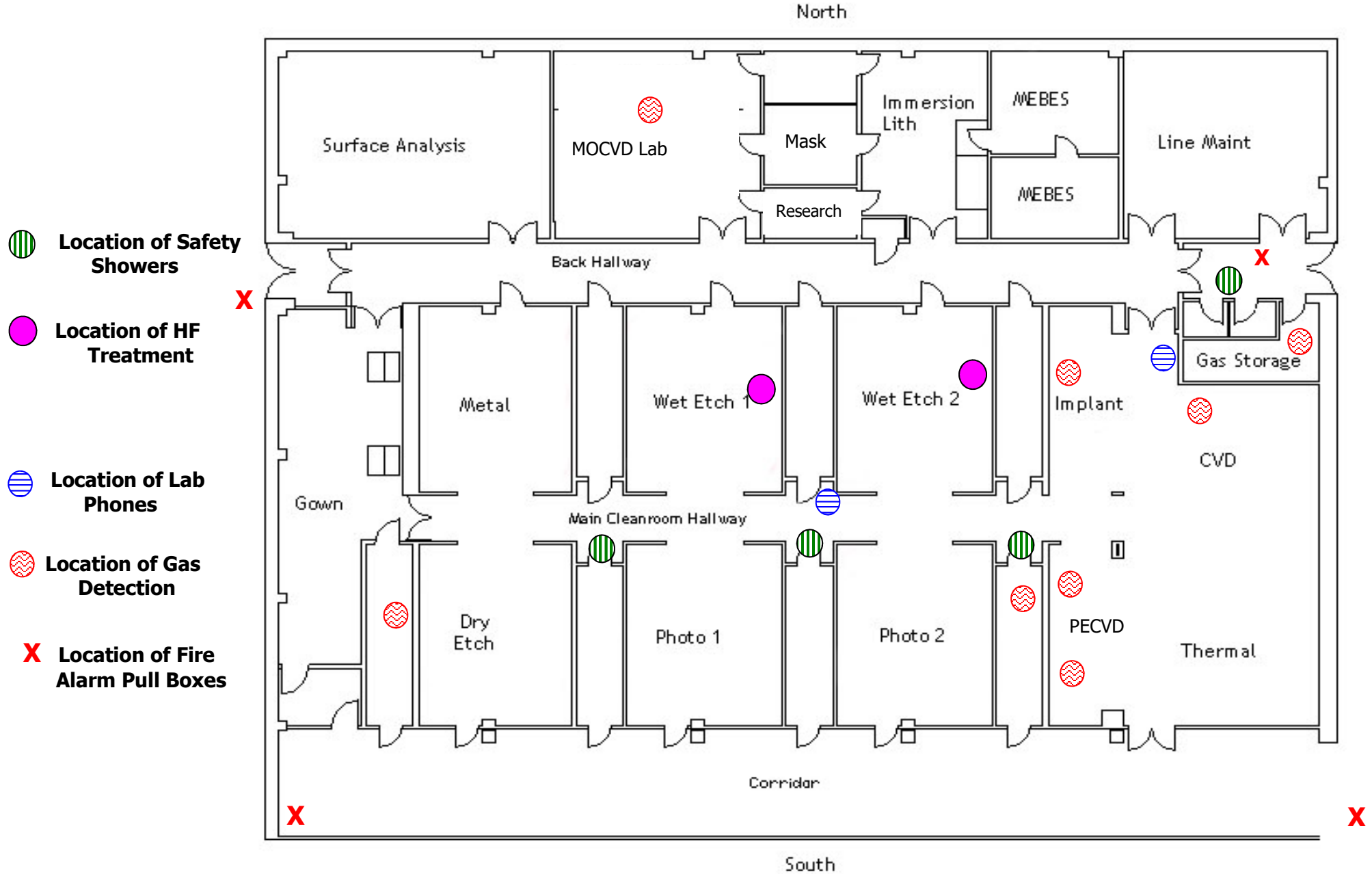
**Northwest Lab Exit – Looking out to outer hallway**



**Building 17 West Exit**

**SNL Lab Northwest  
Emergency Exit**

### 5.13 Location of SNL Safety Equipment





**Fire alarm pull-box Outside NW Exit**



**Safety shower & eyewash in between Lith Bay 1 & Lith Bay 2**



**In main cleanroom hallway in between Wet Etch 1 & Wet Etch 2**

**Lab Phones**



**In thermal room by Implanter**

## 6) SNL Chemical Safety Procedures

Working in the SNL may involve the use of hazardous chemicals. A hazardous chemical may be:

- Toxic
- Corrosive
- Flammable
- Reactive

There are many physical and health hazards associated with wet chemical processing and many ways of protecting oneself.

### 6.1 First Level of Protection – Knowledge of the Hazards & Safe Lab Practices

- The first and primary way of protection is knowledge. Know the hazards of the chemicals you are working with.
- Read the Safety Data Sheets (SDS) and any process data sheets on the chemistry you are using.
  - Information about the composition, specific hazards, means of protection, special hazards, physical data, incompatibilities, etc. can all be found in the SDS.

#### 6.1.1 Safety Data Sheets in the SNL

- SDS are provided by the manufacturer.
- The SNL enters the SDS into the FOM system.
- SDS's are most easily accessed on three computers in the cleanroom
  - Gowning – Room 2700
  - Photolith 1 – Room 2730
  - Photolith 2 – Room 2740
  - Any of the FOM computers in the main cleanroom hallway.
- Log on to the SNL FOM system – go to the chemicals page and download the SDS



Signs near computers that can be used to look up SDS

## 6.1.2 Types of Chemical Hazards – Health, Physical, or Dual

Chemistry can pose health or physical hazards. Some chemicals pose both.

### 6.1.2.1 Health Hazards

- *Corrosive* - any liquid or solid that has a pH lower than 2 or greater than 12.5 or has a severe corrosive rate on steel. Can cause serious skin burns.
- *Irritant* – non-corrosive chemicals that cause reversible inflammatory effects (swelling and redness).
- *Toxic* - substances that are poisonous to human beings or other animals. Some are poisonous to the touch; others are harmful if inhaled; still others are toxic only if swallowed. Some produce immediate sickness, while others may not cause obvious symptoms for months or even year. Hepatotoxins produce liver damage. Nephrotoxins produce kidney damage. Neurotoxins produce damage to the central nervous system
- *Carcinogen* - substances that are capable of causing cancer.
- *Sensitizers* - substances that over time will cause an allergic reaction.

### 6.1.2.2 Physical Hazards

- *Flashpoint* - the minimum temperature at which a substance gives off flammable vapors which in contact with spark or flame will ignite.
- *Flammable* - any liquid having a flash point below 100 degrees F.
- *Combustible* - any liquid having a flash point above 100 degrees F.
- *Pyrophoric* - Any material that ignites spontaneously in dry or moist air at or below 130 degrees F.
- *Peroxide Forming Chemicals* – Oxygenated organic compounds that will react with oxygen to form explosive peroxides.
- *Oxidizer* – A substance which will support combustion or will combust on contact with other materials – do not mix with flammables – can react with metals – doesn't always have oxygen. Gains electrons.
- *Reactive* – Any substance which releases great amounts of energy when exposed to other materials or with the addition of energy. (i.e. reacts violently with water or unstable).
- *Unstable* – Substances which will explode, violently decompose or polymerize with a small initiating force.
- *Compressed Gas* – Gas under pressure in a metal cylinder (rockets!)
  - SNL Users do not change gas cylinders
    1. Cylinders are to be strapped to the wall/tool when in use.
    2. Cylinder caps are on when cylinder is not being used.
    3. Cylinders are to be strapped to their carts during transport.
    4. Cylinders not in use should still be secured.



### 6.1.2.3 Physical Hazards – Fire

- Fire is the most dangerous hazard in the cleanroom – It requires:
  - 1) An oxidizing atmosphere
  - 2) Concentration of flammable gas or vapor within the flammability limits of the substance.
  - 3) Ignition source.
- Usually all three must be present simultaneously.
  - Exception is a strong oxidizer mixed with a flammable solvent. Reaction generates its own heat to start a fire.
- How to prevent?
  - Don't let these conditions exist simultaneously!
  - Solvents used under a fume hood.
  - Solvents are not heated.
  - No ignition sources near sources of flammable vapors.
  - Solvents are not kept near / mixed with strong oxidizers.

### 6.1.2.4 Physical Hazards – Organic Solvents

- Includes Acetone, Isopropyl Alcohol, Methyl Alcohol, Xylene, HMDS
- Are potentially hazardous because,
  1. They are generally flammable.
  2. They can be absorbed through unbroken skin.
  3. They target the organs and nervous system, stored in body where they are toxic.
    - Some are teratogens or carcinogens – read SDS.
- Represent a significant fire hazard.
  - One gallon of acetone could do significant damage to the lab.
- React violently/explosively with chemical oxidizers – peroxide, nitric acid.
- Spills need to be cleaned up immediately.
  - Some vapors are lighter than air, some are heavier.
  - Where are the possible ignition sources?

#### 6.1.2.5 Health & Toxicity Effects

- Health and toxicity effects are gauged upon exposure levels – Generally measured in parts per million (ppm) – can be found in SDS.
- **TLV / PEL** - The Threshold Limit Value (TLV ) or Permissible Exposure Limit (PEL). Workers may be exposed to these substances for up to 8 hours per day 5 days per week. This will be the lowest limit.
- **STEL** - Short Term Exposure Limit. This value is the maximum concentration to which workers can be exposed for a period up to 15 minutes continuously without suffering from: irritation; chronic or irreversible tissue change; or narcosis of sufficient degree to increase accident proneness, impair self-rescue, or materially reduce work efficiency, provided that no more than four excursions per day are permitted, with at least 60 minutes between exposure periods, and provided that the daily maximum exposure level also is not exceeded.
- **IDLH** - Immediately Dangerous to Life and Health, 15 min. escape level as defined by National Institute of Occupational Safety and Health.

Toxicity is also classified according to levels in the GHS lexicon. Categories 1 through 5 are defined with category 1 being the most dangerous (reverse of the NFPA system). Chemicals can also have different toxicity categories depending on method of entry, e.g, Hydrofluoric acid is rated as a category 1 for dermal exposure and a category 2 for inhalation.

Chemicals enter the body through four routes

- Ingestion – chemistry left on your hands while you are eating your lunch, mouth pipetting a chemical. Wash your hands after leaving the lab.
- Skin/Eye contact – liquid or dust touches or spills on you. Certain organic solvents can be absorbed through unbroken skin.
- Inhalation – breathing in dust, mists, fumes – the materials boiling point is not an indicator of its inhalation hazard.
- Injection – broken sharps, needles.

How toxic a chemical is depends on the area of exposure, dose/concentration and entry method.

- A small amount of concentrated HF versus a large amount of dilute sulfuric acid.
  - Which is worse?

Chemicals harmful effects can be classified as either acute or chronic

- Acute – symptoms of exposure occur quickly or within a short period of time
- Chronic – Symptoms of exposure manifest themselves over a long period of time.

## 6.2 Second Level of Protection – Engineering Controls & Safe Lab Practices

- Engineering controls consist of interlocks, automatic shutoffs, exhausted hoods, etc
- The SNL makes use of all of these – key among them is the use of **exhausted hoods**.

### 6.2.1 Rules for use Exhausted Hoods & Wet benches

- 1) All chemical operations to be done at exhausted benches.
  - 2) Proper chemical gear required – Aprons, gloves, goggles/faceshield.
  - 3) Move chemicals well within the bench ~ 12" from edge.
    - a. Do not block any of the exhaust ports/holes.
    - b. Keep your face from out of the hood. Get assistance if necessary.
    - c. Don't put your face over a heated bath.
  - 4) Work surface (and area) should be clean and dry before and after your work.
    - a. Puddles of fluid on floor under a bench may not be water, inform staff.
    - b. If you splash water on a wet bench – please wipe it up.
  - 5) Avoid overcrowding at benches. Get SNL staff for assistance.
    - a. Be aware of incompatible chemicals located next to each other on the same bench.
  - 6) 24 hours maximum parking of "cooling" beakers in hoods for cooling.
  - 7) Do not use cascade rinsers as sinks for disposal of chemicals.
  - 8) Not all decks can be hosed down. – Check specific bench.
- Should your wafer(s) slip out of the boat and fall to the bottom of a heated bath, no attempts will be made by anyone to retrieve it until the bath is cool. At that point, SNL personnel will retrieve the wafer(s).



- Bench is not cluttered/crowded.
- Chemical containers are labeled.
- Chemical containers are well inside hood.

## 6.3 Third Level of Protection - Personnel Protective Equipment (PPE) & Safe Lab Practices

- PPE is not a substitute for good practices including knowledge and minimization of hazards.
- PPE is considered the last line of defense.
- Consists of
  - 1) Chemical Apron – Apron should cover upper chest
  - 2) Face shield
  - 3) Chemical Gloves

### 6.3.1 Rules for use of Personal Protective Equipment

- 1) PPE is required at all wet benches and for all manual chemical processes.**
  - a. This includes the person working at the bench and any observers.**

**If you are in front of a bench with chemistry – you are wearing PPE!**

- 2) The PPE is to be kept in Wet Etch Areas.**

- a. The PPE is either on your body in use or it is hung up
  - b. Do not walk around the lab or cross over to lithography bays with your PPE on.
  - c. Do not use computer or phones with chemical gloves on!
  - d. Don't touch your face with gloves on.
  - e. While processing, gloves may be left at chemical bench you are using. All other gear is either on your person or hung up.
  - 3) Put apron on first, followed by face shield, then gloves.
  - 4) Always check gloves before using. Don't use gloves that are wet inside.
  - 5) All Gloves are permeable
    - a. Permeation is dependent on many factors including the material handled, extent and length of contact.
    - b. There is no such thing as an "ideal" chemically resistant glove.
  - 6) Rinse and dry gloves when through – hang neatly.
  - 7) Get assistance if PPE looks worn/damaged/etc.
    - a. New PPE is in labware cabinets
- Chemicals to be transported in rubber carrier – 1 liter or more



## 6.4 Accident Prevention

Accidents happen in laboratories all the time. Do you know how to prevent them and what to do in case there is an accident? It has been observed that the accident rates in academic labs are much higher than in industrial labs (James Kaufman, president of the Laboratory Safety Institute in Natick, Massachusetts).

How do you prevent an accident? In the sections above, the ways of protecting oneself were described, but they are part of a larger picture.

### **Hazard Recognition and Evaluation**

You should be able to articulate the potential dangers and appropriate procedures for any material you are working with. This was Step One (section 6.1) of our protection plan.

### **Eliminate and Minimize Hazards**

- Substitution - Can you use a less hazardous material?
- Administrative Control - Can you modify your procedure to minimize a hazardous step? Step two (Section 6.2) of our protection plan comes into play here – Engineering Controls
- Personal Gear - Are you using the appropriate PPE? Step three (Section 6.3) of our protection plan.

### **Evaluate Potential Risk**

Have you thought out the possibility of an accident? What is the risk?

Risk is a product of the probability and severity. Working with HF can be severe, but hopefully we have taken steps to lower the probability of an accident. It comes down to weighing the benefit versus the risk involved if the hazards are still present and cannot be mitigated.

### **Maintain Focus on Your Experiment**

Do one thing at a time and do it well. **Do not allow yourself to be distracted and do not distract others.**

The following discussion was summarized from a short but very good presentation given by Kathryn Benedict- Head, Chemical Safety Section; Assistant Director, Division of Research Safety – 10/2004 - [http://science.widener.edu/svb/olcc\\_safety/papers/benedict.pdf](http://science.widener.edu/svb/olcc_safety/papers/benedict.pdf)

## Should you come across an accident or emergency in the cleanroom

Stay calm

Evaluate the scene to make sure you don't put yourself in danger

Start the appropriate response – get help if needed

Assign people jobs

Keep the victim calm as possible, assure the person that you will help them and that more help is coming.

Avoid telling them that they are going to be alright – you do not know. Emphasize that you are going to help them.

## 6.5 Working with Chemicals

- Not all chemicals are safe to be mixed with each other – knowledge is the key! Many chemicals are incompatible with others and could form a highly reactive/explosive mix. The SDS will list the materials your chemical is incompatible with in Section 10 – Stability and Reactivity.
- Partial list of incompatible mixtures

Chemical	Incompatibility
Acetic acid	Nitric acid, peroxides,
Acetone	Concentrated nitric and sulfuric acid mixtures
Ammonium Hydroxide	Hydrochloric Acid
Flammable liquids	Hydrogen peroxide, nitric acid, sodium peroxide, halogens
Hydrogen peroxide	Flammable liquids, metals & their salts
Hydrofluoric acid	Ammonia (aqueous or anhydrous)

### 6.5.1 Manual Chemistry Processing Permit

- Before any researchers perform any manual chemical processing, they must fill out and get approved an SNL Chemical Process Permit Form.
- Exceptions include
  - Manual development using CD-26
  - Acetone or Alcohol rinses
  - Development/Removal of SU8

### 6.5.2 Obtaining Chemicals

- Most chemicals necessary for working in the SNL can be found in either the Acid/Base Cabinet or in the Solvent Cabinets located in the Wet Etch Bays. Other chemistries that are more hazardous in nature (49% HF, Nitric) or are not commonly used are locked in storage cabinets in the lab.
- Do not pour chemicals back into original reagent bottles.
- Put chemicals back in appropriate storage area.
- Do not store chemicals under fume hoods.
- Do not obtain chemicals by dipping out of baths or by pipetting.
- Handling of all chemicals must occur under exhausted hoods.
  - No chemical work to be done on center benches.
- To bring in new chemistry – see section 3.10 for the procedure.

### 6.5.3 Approved Mixtures

- The following are approved mixtures in the cleanroom. Anything not on this list must be approved before use. All of these mixtures are used in the RCA cleaning process.
  - 1) Ammonium Hydroxide / Hydrogen Peroxide / Water
  - 2) Hydrochloric Acid / Hydrogen Peroxide / Water
  - 3) Sulfuric Acid / Hydrogen Peroxide

#### 6.5.4 Rules for mixing chemicals

- When mixing acid to water, ALWAYS ADD ACID – AAA
- When mixing hydrogen peroxide to acid – add the peroxide to the acid.
- When pouring from a bottle into a bath or container, **POUR SLOWLY as to let the air back smoothly in the bottle!**
- Do **not** pour chemistry from a large height down into a container – splashing will occur.

**If you are not comfortable with your setup, handling the beakers of chemistry, pouring, etc. Seek help. You should not feel as something is going to slip out of your hand while pouring or disposing.**

#### 6.6 Specific Chemical Hazards

This section details some particularly hazardous chemistries that are found in the SNL. These generally represent a higher level of physical or health hazards than other chemicals not listed here.

##### 6.6.1 Hydrofluoric Acid & Fluorinated Acids

- Is used to etch silicon dioxide and other materials (glass, quartz, Pyrex).

There are the two chemicals that represent a fluorine poisoning danger

- HF – Hydrofluoric Acid
- $\text{NH}_4\text{F}$  – Ammonium Fluoride
- These three chemicals come in a variety of concentrations and solutions. These are the solutions that will be labeled in the SFML
  - HF Solutions – from 1% to 49%
  - BOE or Buffered Oxide Etch – HF with  $\text{NH}_4\text{F}$  – may be close to neutral pH.
    - 10:1, 5:1, 20:1 - X parts 40%  $\text{NH}_4\text{F}$  and 1 part 49% HF – 10:1 BOE is ~ 4% HF
  - Pad Etch – Ammonium Fluoride ( $\text{NH}_4\text{F}$ ) solution for etching  $\text{SiO}_2$  over Al.
- Solutions of less than 10% may take hours before symptoms appear.
- Solutions of less than 7% may take several hours before onset of symptoms, resulting in delayed presentation, deeper penetration of the undissociated HF acid, and a more severe burn.
- The fluorine ion in the fluorinated acids readily penetrates human skin, allowing it to destroy soft tissues
  - Severe destruction of skin; may require amputation.
- Burns are extremely painful.
- Fluorine ions deplete calcium – body's electrochemistry altered – muscles need Ca.
- Death can and has occurred from fluorine exposure.
- An area the size of the hand (approx. 2.5% of the body surface area) is generally seen as the minimum for potential lethal action following contact with concentrated hydrofluoric acid.

## HF / NH<sub>4</sub>F are dangerous because

1. **It looks like water.**
  2. **It is not initially painful upon contact (For the weaker solutions typically used in the SNL)**
  3. **It is absorbed through unbroken skin.**
  4. **It depletes calcium and destroys tissue.**
  5. **It is potentially lethal – treat as toxic.**
- HF first aid stations are located in Wet Etch I & II (17-2740,2760) on top of the solvent cabinet – calcium gluconate gel – Calgonate from Pharmascience.

### 6.6.2 [HF Case Studies](#)

- 1) "Whilst sitting at a fume cupboard processing mineral samples a laboratory technician knocked approximately 100 mls of hydrofluoric acid (70%) onto his thighs. Immediate 10% body burns ensued. Despite rapid flushing with water and emergency hospitalization he died 15 days later."
  - Department of Consumer and Employment Protection Government of Western Australia, 1994
- 2) "A drop of concentrated HF splashed on to the finger nail of a patient. The finger was insufficiently washed. The exposed point turned gradually to a white-yellowish color, but no further visible changes were observed. Pain occurred 7hr later which continued for about 30 hr. Examination of the tissue under the nail then showed that a pea-sized area had already been destroyed by necrosis requiring surgical treatment."
  - "Symptoms and treatment of HF injuries" D. Peters and R. Miethchen J of Fluorine Chemistry Vol 79 pp 161-165 (1996)
- 3) IMMEDIATE SHOWERING AND APPLICATION OF CALCIUM GLUCONATE TO 22% BURNS RESULTED IN SURVIVAL
  - "Case of a 50 year old worker who survived burns to 22% body surface area from 70% hydrofluoric acid. He showered immediately, had calcium gluconate gel applied to the wounds and was taken to a nearby hospital where he was promptly treated with subcutaneous and intravenous calcium.
  - It is evident that apart from the location of burns, the size of the burns and concentration of the acid, washing the affected area immediately and the application of calcium gluconate gel to reduce the uptake of fluoride ion may prevent a fatality.
    - Greco, R.J., Hartford, C.E., Haith, L.R., and Patton, M.L., 1988, Systemic fluoride poisoning resulting from a fluoride skin burn: Journal of Occupational Medicine, v. 15, p. 39-41

These cases illustrate some of the outcomes of fluorine poisoning due to HF exposure

#### Case 1 - Death

- Did not have knowledge of the hazards
- Did not have proper PPE – no apron
- Did not have proper treatment available – working alone, no calcium gluconate

#### Case 2 – Amputation of finger tips

- Did not have knowledge of the hazards
- Did not have proper PPE – no gloves

### Case 3 – Chemical burns but survived

- Had knowledge of the hazards
- Had proper treatment and response

Accidents can happen even with all of our safety precautions. It is important to do what we can to prevent them and be ready to deal with the situations when they happen

**At the SNL – we will treat even upon the suspicion of HF exposure**

### 6.6.3 [Tetra Methyl Ammonium Hydroxide \(TMAH\)](#)

TMAH is an alkali used in two main areas of semiconductor processing. In higher concentrations (25%) it is used as a crystallographic etch of silicon – similar to KOH etching. In lower concentrations (2.4%), it is used as a positive photoresist developer.

It has always been known that higher concentrations TMAH solutions pose a toxic threat.

- TMAH acts to interfere with the nervous system, often shutting down breathing.
- There is no antidote at this time.
- Death has occurred shortly (30 min) after exposure to quantities of higher concentration TMAH solutions (greater than 7% body surface area exposed).
- So far, there have been no reported deaths due to exposure of developer strengths (one case had the patient on a respirator in intensive care).

The key to TMAH poisoning appears to be strength of solutions and area exposed. Time to decontamination does not appear to be important – absorption through skin may be very rapid.

Symptoms of TMAH poisoning

- Muscle weakness
- Salivation
- 2<sup>nd</sup> or 3<sup>rd</sup> degree burns
- Irregular breathing and heartbeat
- Progressing to coma, shock and in most high concentration cases – death.

The SNL has developers (CD-26) that are at the 2.4% strength. A small amount of developer on your skin will most likely result in a chemical burn. A large amount of developer splashed onto your body is a matter of serious concern that would require immediate hospitalization.

The key – as always – is our procedures for protecting yourself from chemical exposure

- 1) Know the hazards of the chemistry you are working with
- 2) All Chemical operations are done at a wet bench / fume hood
- 3) All protective gear must be worn when working with or around chemistry.

#### 6.6.4 [Piranha Etch](#)

Piranha Etch refers to a solution for removing photoresist / organic residues from surfaces. It is a mixture of sulfuric acid and hydrogen peroxide.

We use solutions of 3:1 or 4:1 (H<sub>2</sub>SO<sub>4</sub>:H<sub>2</sub>O<sub>2</sub>) with 30% H<sub>2</sub>O<sub>2</sub>

- Piranha solutions are very exothermic when mixed, rapidly heating to over 100C in a short period.
- Safety Reminders For Use of Sulfuric Acid/Hydrogen Peroxide Mixtures
  - It is difficult to dispose of piranha because the waste continues to react and decompose for a long period of time. This builds up pressure in the waste bottles, causing them to burst.
  - Commercially stabilized versions of Piranha are available such as Nanostrip
  - Personal protective equipment is always required when working with piranha solutions.
  - Whenever handling Piranha, only use glass containers, preferably Pyrex.
- In preparing a Piranha solution, add hydrogen peroxide to the sulfuric acid - slowly!
  - Piranha solution is very energetic and potentially explosive. When being made it is very likely to become hot, more than 100 degrees C. Handle with care.
  - Substrates should be rinsed and dried before placing them in a piranha bath. Piranhas are used to remove residues of photoresist and acetone, not the compounds themselves.
  - Adding any acids or bases to piranha or spraying it with water will accelerate the reaction. This includes some photoresist developers , some of which are strong bases.
  - Leave the hot piranha solution in an open container until cool on one of the SNL wetbenches.
  - Do not store piranha. Mix only enough fresh solution for each use. Excess solutions should be disposed via the drain (once cool), followed by flushing with copious amounts of water.
  - Mixing hot piranha with organic compounds may cause a very violent reaction. This includes materials such as acetone, photoresist, isopropyl alcohol, and nylon.

#### 6.6.5 [Nitric Acid](#)

Nitric acid poses special hazards due to the fact that it is a strong oxidizer. As such, it should always be kept away from flammables, solvents and metals.

If nitric acid is being used at a manual processing bench, no solvents are allowed on the same bench.

The nitric acid at the SNL is secured and must be requested by the lab users. It is not kept in the Wet Etch bays

### 6.6.6 Peroxides

Peroxides are by their nature oxidizing materials. They are therefore stored separately from flammables and solvents. Hydrogen peroxide can form explosive mixtures with some organic substances.

Another hazard of peroxides is oxygen pressure buildup from decomposition. Once peroxide is taken from its original container, it should never be put back. Used peroxide should be stored in vented cap containers or open containers until decomposition is complete.

The hydrogen peroxide that is found in the SNL is a 30% solution. It should not be confused with the 3% hydrogen peroxide found in stores for treating skin abrasions/cuts/infections.

### 6.6.7 Hazardous Gases

Below is a brief summary of the more hazardous gases found in the SNL. These gases are delivered to the tools via high pressure cylinders (see section 6.1.2.2 – Physical Hazards). All are stored in exhausted cabinets and are monitored by our toxic gas monitoring systems. Users are protected by multiple interlocks and safety systems but should still be familiar with their hazards.

- Boron Trichloride  $\text{BCl}_3$ : Used in the LAM-4600. A **toxic** colorless, fuming liquid or gas with a pungent odor. Reacts rapidly with water forming boric and hydrochloric acids. Used for dry etching of aluminum.
- Boron Trifluoride  $\text{BF}_3$ : Used in the Varian Implanter - A **toxic**, colorless, fuming gas with a pungent odor. Reacts rapidly with water forming hydrofluoric acid. A source of boron for ion implantation. TLV=1 ppm.
- Chlorine-  $\text{Cl}_2$ - Used in the LAM4600. **Corrosive, toxic** greenish-yellow gas with strong irritating odor. Highly irritating to skin, eyes, lungs. Very high concentrations cause fluid in lungs, death. Strong oxidizer. TLV = 0.5 ppm. Used for dry etching of Al and other metals.
- Dichlorosilane  $\text{SiH}_2\text{Cl}_2$ : Used in the LPCVD - A colorless, **flammable, toxic** gas which has an irritating odor and fumes in moist air. TLV = 5 ppm. Will form **corrosive** hydrogen chloride upon exposure to moisture. Used to form silicon nitride.
- Phosphine -  $\text{PH}_3$  - Used in the Varian Implanter - A **toxic/flammable** gas with an odor of decaying fish that ignites at very low temperatures upon exposure to air. A source of phosphorous for doping silicon. TLV = 0.3 ppm
- Silane -  $\text{SiH}_4$  - Used in the LPCVD and P5000- A gas with an unpleasant odor. Used in the chemical vapor deposition of epitaxial silicon, polycrystalline silicon and silicon nitride. TLV = 5 ppm Ignites in air with concentrations down to 1%, extremely **flammable**.
- Arsine –  $\text{AsH}_3$  – Used in MOCVD growth. Gas is **flammable, pyrophoric**, and highly **toxic** hydride gas that is colorless and denser-than-air. TLV=0.05 ppm

## 6.7 Chemical Labware

### 6.7.1 General Considerations

- Check glass labware before using for cracks.
- Generally, no hydrofluoric in glass/Pyrex/quartz containers. HF etches all these.
- Approved labware and fixtures only – check before bringing in your own.
- Labware will belong the various groups/researchers, you will be assigned a storage spot in one of the wet etch bays for your labware. Rinse and dry before putting away.

### 6.7.2 Best Practices for Manual Chemical Processing

- Move your processes in ~12" from the edge of the bench.
- Plan your work – know what you have to do step by step – have your supplies/materials ready.
- Only have what you need on the wet bench. Don't crowd! No clutter!
- Handle labware carefully, use boats and beakers properly.
  - Be careful with nitrogen blowoff guns near chemistry.
  - Need to pour chemicals in a bath – use a beaker with a handle.
  - Can't reach – get assistance.
- Clean up when you are done
  - Put your wafers/materials away.
  - Dispose of chemistry properly.
  - If leaving hot chemistry to cool – let us know what you are doing.
- Double contain chemicals (small beaker of chemistry in a larger pan). This is known as secondary containment.
- Do not distract others working at a wetbench.

### 6.7.3 Hotplates

Hotplates represent a higher level of risk and are therefore kept locked up and are released to users upon request and a brief explanation to SNL staff what it is that you are heating.

- Approved mixtures on hotplates only, ask first.
- No plastic or aluminum foil on hotplates. Approved labware only – pyrex, quartz
- Keep signage away from hotplate surfaces.
- Hotplates must be attended – do not leave the area. Hotplates should have secondary containment. Beakers can fail under heating.
- No heating of solvents with flashpoints <130°F.
- No heating of HCl solutions – vapors are very corrosive even at room temperature.
- Wafer baking hotplates are not for chemicals. – Vacuum grooves.

#### 6.7.4 Wafer Cassettes & Boats

There several wafer cassette styles and materials in the cleanroom

1. Polypropylene Shipping and Machine Cassettes

- Used in wafer shipping containers and for moving wafers in & out of processing tools
- Do not use for wet chemistry



2. Metal Machine Cassettes

- Used in moving wafers in & out of processing tools
- Do not use for wet chemistry



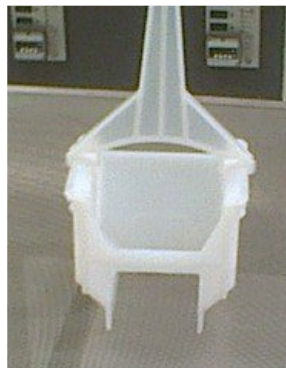
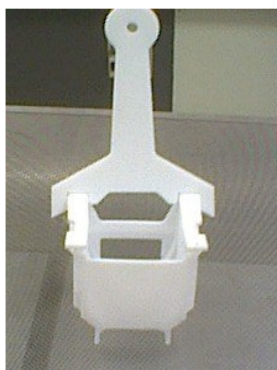
3. Quartz Cassettes

- Used in moving wafers in & out of high temperature furnaces
- Do not touch with gloved hands – only use appropriate handling tools
- Do not use for wet chemistry



4. Teflon Cassettes

- Teflon has high resistance to chemicals and temperature, PFA and TFE varieties
- Much heavier than polypropylene cassettes
- Teflon can be colored – do not use colored Teflon for processing



## 6.7.5 Cassette Handles

There are two type of handles used to lower Teflon boats into the chemical baths.

### 1. Slingshot Style

- Fasten onto top of cassette through notch.
- Slide down cassette on track until handle stops – slide handle all the way to end of cassette
- Handle is not stable in middle.
- These handles are more appropriate for open baths with no covers.



### 2. Squeeze Style

- Fasten onto top of cassette in notches on end of cassette.
- Use right size handle for cassette – 4" and 6" versions – do not mix
- Do not tilt handle & boat – hold straight up.
- This style is more appropriate for baths where a cover is used.




## 6.8 Chemical Hazard Labeling System

- The SNL uses the Globally Harmonized System (GHS) system for chemical labeling
  - International standard for labeling chemistry.
  - Labels will contain more than just basic hazard rating – specific warnings and dangers.
  - Pictograms used on labels rather than numbering system.

### GHS Compliant Label Example

### Hydrofluoric acid

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DANGER

Fatal if inhaled, if swallowed, or in contact with skin. Causes severe skin burns and eye damage. Effects may be delayed. Do not eat, drink or smoke when using this product. May be corrosive to metals.

**RESPONSE**




Immediately call a doctor or other medical personnel.

**If swallowed:** Rinse mouth. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. **If on skin (or hair):** Take off immediately all contaminated clothing. Wash skin with water or shower. Wash contaminated clothing before reuse. Contaminated skin must be treated with calcium gluconate solution. **If inhaled:** Remove person to fresh air and keep comfortable for breathing. Absorb spillage to prevent material damage.



**PREVENTION**

Do not breathe mist or vapors. Use only outdoors or in a well-ventilated area. Where exposure limits are exceeded, wear respiratory protection. Do not get in eyes, on skin, or on clothing. Wash skin and eyes thoroughly after handling. Wear protective gloves and clothing, and eye and face protection. Keep only in original container.

GHS - Hazard Pictograms and Related Hazard Classes		
		
<b>Expanding Bomb</b> <ul style="list-style-type: none"> <li>• Explosives</li> <li>• Self-reactives</li> <li>• Organic Peroxides</li> </ul>	<b>Corrosion</b> <ul style="list-style-type: none"> <li>• Skin corrosion/burns</li> <li>• Eye damage</li> <li>• Corrosive to metals</li> </ul>	<b>Flame Over Circle</b> <ul style="list-style-type: none"> <li>• Oxidizing gases</li> <li>• Oxidizing liquids</li> <li>• Oxidizing solids</li> </ul>
		
<b>Gas Cylinder</b> <ul style="list-style-type: none"> <li>• Gases under pressure</li> </ul>	<b>Environment</b> <ul style="list-style-type: none"> <li>• Aquatic toxicity</li> </ul>	<b>Skull &amp; Crossbones</b> <ul style="list-style-type: none"> <li>• Acute toxicity (fatal or toxic)</li> </ul>
		
<b>Exclamation Mark</b> <ul style="list-style-type: none"> <li>• Irritant (eye &amp; skin)</li> <li>• Skin sensitizer</li> <li>• Acute toxicity</li> <li>• Narcotic effects</li> <li>• Respiratory tract irritant</li> <li>• Hazardous to ozone layer (non-mandatory)</li> </ul>	<b>Health Hazard</b> <ul style="list-style-type: none"> <li>• Carcinogen</li> <li>• Mutagenicity</li> <li>• Reproductive toxicity</li> <li>• Respiratory sensitizer</li> <li>• Target organ toxicity</li> <li>• Aspiration toxicity</li> </ul>	<b>Flame</b> <ul style="list-style-type: none"> <li>• Flammables</li> <li>• Pyrophorics</li> <li>• Self-heating</li> <li>• Emits flammable gas</li> <li>• Self-reactives</li> <li>• Organic peroxides</li> </ul>

All chemicals are labeled, all the time

- **Users that need chemical labels are to obtain the proper labels from SNL staff before they perform their work.**
- **Users may not create their own chemical labels.**

## 6.9 Chemical Labeling & Storage

- **All chemicals to be labeled – all the time.** Labels must be GHS compliant.
- Secondary containers –obtain containers and labels from SNL Staff. Procure these before you start your processing.
- For Stored Chemicals – Appropriate containers may be obtained from SNL staff.
  - The storage container material must be compatible with the chemistry to be stored.
  - Failure to properly label stored chemicals will result in their disposal.
  - Hydrogen peroxide chemistries must be in vented containers.
  - DO not use food/beverage containers for chemical storage.
  - Chemical containers must have an appropriate GHS label and the date the bottle was brought into the SNL or was created.
- For Chemicals in Use
  - “Manual Chemical Permit” Forms are required for all chemicals with the exception of
    - Manual Development with CD-26– disposal down drain
    - Acetone Rinse – disposal in solvent waste
    - Isopropyl Alcohol Rinse – disposal in solvent waste
    - Remover PG/NMP – disposal in solvent waste.
  - “Equipment in Use” form for CD-26, Acetone, IPA or Remover PG.
  - GHS free standing signs for all chemicals in use.
- Do not use fab wipes or any other lab forms to write down the chemicals you are using.
- **Unlabeled chemicals**
  - **Should be treated like HF**
  - **Inform SNL staff.**

Note: just because it tests pH neutral doesn't mean that it is water!

- Store chemicals in appropriate cabinets and containers – not on benches/hoods.
- Containers must be obtained from SNL Staff. Do not bring in your own chemical containers.
- Labels are also to be provided by the SNL, you may not make your own.

## 6.10 [Information on Chemicals in the SNL](#)

### 6.10.1 [Organic Solvents](#)

Acetone - CH<sub>3</sub>COCH<sub>3</sub> - *Wet Etch* - A colorless, highly flammable liquid with a sweetish odor. Used for cleaning and removing photoresist. Repeated contact can cause irritation to skin and eyes. High vapor pressure, heavier than air.

Isopropyl Alcohol - CH<sub>3</sub>CHOHCH<sub>3</sub> - *Wet Etch* - A flammable liquid, boiling at 82.5 degrees C. Used for cleaning. Repeated contact can cause irritation to skin and eyes. Heavier than air.

Methyl Alcohol - CH<sub>3</sub>OH - *Wet Etch* - A colorless flammable liquid with a mild odor. Readily absorbed through skin, repeated exposure can lead to liver damage and blindness. Used for cleaning.

Hexamethyldisilazane (HMDS) - (CH<sub>3</sub>)<sub>3</sub>SiNHSi (CH<sub>3</sub>)<sub>3</sub>/C<sub>6</sub>H<sub>4</sub>(CH<sub>3</sub>)<sub>2</sub> - *Photoresist Coating* - A colorless flammable liquid used to promote adhesion of photoresist to the underlying film or substrate. HMDS may react with water to release ammonia. May cause dizziness, nausea, headache. Prolonged liquid contact may cause irritation. Heavier than air. Can be toxic if inhaled.

Propylene Glycol Monomethyl Ether Acetate (PGMEA) - *Lith* - A combustible liquid with a sweet ether like odor. It will cause eye, nose, throat irritation. Major solvent component of many photoresists. Heavier than air.

Ethyl Lactate - *Lith* - A combustible liquid with a mild odor. May irritate eyes and lungs. Major solvent component of many photoresists. Heavier than air.

NMP- N-Methyl-2-pyrrolidone – *Lith* – A combustible liquid with an amine odor. Component of resist strippers and lift off agents. Skin and eye irritant.

### 6.10.2 [Acids](#)

Acetic Acid CH<sub>3</sub>COOH: *Wet Etch* - A corrosive, colorless liquid with a pungent vinegar like odor. Dilute solution used in stop bath for film processing. Used in conjunction with a strong acid for cleaning and etching. It is also a combustible liquid.

BOE (Buffered Oxide Etch): *Wet Etch* - A corrosive/toxic colorless liquid mixture of HF and Ammonium Fluoride, may cause severe burning upon exposure and possibly fatal if untreated. Used for etching silicon dioxide.

Freckle Etch: *Wet Etch* - A corrosive liquid of phosphoric, acetic, nitric and fluoroboric acids. It is used to remove silicon nodules left over from etching of Al/Si alloys.

Pad Etch: *Wet Etch* - A corrosive/toxic colorless liquid of Ammonium Fluoride may cause severe burning upon exposure, and possibly fatal if untreated. Used for etching silicon dioxide over Al.

Hydrochloric Acid HCl: *Wet Etch* - A corrosive, colorless liquid, sharp irritating odor. Used in cleaning of silicon wafers.

Hydrofluoric Acid HF: *Wet Etch* - A colorless corrosive/toxic fuming liquid or gas with a strong, irritating odor. It can be buffered with ammonium fluoride to prevent rapid change of chemical activity. Used for etching silicon dioxide and cleaning.

Nitric Acid: HNO<sub>3</sub>: *Wet Etch* - A corrosive colorless liquid with a choking odor which fumes in moist air. It is a solution of NO<sub>3</sub> and H<sub>2</sub>O. Fuming nitric acid contains an excess of NO<sub>3</sub>. Used for etching and cleaning of wafers. A very strong oxidizer, keep away from solvents and other flammable materials.

Citric Acid: C<sub>6</sub>H<sub>8</sub>O<sub>7</sub>: *Wet Etch* - A colorless, odorless liquid that causes eye irritation . May be harmful if swallowed. May cause respiratory tract irritation. Used mainly for III-V processing

Phosphoric Acid: H<sub>3</sub>PO<sub>4</sub>: *Wet Etch* - A colorless, odorless **corrosive** liquid that causes severe skin burns and eye damage. May cause respiratory irritation. Used primarily for aluminum etching.

Sulfuric Acid H<sub>2</sub>SO<sub>4</sub>: *Wet Etch* - A **corrosive** colorless oily liquid commercially sold 93 to 98% H<sub>2</sub>SO<sub>4</sub> the remainder being H<sub>2</sub>O. Used for cleaning wafers and stripping photoresist. Sulphuric acid mists are a suspected carcinogen.

### 6.10.3 Bases

Potassium Hydroxide KOH: *Wet Etch* - Colorless sticks, flakes, powder or pellets soluble in water. Used for etching silicon. **Corrosive**, especially damaging to eyes.

Sodium Hydroxide NaOH: *Wet Etch* - A white material sold as pellets, flakes, lumps or sticks. Aqueous solutions are known as soda lye. Used for etching silicon. **Corrosive**, especially damaging to eyes.

Ammonium Hydroxide NH<sub>4</sub>OH: *Wet Etch* - A colorless liquid used in cleaning. Very pungent odor. High concentrations can cause fluid in lungs. **Corrosive**

Tetramethyl Ammonium Hydroxide (TMAH): *Wet Etch & Photoresist Develop* – Corrosive liquid that can cause burns to skin and eyes. May be fatal if swallowed or absorbed through skin. Used in many photoresist developers. Solutions are **corrosive** and **toxic**. CD-26 is 2.4% TMAH – still very dangerous in high body surface areas. No known antidote.

### 6.10.4 Gases

Ammonia NH<sub>3</sub>: *LPCVD* - A colorless, strongly alkaline (**corrosive** with exposure to moisture) and extremely soluble gas with a characteristic pungent odor. Used to form silicon nitride.

Argon Ar: *PVD* - An inert gas used in sputtering equipment. An asphyxiant gas.

Arsine AsH<sub>3</sub>: *MOCVD* – Flammable, pyrophoric and highly toxic gas. Denser than air and odorless. TLV = 0.05 ppm

Boron Trichloride BCl<sub>3</sub>: *Dry Etch* - A **toxic** colorless, fuming liquid or gas with a pungent odor. Reacts rapidly with water forming boric and hydrochloric acids. Used for dry etching of aluminum.

Boron Trifluoride BF<sub>3</sub>: *Implanter* - A **toxic** colorless, fuming gas with a pungent odor. Reacts rapidly with water forming hydrofluoric acid. A source of boron for ion implantation. TLV=1 ppm.

Chlorine- Cl<sub>2</sub> - *Dry Etch* - **Corrosive/toxic** greenish-yellow gas with strong irritating odor. Highly irritating to skin, eyes, lungs. Very high concentrations cause fluid in lungs, death. Strong oxidizer. TLV = 0.5 ppm. Used for dry etching of Al and other metals.

Dichlorosilane SiH<sub>2</sub>Cl<sub>2</sub>: *LPCVD* - A colorless, **flammable, toxic** gas which has an irritating odor and fumes in moist air. TLV = 5 ppm. Will form **corrosive** hydrogen chloride upon exposure to moisture. Used to form silicon nitride.

Forming Gas- H<sub>2</sub>N<sub>2</sub> - *Oxidation Furnace* - A mixture of hydrogen and nitrogen gas. Percentage varies. Used in sintering and annealing of silicon wafers. **Flammable**.

Freon 14 - CF4 - *Dry Etch* - Inert gas used in plasma etching. An asphyxiant gas.

Hydrogen - H2 - *Oxidation Furnace* - A colorless, odorless extremely **flammable** gas. Used in wet silicon dioxide growth.

Oxygen - O2 - *Dry Etch & Oxidation Furnace* - A colorless odorless gas that supports combustion – strong oxidizer. Used for silicon dioxide growth and in plasma ashing equipment.

Phosphine - PH3 - *Implanter* - A **toxic/flammable** gas with an odor of decaying fish that ignites at very low temperatures upon exposure to air. A source of phosphorous for doping silicon. TLV = 0.3 ppm

Silane - SiH4 - *LPCVD* - A gas with an unpleasant odor. Used in the chemical vapor deposition of epitaxial silicon, polycrystalline silicon and silicon nitride. TLV = 5 ppm Ignites in air with concentrations down to 1%, extremely **flammable**.

Sulphur Hexafluoride - SF6 - *Dry Etch* - A gas used in plasma etching. An asphyxiant gas.

### 6.10.5 Other

Photoresist: A light sensitive polymer; negative photoresist is typically cyclized rubber and bisazide, positive photoresist is typically composed of diazonaphthoquinone (DNQ), novolak resin and a solvent. Classified as a **combustible** solvent as it's makeup is mostly organic solvents.

Polyimide: A spin on plastic like material. Classified as a **combustible** solvent.

Aluminum Etch: A corrosive mixture made especially for etching aluminum in integrated circuit fabrication. Contains Phosphoric Acid, Nitric Acid, Acetic Acid..

Hydrogen Peroxide H2O2: An oxidizer used in cleaning of silicon wafers. **Unstable** colorless liquid that decomposes into water and oxygen. (30% not the 3% concentration found in drug stores). Considered a **corrosive** at the 30% solution strength. Ingestion of 30% peroxide is **toxic**.

Spin-on-Dopants: An organic material that has Boron or Phosphorous or other metals attached to the molecule. It is spin coated on silicon wafers and baked at high temperatures (~1000°C) and the dopants diffuse into the silicon. Many are classified as **combustible** due to the casting solvents.

Spin-on-glass: An organic material that has SiO2 attached to the molecule. It is spin coated on silicon wafers and baked at high temperatures (~1000°C) and the organics decompose leaving SiO2. Many are classified as **combustible** due to the casting solvents.

### 6.10.6 Hazardous Gas Locations

<b><u>Gas Type</u></b>	<b><u>Location</u></b>	<b><u>Point of Use</u></b>
Silane 100%	17-2775, Cab 3 & 17-2770	LPCVD
Dichlorosilane	17-2775, Cab 3 & 17-2770	LPCVD
Ammonia	17-2775, Cab 1 & 17-2770	LPCVD
Phosphine 15%, in Hydrogen 85%	17-2770 Implanter	Ion Implanter
Boron Trifluoride	17-2770 Implanter	Ion Implanter
Chlorine	17-2720	Plasma Metal Etcher
Boron Trichloride	17-2720	Plasma Metal Etcher
Forming Gas (5%H <sub>2</sub> in N <sub>2</sub> )	17-2775	Diffusion Furnaces
Hydrogen	17-2775	Diffusion Furnaces
Arsine	17-2830	MOCVD
Phosphine	17-2830	MOCVD

## 6.11 Hazardous Waste

- A chemical is a hazardous substance if it is **ignitable**, **corrosive**, **reactive** or **toxic**.
- SNL Policy
  - Chemicals that are hazardous must be disposed of through a licensed waste disposal firm.
  - Hazardous waste can be collected in suitable containers and stored up to 90 days after the date of starting accumulation in designated satellite accumulation areas.

### 6.11.1 Disposal of Solvents

- Classified as hazardous waste
  - Includes photoresist (positive and negative)
  - Cannot be disposed of in sinks.
- 1) Put in Used Solvent bottle in Solvent Cabinets in Wet Etch 1 & 2.
    - **No water based chemistry – No water at all.**
      - **This includes developers (CD-26 / TMAH / NaOH)**
    - **No acids / oxidizers**
  - 2) Fill out logsheet attached to bottle
    - Name, date, chemical, amount, use.
- Example: Reaction of HMDS with a small amount of water produced enough ammonia to clear the lab.
  - You cannot evaporate a solvent to dispose of it.
  - **Know what you are disposing of – seek help, don't assume.**



#### 6.11.2 Disposal of Acids and Bases (not used for metal etch)

- Down the sinks in the chemical benches with plenty of water.
- Includes TMAH (Positive Resist) developer and acids/bases mixed with water.
- Goes to neutralization tank in basement.
- **DO not dump hot chemistry – let it cool, let us know.**

#### 6.11.3 Disposal of Metal Etchants

- Classified as hazardous waste.
- Do not pour down drains.
- Put into separate container – label date of collection, see SNL staff for assistance before you start processing.

#### 6.11.4 Disposal of Mixtures from Different Waste Streams

- Example - Acids & solvents – used for porous silicon, Solvents & water
- Get assistance from SNL staff before you start processing.

#### 6.11.5 Disposal of Wipes / Foil with Solvents

- Do not throw away fab wipes/pipets/foil with liquid solvent/photoresist still on them in regular trash. Put in yellow metal trash cans.

#### 6.11.6 Disposal of sharps

- This includes wafers, broken glassware, razors, etc.
- Disposal of these materials may injure those that are removing trash.
- Dispose in supplied sharps disposal containers

#### 6.11.7 Empty Bottles

- Acid and Alkali containers to be tripled rinsed before disposal – mark as rinsed – place in red marked trash receptacles in back hallway.
- Solvent bottles - Material must be gone except for residue - place in red marked trash receptacles in back hallway.

## Revision Record

<b>Rev</b>	<b>Changes</b>	<b>Date &amp; Author</b>
A	Issue	9/8/08 - TG
B	Renamed SOP	10/15/08 - TG
C	Removed Super-User from certification process – SNL Staff Certifier	3/30/09 - TG
D	Clarification of OH* specific purpose, Restrictions on research group reservations, addition of Freckle Etch, response for accidents, observers wear PPE, pouring chemistry, addition of best practices	9/03/09 - TG
E	Added Roles & Responsibilities, Changed process for OHS, Added restrictions on stored chemicals, Added LOTO, Split spills and exposures into incidental and emergency with different procedures, Added accident prevention section, Added section on specific chemical hazards	8/16/10 - TG
F	Added section on TMAH, updated intercom phones	9/4/11 - TG
G	Cell phone restrictions, MSDS locations, empty bottles	9/1/12 - TG
H	Updated Safety Training with Class Badge, Mention of GHS	8/22/13 - TG
I	Updated to GHS information, Chemical Process Permit form	6/19/14 - TG
J	Minor revisions	8/24/15 - TG
K	Minor revisions	8/31/16 - TG
L	Change locations of SDS computers, remove chlorine alarm reference for exiting, minor revisions/clarifications. Switched order of sections 6.8 & 6.9	8/31/17 - TG
M	Minor revisions	8/31/18 - TG
N	Added two more emergencies, updated emergency actions	9/1/19 - TG
O	Removed staff / updated with FOM / new labware procedures	8/10/23 - TG