



4D LABS

User and Safety Manual

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Safety Philosophy

The staff and management of the 4D LABS User Facilities have implemented measures to ensure that the Facility provides a clean and safe working environment. It is the responsibility of all users and staff to act in a professional, courteous, and safe manner at all times while in the Facilities.

1. Introduction

This safety manual was developed by 4D LABS' staff and management, and is specifically designed for the 4D LABS Facilities. This document is a reference manual covering basic safety practices for use in the 4D LABS Facilities. It applies equally to all users and staff and governs both safety and operational rules. All users are expected to have read and understood these procedures before entering the Facilities. The 4D LABS Clean Room is located at SFU in the TASC 2 building, Room 6060. The User Facility house a large investment in process equipment that is fragile and sensitive. 4D LABS houses toxic gases and chemicals, which pose significant hazards if handled incorrectly. This manual attempts to document acceptable operating procedures and conduct for use of the User Facility, which includes the Clean Room. It is impossible, however, to define a policy for every conceivable situation. Rules and policies are no substitute for common sense. Anyone who fails to act in a professional, safe, and responsible manner while in the User Facility will be banned from further access at the discretion of the management. Users' suggestions and feedback on the User Facility, its staff, its operation, and its equipment are welcome at all times.

1.1 Clean Room Classification

The 4D LABS Clean Room is classified as an ISO 5 clean space (also commonly referred to as Class 100). The basic criterion for this classification is a count of not more than 3520 particles greater than or equal to one half micron (micrometer) per cubic meter of air.

2. General Procedures for the User Facilities

2.1 Access

Access to the User Facility is limited to certified users, 4D LABS staff, and authorized SFU campus personnel who have completed the required training and orientation. Certified users will be allowed personal access at any time during normal operating hours. After-hours access may be granted on an individual basis with tool usage limitations. Use of the User Facility is a privilege that can be revoked by the 4D LABS management at any time.

Access to the User Facility begins with procedures to receive safety and orientation training, initiate billing for facility usage, and obtain an access card.

2.2 New Account

Before beginning training or using the equipment within the User Facility, new users must complete the registration forms found on the 4D LABS website. Once these forms have been completed, the user will begin safety training and tool-specific training in the appropriate Facility

2.3 Safety Training

The appropriate safety training must be successfully completed by all users prior to use of the equipment in the User Facility. Access to the facility requires all users to maintain regular safety training as required by both the EH&S Department and the 4D LABS Facilities at SFU.

Users from SFU must successfully complete the required SFU EH&S Department safety training courses. This courses must be taken at least every three years for all SFU users. Users from SFU who have not completed the SFU EH&S Department's training within the last three years will be required to complete this training prior to receiving access to the equipment within the User Facility. These users will also need to successfully complete the next safety training course offered by the EH&S Department and then inform the 4D LABS staff in order that the staff may update the user's files accordingly.

Users that are not from SFU (external users) must pass safety training courses required by their own employer and have proof of this employer safety training. These users must also pass safety quizzes issued by 4D

LABS. All users (internal and external to SFU) must also successfully complete the relevant safety courses offered by the 4D LABS staff. Trained users can receive a “4D LABS User Training” form for their records.

2.4 Tool Training

The equipment in 4D LABS may be used only by certified users who have been specifically trained in its use and approved by the equipment owner.

Training on specific equipment is conducted in a three-phase approach leading to independent and unsupervised operation by a user. Phase 1 is an explanation/observation step wherein the tool owner demonstrates all operations on the process tool and explains the theory of operation. Phase 2 is a dependent step wherein the new user conducts tool operations with assistance from the tool owner. Phase 3 is a more independent step wherein the new user conducts tool operations under direct supervision of the tool owner. Phase 3 is complete when the new user has demonstrated to the tool owner independent operation of the tool. Any phase may be repeated or lengthened at the discretion of the tool owner, who determines when a user is fully certified to operate the process tool independently. After passing all three phases of training, a user can independently operate the process tool without direct supervision. Any qualified user who has not used the tool for more than 3 months will be disqualified from online booking and will require a Phase 3 training session to re-qualify as an independent tool user.

Our tool owners, listed on the 4D LABS tools pages, will suggest an estimated training schedule for new users. In Phase 1 of training, up to 3 trainees can attend the training, but billing charges will be shared equally between all trainees. Please ask the tool owner for permission if additional trainees are to be included in the training session. In training Phase 2 and 3, only one trainee can attend.

Users are **NOT** allowed to train new users. New users should ask the tool owner for permission if any observer(s) is (are) to be included in the tool session. Qualified users are encouraged to work together to get the most out of the tools. However, functions that have not been demonstrated on the specific tool should only be tested in the presence of, and with the permission of the relevant tool owner.

2.5 Access Cards

After completing the 3 phases of training, users can apply for their own access card to the User Facility, which includes the Clean Room. When all documentation has been completed and training received, users will complete and submit the 4D LABS Access Card Agreement form. There is a service charge and deposit for all access cards. Loss of this access card will require an application for a replacement card. Lost access cards must be reported immediately to 4D LABS staff. The staff will coordinate the deactivation of all returned or lost access cards. Deposits are refundable with the return of the access card at the end of the user's project.

The access card may be further updated for after-hours access. This level of entry may be granted for experienced users who require extended access and present a strong case for it. The project supervisor must also approve this special request.

2.6 Visitors

Visitors into the Clean Room must be authorized by 4D LABS management and escorted by a staff member. Visitors are not allowed to operate equipment, to use chemicals, or to be left alone. An authorized service contractor may be left alone, but must first be authorized by the manager, and must be provided an orientation to safety and evacuation procedures, as well as access to a contact person at all times.

Visitors in other areas of the facility need permission from the tool owner and need to sign-in at the reception desk. Users are not permitted to bring visitors or observers without prior permission of 4D LABS staff.

2.7 User Conduct

Proper conduct, safe practices, and a professional attitude are required at all times. This facility is used by a broad client base; many sensitive experiments are taking place on a regular basis. You must act in a manner that will not disturb other researchers using 4D LABS. As a user of the Facility you are responsible for reporting any activities that deviate from acceptable behavior. Any violator(s) may lose access privileges. Any damage to the facility and/or equipment may also be charged to the user at the discretion of 4D LABS management.

2.7.1 Policy

The policy is a 'three strikes and you're out policy'. Gross negligence, however, may result in an immediate suspension of User access. Once a user has had access removed, the user has to reapply and begin training again. They will also be placed on probation until they have proven that they will not be a problem in the facility. To ensure that a user knows how many strikes (demerits) they have, an email describing the violation will be sent to them and to their supervisor. This policy is not to punish people who are learning and make mistakes or occasional lapses in judgment. These are understandable and are part of the learning process. The point of this policy is to deal with users that consistently put their needs and desires above the safe and efficient operation of the facility. Please encourage safety and proper lab usage among the other lab users and report any violations to the 4D LABS staff. Violations may be safety or non-safety related.

2.7.2 Potential Demerit Offences

1. Consistent violation of protocols.
2. Consistent violation of safety policies.
3. Intimidation of other users (taking over lab space, damaging other user's devices, etc.).
4. Damaging equipment by not following procedures after sufficient training or making unauthorized modifications to the equipment.
5. Using equipment without the proper training sign-off.
6. Abusing equipment scheduling.
7. Consistent improper/incomplete use of the billing system.

2.7.3 Procedures

First Offense: The Manager will send an email to the user and copy the user's supervisor indicating the offense and the fact that it is a first warning.

Second Offense: The Manager will send an email to the user and copy the user's supervisor indicating the offense and the fact that it is a second warning. In addition, a face-to-face meeting will be arranged between the user, their supervisor, and the Manager.

Third Offense: The individual will be expelled from the respective Facility or Clean Room.

Enforcement: All 4D LABS staff have the responsibility to ensure the proper and safe operation of the facility. All staff can ask a user to conform to the policies. The Manager will administer the 'Three Strikes' policy.

2.8 Hours of Operation

The normal hours of operation are **9:00 am to 5:00 pm, excluding holidays and weekends**. Usage outside of these operating hours must be authorized by individual tool owners. Users are encouraged to work within these hours whenever possible. Certified users utilizing the Clean Room after normal hours must adhere to the requirements outlined in the After-hours Usage section of this manual.

2.9 After Hours Usage

2.9.1 Procedures

After-hours privileges will be granted on an individual basis. A user may only be given after-hours access if they are a certified user of the equipment they wish to operate. The tool owner of the equipment in question will determine if the user can access the equipment after-hours. An additional training session may be required prior to granting this extra level of access. After a user has been granted after-hours access on a specific tool, if they have not used it for more than one month, they must check with the tool owner before using it again after hours.

All Clean Room users must sign in on the after-hours log sheet outside the Clean Room entrance. The user has two options to help ensure their safety while working after-hours in the Clean Room: the first option allows the user to work as long as another authorized user is present anywhere in the Clean Room facility; the second option requires the after-hours user to phone in to SFU Security (dial 778-782-3100) to establish the user's presence in the Clean Room. This second option requires an initial call announcing the user's entry into the Clean Room, mandatory check-in calls to SFU Security every hour, and a final call to establish the user's time of departure from the Clean Room. Departing users can use the phone at the entrance to the Clean Room, located near the after-hours log sheets, for this final call to SFU Security.

Failure to make the required check-in calls will result in emergency response by SFU Security, which may include their need to quickly enter the Clean Room. Costs incurred for cleanup of the Clean

Room facility following a failure to make the required check-in calls will be assessed against the offending user and his/her company or supervisor. The user also *must* sign out when leaving the Clean Room.

After-hours access can be revoked for reason without warning. Some examples of reasons to revoke after-hours access include, but are not limited to: acting in an unsafe manner in the Clean Room, improper operation of equipment, using equipment that the user is not certified on, failure to adhere to the buddy system or Security check-in calls, or not following proper cleanliness procedures. After-hours access is a privilege and must not be abused.

2.9.2 Equipment

Access to the following equipment and processes is prohibited[‡] after-hours:

- Tystar Mini Tytan Furnace

- NEXX plasma-enhanced chemical vapour deposition (PECVD)

- Chlorine-based reactive ion etcher (RIE 1)

[‡] Prohibited access: Absolutely no user may access this equipment or processes while working after hours.

The following equipment and processes have restricted* access after-hours:

- Use of hydrofluoric acid

- Use of any other acids (e.g., Nanostrip, Aqua Regia, Piranha)

- Heating of any organic solvents

* Restricted access: Only qualified users may access this equipment while accompanied by another user who is also certified on the aforementioned equipment and processes. Absolutely no user may access this equipment or processes if working alone, or if accompanied by a user who is not certified to use this equipment or process.

All other equipment and processes are allowed for certified users after-hours.

2.10 Telephones

There are telephones throughout the User Facility. The phones can be used for person-to-person communication, for emergency communication, and for check-in calls to SFU Security Operations.

Emergency calls: If an injury occurs in 4D LABS, dial **2-4500** to provide your location and the type of injury to the emergency responder. Then notify staff members of the incident.

2.11 User Storage Inside and Outside of the Clean Room

2.11.1 Lockers and Storage of Personal Belongings

Food or drinks are **NOT** allowed in the working area of our facility. They can be temporarily kept in our lockers. Users may store personal belongings in the lockers located in the hallway outside the entrance to the Clean Room for a daily rate. Users may sign out a locker key from the 4D LABS staff for day use of a locker. Lockers are for storage of jackets, backpacks, winter boots and other items not permitted in the work spaces or Clean Room. No hazardous chemicals are permitted to be stored in the lockers. Users breaking these rules may receive a fine (e.g., \$1,000) proportional to their impact on the cleanliness of the gowning room and the HEPA filters.

2.11.2 Storage Locker in the Clean Room

No storage of personal items or supplies is permitted within the gowning room of the Clean Room. One locker is provided to each user for storage of their samples, wafers, tweezers, and notebooks. These bins are located in the Clean Room. No hazardous chemicals are to be stored in these bins. All chemical storage must be arranged through the 4D LABS staff.

Users are responsible to clean-up after themselves whether working inside or outside of the Clean Room. No samples, notebooks or waste should be left overnight on the counters. Users need to put away all their own samples and supplies on a daily basis. Each user should also return all supplies, chemicals, and labware to its proper place of storage within the User Facility.

2.12 Alarms and Evacuation Procedures

The 6000 level of TASC 2 has two different alarm types and corresponding evacuation procedures: Fire Alarm and Gas Alarm. Regardless of the alarm type, personnel must not delay for any reason during evacuation.

2.12.1 Fire Alarm

In the event of a fire alarm, all personnel are required to evacuate immediately via the nearest safe exit. Do not re-enter the building until it is deemed safe to do so by Campus Security. Assemble on the grassy slope area located outside the TASC 2 south main entrance and await instructions from Emergency Responders. For further information, please refer to the TASC 2 Evacuation Plan boards located throughout the building.

2.12.2 Gas Alarm

In the event of a gas leak, the system will trigger either a level 1 or level 2 gas alarm based on the gas concentration detected.

Level 1

The level 1 gas alarm is activated when a detected gas leak is at the 8hr safe exposure limit. In such an event, a blue strobe and horn alarm will sound throughout the 6000lvl of 4D LABS in TASC 2. All personnel located within the 6000lvl of 4D LABS are required to evacuate immediately to the TASC 2 6000 level atrium and await further instruction from Emergency Responders. Do not re-enter the building until it is deemed safe to do so by 4D LABS Staff and Campus Security. It is important to acknowledge that a level 1 alarm may quickly escalate to a level 2 alarm.

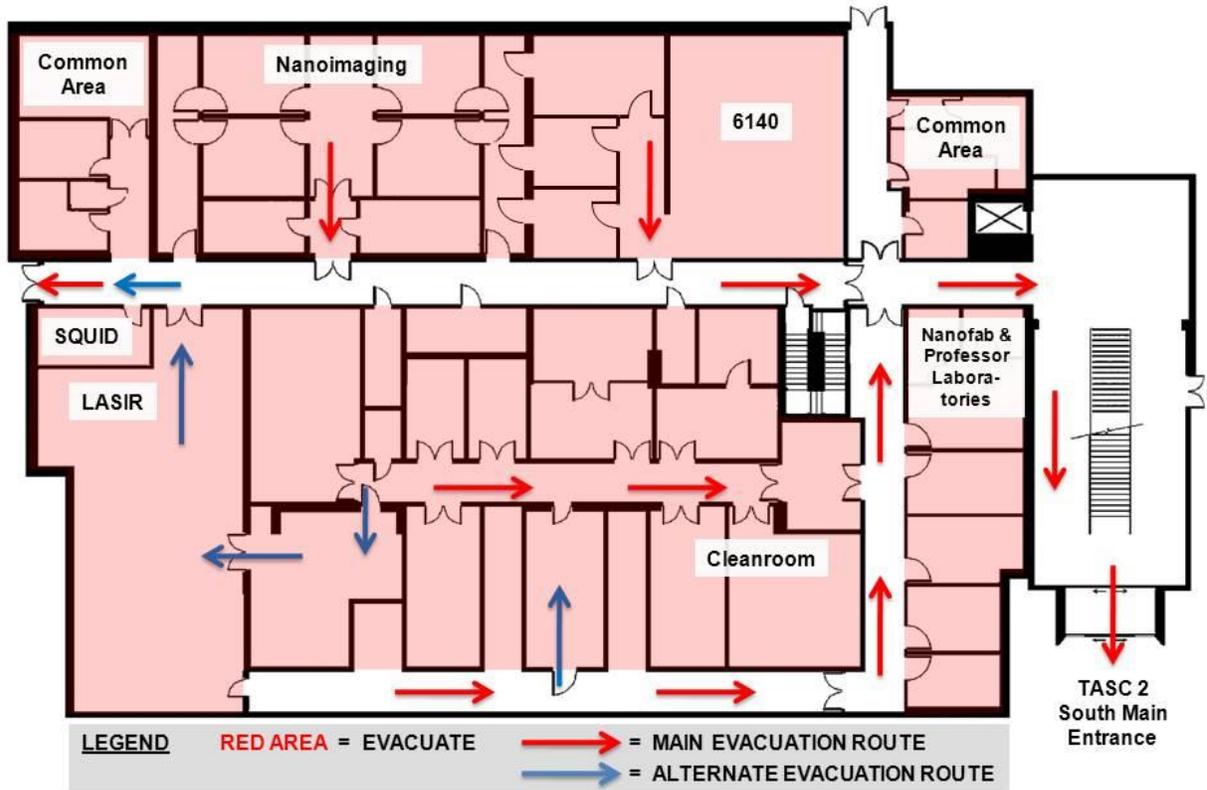
Level 2

The level 2 gas alarm is activated when a detected gas leak has exceeded the 15min safe exposure limit. In such an event, the fire alarm is automatically triggered and all TASC 2 personnel are required to follow the fire alarm evacuation procedure, as previously described.

2.12.3 Clean Room Evacuation

During a fire alarm, or level 1 or level 2 gas alarm, all Clean Room personnel are required to evacuate immediately. *Personnel must not degown in the gowning area* as this can create unwanted traffic in the evacuation route and slow down evacuees that are in need of medical attention. Once evacuated, Clean Room personnel must remain within the assembly area until they are accounted for by the Emergency Responders who will be checking the Clean Room log sheet and ensuring that all personnel have evacuated.

2.13 Evacuation Routes



2.14 Fire Extinguishers

Carbon dioxide fire extinguishers covering Class B and Class C fires (electrical and chemical) are wall-mounted throughout the User Facility. Under no circumstances should a Class A-B-C dry powder extinguisher be discharged in the Clean Room or any Greyspace area. The resulting contamination from use of a dry powder extinguisher would be catastrophic in the Clean Room.

Standard fire emergency protocols must be followed by all users at all times. The presence of fire extinguishers in the User Facility in no way represents a recommendation to stand and fight a fire; evacuation of personnel and initiating a building fire alarm are the only recommended courses of action in the event of fire.

Should a person decide to extinguish a small fire or spark situation, he/she must bear in mind the very limited capacity of the carbon dioxide extinguishers in the facility, and apply the extinguisher stream to

the source of ignition as instructed in laboratory safety training at SFU. The person who elects to fight a small fire must situate him/herself with his/her back to a clear fire exit presenting a route for a quick exit from the area of the fire.

3. Equipment use

3.1 Equipment Operation

The process equipment in the 4D LABS User Facility is highly sophisticated and delicate, and can be potentially hazardous if not used properly. Each instrument has operating instructions, restrictions, and safety rules in place to ensure safe and proper operation of the instrument. Failure to follow proper procedures can result in personal injury, expensive equipment damage, and costly down time. Should any incident occur during a session that makes the tool unavailable, the user should make sure that the tool owner is notified immediately and write down what happened in the logbook. If the tool owner is not available at the moment, the user should send an email/phone message immediately to the tool owner, and write a sign by the tool indicating that the tool is down. Incoming users should not use the tool when such a condition exists.

Users are **NOT** allowed to take phone calls or check messages when actively using our tools (e.g., hands on the tool). If you must take a call or check a message, ensure the tool is in a safe state and step away from the tool to take the call.

Assistance lasting longer than 15 minutes will be charged at our standard training rates. Unless these sessions are scheduled in advance, there is no guarantee of staff availability. Please note that troubleshooting a problem with the tool will not be charged.

Some tools have multiple options. Users should discuss with the appropriate tool owner which functions to learn first. Inexperienced users must start with the basic functions. Users will **NOT** get trained on advanced functions until sufficient tool experience has been recognized by the tool owner. Training on advanced functions will be charged, and divided to multiple phases as needed. Qualified users are encouraged to work together to get the most out of the tools. However, functions that have not been demonstrated on the specific tool should only be tested in the presence of and with the permission of the relevant tool owner.

Users must not handle liquid nitrogen and/or gas cylinders without receiving the appropriate safety training and should ask for assistance from the tool owner for handling liquid nitrogen and/or gas cylinders.

3.2 Equipment Booking

All use of major equipment in the User Facility must be scheduled in advance on our booking website. If you must change a booking, please do so at least 8 hours prior to the appointment. In addition to scheduling, all equipment use must be recorded in the electronic booking system *and* in the log book next to the tool. The spreadsheet is for billing purposes and the log book is for maintenance purposes. Misuse of these scheduling and billing systems will result in disciplinary actions according to our policies.

3.3 Computer/Internet Use in the User Facility

There are numerous computer systems throughout the 4D LABS Facility including several general-use workstations. All computers in the facility are for work use only and not for personal use. In addition, the Internet is available on several computers for data transfer and research. Users are not permitted to download anything other than research papers or related material (no music, movies, etc.). No software may be installed on the computers in either Facility without permission. If a user needs a special program installed, they must discuss it with a staff member.

Users must not use the computers in either Facility for long-term data storage. All research data should be transferred to personal computers as soon as possible. Data may be transferred with a USB drive or sent by email. All user files may be periodically removed from facility computers.

3.4 General Guidelines for Using Electron Microscopes

Any samples that might have magnetic properties should be brought to the attention of the tool owners before samples are placed in the tools. Screening of those samples is needed to avoid potential contamination or damage to our tools. Please knock gently on the door and ask for permission if you intend to visit a tool suite where someone might be working. Work with electron microscopes is very vibration-sensitive. Please open and close doors gently.

3.5 Maintenance and Troubleshooting

All maintenance, repair, and troubleshooting activities will be conducted solely by 4D LABS staff. Under no circumstances will any user undertake such activities on any process equipment. Any equipment problems must be immediately reported to 4D LABS staff, who will take the necessary steps to resolve equipment issues.

4. Overview of Laboratory Hazards

The User Facilities at 4D LABS houses many process tools which are serviced by high voltage electricity, pressurized gases, liquid chemicals, radiation sources, and mechanical components. Each of these utilities poses its own set of risks to the user, who must be aware of the presence of hazards on the specific tools he/she is using.

Hazards in the 4D LABS User Facilities fall into several general categories. The first consists of wet chemicals including acids, bases, and organic solvents commonly used for etching and lithography. Secondly, the facility uses a variety of compressed gases, some of which are toxic, corrosive, flammable, or explosive. The third mechanical hazards exist wherever drive belts, pulleys, lead screws, and chamber lids are present. Electrical hazards, always exist when using the process equipment inside the Facilities. Radiation hazards are presented by Radio Frequency generators, laser sources, infrared lamps, and ultraviolet light. Thermal hazards exist where process tools produce high heat or extreme cold in their operation. Seismic hazards are present in buildings located in regions of potential seismic activity, such as the greater Vancouver metropolitan area.

4.1 Wet Chemical Hazards

Chemicals commonly used in the laboratory can cause severe burns, deep tissue injury, organ damage, and can ignite and explode. The greatest health risks posed by liquid chemicals are environmental (fire, explosion), direct contact with skin and eyes (tissue damage), and inhalation (pulmonary damage or long term chronic effects). Make every effort to understand the chemical processes you use and respect the

chemicals you work with. Knowing the general rules for how to safely transport, pour, use, and dispose of these chemicals is every user's responsibility. If unsure of the hazards of a particular chemical, or the method of proper use, consult the SDS and/or contact a staff member.

4.2 Chemical hazard classification

4.2.1 Corrosives

A corrosive (or "caustic") chemical destroys or permanently damages living tissue. On contact, corrosives can destroy skin and underlying tissues. Splashes in the eyes can cause blindness. Inhalation of vapors can destroy lung tissue. Corrosives in the laboratory include acids and bases. In case of localized external exposure, promptly flush the affected area with plenty of water for at least 15 minutes. Exposure of the eyes to corrosive chemicals is extremely serious; flush immediately, either with a spray gun at your wetbench or the nearest eyewash station. For any exposure to corrosives, you should get help. The victim should be taken to the emergency center for evaluation and treatment.

4.2.2 Oxidizers

Technically, an oxidizing agent is a chemical compound that readily gains electrons in a chemical reaction. When mixed with compounds that can act as reducing agents, the result is often a violent reaction, possibly an explosion. Oxidizers should not be stored or mixed with solvents that generally make excellent reducing agents. The most commonly noted example of an oxidizer in the laboratory is hydrogen peroxide. However, other compounds, such as acetic acid and nitric acid, are oxidizers as well as corrosives.

4.2.3 Water Reactives

Water reactive is used to describe compounds (generally concentrated acids and bases), which very quickly generate heat and/or gas upon mixing with water. The primary hazard presented by water-reactive compounds is incomplete mixing, which can lead to superheating and explosion. Thus, water-reactive mixtures should never be poured directly into a sink drain.

4.2.4 Flammables

These compounds include most solvents, such as acetone, isopropanol, and methanol. In air, above a critical concentration, called the "flash point", the vapors from a flammable can ignite and explode. The source of ignition may be heat (such as a hot plate) or a spark (such as from an electrical tool). Because the vapors can travel over considerable distances, the source of ignition can be far away from the flammables container itself.

To minimize hazards, always work well within the exhausted area of the appropriate wetbench. The air pulled into the exhaust area will keep the concentration of vapors below the flash point. Where possible, minimize the quantities of flammables used. Before working with flammables, always note the location of the nearest safety shower and fire extinguisher. Flammables should be stored in the designated flammables cabinet; no flammables may be stored elsewhere in the laboratory.

4.2.5 Toxics and Poisons

A toxic material is one that has poisonous or harmful effects on the human body. Care must be taken to limit or avoid exposure to such materials, and to use proper personal protective equipment when exposure is unavoidable.

4.2.6 Non-toxics

A non-toxic material is one that is not likely to result in harmful effects with *normal* use. This designation is used sparingly. Pure water is considered non-toxic.

4.3 Gas Hazards

Compressed gases pose both chemical and physical hazards. The primary health risks posed by gases are the physical hazards (fire, explosion) and inhalation (toxics and corrosives). Because of these potential hazards, safe use of these gases is strictly controlled by Provincial and local regulations, as well as by SFU policy. Although potential hazards are minimized by use of engineering controls and the toxic gas monitoring system, as a user, you must still be aware of the types of gases and the hazards posed in the equipment you operate.

The following hazardous gases are used in the Clean Room:

Gas	Assay	Hazard
100% Silane	SiH ₄	Spontaneous ignition. Toxic.
Dichlorosilane	SiCl ₂ H ₂	Corrosive. Toxic.
Ammonia	NH ₃	Corrosive. Toxic.
Hydrogen	H ₂	Flammable.
Boron Trichloride	BCl ₃	Highly Toxic.
Chlorine	Cl ₂	Corrosive. Highly Toxic.
Oxygen	O ₂	Combustible
Nitrogen	N ₂	Asphyxiation
<i>Several Noble Gases</i>	Ar or He	Asphyxiation
<i>Several Fluorinated Gases</i>	SF ₆ , CF ₄ , or CHF ₃	Asphyxiation

4.4 Mechanical Hazards

Mechanical hazards may be posed by many pieces of equipment and their support equipment found in the User Facility and Greyspace areas of 4D LABS. Typical hazards might include pinching of fingers and snagging of clothing, posed by various exposed gears, stepper motors, or vacuum chamber lids. All users are advised to use common sense and basic precautions when working around such pinch and snag hazards.

4.5 Electrical Hazards

The danger of injury due to electrical shock is present wherever electricity is used. Although all equipment is interlocked to prevent exposing users to electrical hazards, you must be acquainted with the electrical hazards that may be encountered on the tool you are using.

The primary effects of electric shock are due to current flowing through the body. Burns occur wherever the body completes a circuit connecting the power source with the ground. Although the resistance of dry, unbroken skin to electric current is relatively high, the amount of current needed to kill a

person is small. It is easy to exceed lethal levels of current, especially if the skin is broken, wet, or damp with sweat.

Unless it is in your training, never open electrical enclosures or cabinets on equipment, even when the power is off. If you feel an electrical "tingle" when you touch a piece of equipment, stop using the tool and immediately notify 4D LABS staff. Never stick your hands, fingers or conductive tools inside equipment. Immediately notify 4D LABS staff of any potential electrical hazard that you notice.

4.5.1 Emergency Procedures for Electrical Accidents

1. Do not touch the person. Touching the victim can result in you also becoming a victim.
2. Call/shout for help. Notify 4D LABS staff and have someone call Campus Security (2-4500).
3. Shut off the electrical power if possible.
4. Remove the victim from the live contact using a nonconductive material such as a hard rubber or wood rod, as quickly as possible.
5. Keep the victim warm and accompany them until help arrives.
6. Following the accident, complete an SFU incident report.

4.6 Radiation Hazards

4.6.1 Ultraviolet Radiation

All relevant equipment is shielded to prevent direct exposure, but exposure risks may arise from reflection. Report to the 4D LABS staff any damage to shielding on the equipment or to the protective goggles. While the user is allowed to look at the plasma cloud of some process tools through viewing ports to check for appropriate coloration of the plasma, he/she should limit their optical exposure time as a precautionary measure. Do not compromise the safety interlocks on these tools.

4.6.2 Electromagnetic Radiation

Electromagnetic radiation is a hazard presented by equipment using Radio Frequency (RF) power. If you have a pacemaker, be aware that RF sources are present in the laboratory. All equipment is shielded to prevent exposure; report to 4D LABS staff any damage to shielding on the equipment or cables.

4.7 Thermal Hazards

4.7.1 Cold Hazards

The user is advised to be cautious around any potential cold hazards. It is important to not touch anything that is a cold hazard or is not insulated against a cold hazard with any bare or inappropriately covered skin. The primary risk lies in the possibility of skin freezing to the unit on contact, causing it to stick. Depending on the duration of skin contact, the possibility of deep tissue freezing or frostbite exists and should be avoided. Cold hazards also exist where liquid nitrogen is used in the cold trap for some equipment.

4.7.2 Burn Hazards

Hot surfaces exist in the User Facility that can pose a contact hazard for the user. Hot plates, ovens and furnaces are used within the Fabrication Facility. Care must be taken when removing beakers or other receptacles since there are no visible indicators of heat on glassware. Any hot plates found unattended and without appropriate notation in the log book will be turned off immediately.

4.8 Seismic Hazards

In the event of seismic activity, 4D LABS users are advised to follow standard recommendations to avoid personal injury from falling objects or from falling structural elements of the building. These recommendations are as follows:

1. Move to seek the cover of a heavy table or furniture that will shield you from falling or flying debris. Practice the “duck, cover, hold” technique of covering the head and neck with your arms while holding onto the furniture protecting your body.
2. Count to 60 after all shaking stops, then evacuate the facility and make your way to the Evacuation Assembly Point on the grassy hill on the south side of the TASC2 building. Remain alert for overhead power lines, downed power lines, and any structures overhead that could fall during an after-shock.
3. Do not re-enter the building until instructed to do so. There is a high probability of after-shocks following the initial shake, some of which may be more powerful than the initial earthquake. After-shocks may also cause objects or structural elements to move even if they seemed stable during the initial

earthquake activity; the loosening effect of the first shake may set the stage for further damage to take place during subsequent seismic activity.

5. Chemical Safety

5.1 Chemical Handling and Labeling

Handling chemicals in the User Facility is a common practice. Chemicals are periodically refreshed and are brought into the User Facility by staff. Clean Room chemicals are retrieved from the chemical storage area and are introduced into the Clean Room via a pass-through by Clean Room staff.

- **Transport:** Use a transport cart with a secondary container or bottle carriers when moving bottles containing chemicals. Use caution and proceed slowly when transporting chemicals. Do not transport chemicals that are incompatible with one another. Never transport acids with solvents or bases. Acids can produce heat from an exothermic reaction and can lead to ignition of solvents. Acids mixed with strong bases can produce violent reactions that can cause the chemicals to suddenly splash onto personnel.
- **Chemical Deliveries:** A 4D LABS staff member will receive chemicals and place them into appropriate chemical storage cabinets, refrigerator, or shelves. All bottled chemicals must be handled with chemically resistant gloves and eye protection. It is a recommended practice to wash hands after handling chemicals and chemical containers.
- **Pouring:** Move slowly, and hold the bottle with two hands. One hand should be firmly around the neck and the other hand should support the bottom of the bottle. Immediately clean up any chemical residue on the outside of the bottle.
- **Labeling:** All chemical containers are required to be labeled using an appropriate marking pen, even if they will not be left unattended. Containers should be labeled before chemicals are poured in. Moreover, if you are using a fresh, previously unopened bottle of chemical, label it with the date that it is opened.

You can use plastic ID labels when using chemicals in Petri dishes or beakers. Labels **must** identify:

1. Contents (i.e. chemical name and concentration)
2. User's first & last names; initials are insufficient.
3. Notable hazards or important safe handling information (e.g. spontaneous ignition, toxic fumes, etc.).
4. Date

If the chemicals are to be left unattended on a wetbench also include what time the user will return to the chemical and contact information for the user.

5.2 Chemical Personal Protective Equipment

Personal Protective Equipment (PPE) is mandatory when using chemicals. It is important to be aware of the proper personal protective equipment for each process. Some chemicals and toxic gases require specialized PPE training, and this equipment cannot be used without proper training. Secondary gloves are required for most chemical processes. The personal protective equipment available to all users in the Wet Labs is listed below:

- Acid Aprons
- Nitrile gloves*
- Wrist-length neoprene and nitrile gloves
- Face shields, safety glasses, and safety goggles

* Nitrile gloves used in the Clean Room provide minimal chemical protection, and are primarily used to control human particulate contamination. A second set of gloves (e.g., neoprene or nitrile gloves) is recommended for chemical handling.

For PPE to be effective, proper use is essential. The following describes the procedures required to provide maximum protection when using the supplied PPE.

- **Adjustable face shield:** The face shield is used in conjunction with safety glasses. It can be adjusted to fit most head sizes. There are adjustment knobs on the straps that can be used to tighten the apparatus around the head. There are other adjustment knobs that can be used to make the face shield snug and secure. Do not use the face shield if the adjustments are too loose; it may fall off your head or otherwise obscure your vision.
- **Secondary Chemical gloves:** Choose gloves that fit over the mandatory protective nitrile glove. A

glove that is too loose will not provide the required dexterity needed to use the chemical process equipment (e.g., timer buttons, tweezers, and wetbench controls).

5.3 Eyewash Stations and Safety Showers

The safety showers and eyewash stations are to be used in the event of spillage or splashing of wet chemicals onto a person's clothing, skin, or eyes. It is critical that any person suffering contact with wet chemicals in the Wet Labs act quickly to flush the contact area with a large volume of water as the first step taken in response to the emergency.

In the event of clothing or skin contact, the person must step under the safety shower and activate full flow of water by pulling down on the overhead handle while still fully clothed. While standing under the safety shower stream, the person must disrobe completely and pile their clothing for decontamination and/or disposal. The person must remain under the full stream of water for a minimum of 15 minutes, during which time their laboratory buddy or 4D LABS staff must place a call to Campus Security at 2-4500 to report the emergency.

In the event of eye contact, the person must manually hold open their eyes, lean over the eyewash outlets, and activate full water flow into their eyes using the foot paddle control attached to the eyewash station. Rinsing of the open eyes should be done for a minimum of 15 minutes, during which time their laboratory buddy or 4D LABS staff must call Campus Security at 2-4500 to report the incident.

- **Eyewash stations**

- Located at the end of the chemical wetbench in room 6060.3
- Also located in the corridors immediately outside the Clean Room and outside room 6140

- **Safety Showers**

- Located at the end of the wetbench in room 6060.3
- Also located in the corridor outside room 6140

5.4 Safety Data Sheets (SDSs)

SDSs provide information about all chemicals (wet and gaseous) used in the 4D LABS User Facility. Each sheet includes data on product composition, reactivity, health effects, necessary personal protective equipment (PPE), exposure prevention measures, and emergency procedures.

Full copies of SDSs are available on several labeled computers throughout the User Facility. Users are advised to refer to these to refresh their knowledge of hazards and procedures before starting work on any process tool.

5.5 Chemical Spills and Chemical Spill Response

5.5.1 Initial Response and Risk Assessment

If an explosion hazard, fire hazard, and/or toxicity hazard exists:

1. Pull the fire alarm and evacuate all personnel.
2. If safe to do so, turn off ignition sources and nearby equipment.
3. Do not attempt to remove injured persons if doing so risks your health and/or safety, or risks further injury to the injured.
4. If safe to do so, note the hazardous materials involved. Arrange to secure the Safety Data Sheet (SDS) for the materials involved in the incident. The SDS will be needed by responding emergency personnel.
5. Evacuate the building and locate 4D LABS staff and Campus Security emergency responders to relay significant details about the emergency.
6. Submit an online EHS Incident Report.
7. If no immediate safety risk is present, proceed to Spill Size Assessment.

5.5.2 Spill Size Assessment

A major spill is:

1. A spill of 50mL or greater, **or**;
2. At risk of chemical vapours exceeding safe levels during spill cleanup.

A minor spill is:

1. One that does not meet the major spill criteria, **and**;

2. Is assessed to pose minimal risk to lab occupants

5.5.3 Spill Responses

In the event of a major spill:

1. Alert others nearby and immediately evacuate the area. DO NOT ATTEMPT TO CLEAN UP.
2. Call Campus Security at 2-4500.
3. Call 4D LABS staff.
4. Put a barrier and sign to prevent entry to the affected area.
5. Standby for emergency responders and provide information as per request.
6. Submit an online EHS Incident Report.

In the event of a minor spill:

1. Alert others nearby and inform them of the potential risks. Ensure you are working in a well ventilated area.
2. If in need of assistance, contact the appropriate 4D LABS staff member.
3. Select the appropriate clean up procedure for the type of spill.
4. After clean-up, rinse contaminated PPE with plenty of water to remove any chemical residues before reusing.
5. Notify 4D LABS staff to replenish materials used for spill response and to discuss corrective/mitigative action for future occurrences.

5.5.4 Clean-up Procedures

Solvents

1. Retrieve the universal sorbent pads, located within the wall box inside the Acid Bench Room.
2. Place a sorbent pad on the spill. Ensure to catch any chemical runoff.
3. Dispose the pad(s) into a plastic bag. (Plastic bags are located on the top of the wall box.)
4. Label the plastic bag indicating the appropriate solvent(s) and place the plastic bag into Transfer Bay 1 (OUT).
5. Request 4D LABS staff to place a hazardous waste pick up request on your behalf.

Hydrofluoric Acid (HF)

1. Ensure that all required Personal Protective Equipment (PPE) is equipped as mandated.

2. Gently spray with the HF Acid Eater, working from the outside of the spill inward.
3. Test with pH paper to confirm neutralization (the PH should be between 6 and 9).
4. Allow neutralized liquid to cool.
5. Retrieve the universal sorbent pads, located within the wall box inside the Acid Bench Room.
6. Place a sorbent pad on the neutralized spill. Ensure to catch any chemical runoff.
7. Place used sorbents into the normal garbage can for disposal (follow appropriate waste disposal guidelines).
8. Clean the spill surface area with water at least two times and wipe to dry.

Acids

1. Find the acid neutralizer bottle.
2. Gently spray with the acid neutralizer, working from the outside of the spill inward.
3. Test with pH paper to confirm neutralization (the PH should be between 6 and 9).
4. Allow neutralized liquid to cool.
5. Retrieve the universal sorbent pads, located within the wall box inside the Acid Bench Room.
6. Place a sorbent pad on the neutralized spill. Ensure to catch any chemical runoff.
7. Place used sorbents into the normal garbage can for disposal (follow appropriate waste disposal guidelines).
8. Clean the spill surface area with water at least two times and wipe to dry.

Bases

1. Find the base neutralizer bottle (Do NOT use Kolorsafe Base Neutralizer on any solution containing metallic nitrates, cyanides, sulfides, oxidizers, or hypochlorate solutions).
2. Gently spray with the base neutralizer, working from the outside of the spill inward.
3. Test with pH paper to confirm neutralization (the PH should be between 6 and 9).
4. Allow neutralized liquid to cool.
5. Retrieve the universal sorbent pads, located within the wall box inside the Acid Bench Room.
6. Place a sorbent pad on the neutralized spill. Ensure to catch any chemical runoff.
7. Place used sorbents into the normal garbage can for disposal (follow appropriate waste disposal guidelines).
8. Clean the spill surface area with water at least two times and wipe to dry.

6. Chemical Policies

6.1 Wetbench Usage Guidelines

The 4D LABS User Facility provides several wetbench process tools: an organic bench for acetone, isopropanol, and other organic solvents; an acid bench for acids, such as hydrofluoric acid, and BOE; and a developer bench for developing photoresists and cleaning of quartz tubes. The following are guidelines for the proper and safe use of each of the wetbench areas.

1. Safety glasses and nitrile gloves are the basic level of required PPE; most chemicals require additional PPE.
2. The wetbench areas must be kept clean at all times to avoid cross-contamination of samples.
3. Heating of any solvents on the wetbenches must be approved by 4D LABS staff. Appropriate signage and labels are required during heating to avoid injury to other users and/or a solvent fire.
4. All waste solvents, acids, and developers must be collected and put into the appropriately labeled waste solution receptacles. Be very cautious to avoid accidental mixing of waste; waste should only be added to appropriately designated and labeled waste containers. If you cannot find an appropriate waste container, contact the 4D LABS staff. There is no dumping of waste solutions directly down wetbench drains.
5. In the case of HF and BOE solutions used at the acid wetbench, it is permitted to pour waste solutions down the specific drain that lead to the HF neutralization tank.
6. When quartz tube cleaning is done at the developer wetbench, the waste solution will be directed to drain into the HF neutralization tank. This process is carried out by 4D LABS staff.
7. Acid waste, base waste, and organic solvent waste must never be mixed together in the same container; this can produce an explosive reaction. Even some solutions of acids must not be mixed and must be discarded in separate containers to avoid explosive reactions. If you have any questions regarding waste disposal, ask the 4D LABS staff for assistance.

6.2 New Chemical Approvals

To get clearance for new chemicals, users should provide the following information in electronic form to the appropriate 4D LABS staff member.

- SDS
- quantity of chemicals to be stored in 4D LABS
- intended purpose of the chemicals
- equipment that will be used with the chemicals
- protective gear and other supplies that may be needed
- disposal plan

The new chemical approval form can be found on the policies page of the 4D LABS users site. Permission will be granted for new chemicals on a case-by-case basis. The determination will be based on the hazard of the substance towards equipment or personnel. The following categories of chemicals are banned:

- powders due to the hazard of generating particulates in the Clean Room
- thiols and silanes due to the contamination hazard of surfaces in the Clean Room

In general, each wetbench is dedicated for a specific class of chemicals. The organic bench is used for all organic and halogenated solvents. It is also used for spin-coating hazardous materials, such as nanoparticles. The acid wetbench is assigned to acids and bases, including most etchants. The developer wetbench is used mainly for aqueous solutions, such as photoresist developers. The plan for newly approved chemicals will include information regarding where the work is to take place and a disposal plan for any generated waste. If necessary, the plan must also include a spill response procedure for chemicals requiring a response different from those outlined above.

6.3 Labware Use & Cleaning

6.3.1 Labware

Use chemical containers of the appropriate size as well as an appropriate material in order to minimize waste and hazards. Bear in mind that chemical disposal costs may be higher than the original cost of the chemical. If a solution is to be heated, only glass should be used. Because HF is incompatible with glass, only plastic ware should be used at room temperature for an HF process. If your research requires

heated HF, contact the Clean Room staff to advise on specific plastic materials that will withstand your temperature requirement.

Clean glassware and plastic ware for general use are available on storage shelves in the wetbench rooms. Users are not authorized to store labware for their own use. Some labware has been designated for specific chemicals. If it is available for your process chemistry, use the designated labware. If there is no labware of the appropriate size designated for your process, use unlabeled labware; **do not use labware designated for a different process chemistry.**

Before any chemicals are used, it is the user's responsibility to be familiar with chemical hazards, to be aware of the specific waste disposal policies for those chemicals, and to ensure that there is a suitable waste disposal container available. Each user is responsible for disposing of waste appropriately and cleaning and drying the labware which they have used promptly.

6.3.2 Wetbench Cleanup

When the user has finished working on a wetbench, all items placed on the bench by the user should be removed, including containers, wipes, thermometers, and hot plates. Any wipes with water soluble chemicals on them should be rinsed, squeezed dry, and placed in a garbage can. Any chemicals spilled on the wetbench must be cleaned up by the user. Any chemicals used by the user should be disposed of in a designated waste container.

Chemicals which are to be used again later in the day may be left on a wetbench; however, there is not sufficient room on the wetbenches to allow users to store chemicals for long periods of time. By the end of each day, all items used should be cleaned up, except as follows. Hot chemicals may be left overnight to cool but a note to this effect must be placed on the container. If required by the process, substrates may be left to soak overnight but, again, a note to this effect must be left on the container. Whenever a chemical container is left on the wetbench overnight it must follow the labware label guidelines. It should be cleaned up promptly the next day.

6.3.3 Cleaning of Labware

1. Thoroughly rinse labware three times with DI water.
2. Place labware in basin on top of dishwasher in wetbench room to be cleaned.

6.4 Chemical Storage

Chemicals are to be stored in properly designated areas; these include clearly labeled chemical cabinets or the refrigerator. Transfer chemicals only in the appropriate fume hood. Note that each fume hood (or wetbench) is designated for a specific type of chemistry and set of processes. These chemistries are not to be mixed. The Clean Room has separate chemical fume hoods for organic solvents, bases, and acids, and the hoods are labeled accordingly. Do not store incompatible substances next to each other. If you do not know what chemicals are incompatible you must contact a 4D LABS staff member before using the chemicals.

6.5 Chemical Waste Disposal

Chemical waste generated in the Wet Labs must be stored in a properly labeled container and placed in the designated storage areas. SFU is contracted with a company for the removal and disposal of chemical waste. Waste is removed on specific days. **DO NOT take chemical waste to Science Stores.** 4D LABS staff will assist with making the necessary arrangements for chemical disposal using information that you provide to them. Labels on waste containers must indicate all chemical contents (no chemical formulas) as well as concentrations.

6.5.1 Liquid Chemical Waste Disposal Procedure

1. Select an appropriate waste container for the solvent you are disposing.

Note: If you cannot find an appropriate waste container or it is full, request assistance from the 4D LABS staff.

2. Place the waste container into the sink in the bench. Then remove the container cap.
3. Use an appropriate funnel labelled "For Waste Disposal" and place it into the waste container. Glass and plastic funnels are available in the cleanroom.
4. Pour the liquid waste very slowly into the container. Make sure the waste chemical is at room temperature before dumping it into the waste container.
5. Put the cap back on the waste container. Make sure you do not overtighten the caps.
6. Get a cleanroom wipe and wipe the bottom of waste container. Ensure it is dry.
7. Return the waste container to its storage location.

8. Rinse the funnel into the sink with plenty of water and return the funnel to its original tray.
9. Rinse the cleanroom wipe thoroughly with water and dispose of it in the chemical solid waste garbage.

6.6 Disposal of Sharps

Under no circumstance are any sharps to be disposed of with regular trash. Improper disposal could endanger 4D LABS staff or other SFU staff involved with the disposal of the trash. In all circumstances the sharps should be discarded in the appropriate waste disposal container and 4D LABS staff will arrange for further disposal. There are sharps disposal containers in Transfer Bay 1 (near the acid wetbench) and on the shelf in the spin coater room.

6.7 Disposal of Empty Bottles

Empty plastic or glass solvent bottles must be kept in the solvent cart located near the organic wetbench. 4D LABS staff will clean these bottles. Appropriate bottles will be recycled as waste containers, and staff will change the label for the designated chemical waste. Do not leave empty photoresist bottles inside the fridge. Store these bottles in the "Out" bay of Transfer Bay 1 located in the acid wetbench room.

6.8 Hydrofluoric Acid (HF)

Hydrofluoric acid (HF) poses unusual hazards to the user and requires unique safety measures. Hydrofluoric acid (HF) is an extremely dangerous chemical. Because it is commonly used in the Clean Room in various concentrations, you may become exposed to HF even if you do not use it. Therefore, you must be aware of HF safety procedures. The primary hazard lies in HF contact with skin and/or clothing of the user. A secondary hazard is associated with inhalation of HF fumes. In the event of a spill, HF requires specific containment, neutralization, and disposal procedures. The area where HF is used and stored is limited to the acid wetbench area. A HF Acid Eater Spill Kit (including absorbents) and the Emergency Kit for Hydrofluoric Acid are both located near the acid wetbench. Stay alert and work carefully in this area of the Clean Room.

6.8.1 Personal Protection Equipment (PPE)

PPE consists of nitrile gauntlets, an apron covering your Clean Room smock, and a full face shield. Special care must be taken to prevent dripping or splashing of HF onto your feet or lower legs; standard Clean Room booties and footwear will not serve as an adequate barrier to HF exposure.

6.8.2 Contact Exposure

Skin and eye contact with HF are to be avoided at all cost. While there is little or no physical pain experienced by the user upon contact, HF will pass through soft tissue and react with the skeletal system, breaking down and consuming bone calcium. There may be a rosy light red patch of skin discoloration at the point of contact, but this sign is often ignored or discounted in the absence of significant physical pain. Pain may only be associated with exposure to high concentrations of HF, and the onset of pain may also be delayed by a few hours as the HF reacts with calcium in the nervous system. If you feel you may have been exposed, it is best to take immediate preventative action. If you are exposed to HF, follow the procedures listed below:

1. Immediately remove contaminated clothing.
2. Rinse with copious amounts of water under a Safety Shower or eye wash.
3. Report the exposure to your laboratory buddy or Clean Room staff.
4. Apply Calcium Gluconate gel by a gentle massage onto the exposed area of skin for 15 minutes (do not use on eyes). Calcium Gluconate is stored in the "Emergency Kit for Hydrofluoric Acid Burns" located in the acid wetbench room.
5. Call **2-4500** to report the incident.
6. Continue to monitor the exposed area; a buddy or safety officer will need to continue to monitor your health. If conditions worsen, you will need to be taken to a hospital.
7. Fill out an SFU incident report form.

6.8.3 Inhalation Exposure

All laboratory work with HF should be performed using an approved fume hood, which provides constant exhaust air flow across the sample or container. If inhalation exposure is suspected:

1. Remove the affected person to fresh air.

2. Give mylanta or 4 effervescent calcium gluconate tablets (600 mg) by mouth every 2 hours until the patient is admitted to hospital. These tablets can also be found in the "Emergency Kit for Hydrofluoric Acid Burns".
3. Call **2-4500** to report the incident.
4. Fill out an SFU incident report form.

6.9 Nanoparticles

All nanoparticle sample preparation must be done inside a fume hood. Working inside a fume hood minimizes exposure to potentially harmful gases, vapours, aerosols and fumes. The sash also provides a physical barrier that can protect from splashes and debris. An exception may be permitted in the event the user must work with dry nanoparticle samples, e.g. powders. The user must receive permission from 4D LABS prior to any work involving nanoparticles outside a fume hood.

4D LABS has a dedicated nanoparticle workspace fume hood. Users must abide by the PPE requirements when working within the fume hood. The fume hood must be lined with clean aluminum foil at all times. If the foil is contaminated at any point, it must be replaced immediately and disposed of as nanoparticle waste. Additionally, all work must be done on top of clean disposable absorbent liners. These prevent the aluminum foil from being contaminated and provides a second layer of protection.

When working inside the wetbench, the sash should be at or below the indicated recommended height and all materials within should be located at least 15cm behind the plane of the sash. The fume-hood should be clear of any obstructions and unnecessary chemical containers to ensure good air flow.

Users must not leave behind any samples, chemicals, or equipment when concluding their work.

6.9.1 Personal Protective Equipment (PPE)

Appropriate PPE must be worn at all times. Double gloving is required for any high risk activities. High risk activities include any work that is likely to cause contact with nanoparticle materials and/or related by-product or waste. There may be other situations that warrant double gloving, thus, a thorough risk assessment must be done prior to commencing work.

When the outer gloves are contaminated, they must be removed by peeling them off and onto themselves in order to contain any nanoparticles; subsequently the outer layer gloves are included in the

nanoparticle waste to be disposed. Meanwhile, the inner gloves should remain as a clean and uncompromised layer of safety between the work environment and skin, allowing for further work or completion of work. When finished work, users must remove the final layer of gloves and wash their hands prior to exiting the room.

6.9.2 Waste Disposal

All solid nanoparticle waste must be contained in a zip-lock bag, labelled with a felt pen indicating 'nanoparticle' and materials contained, and placed within the designated waste bin located in the nanoparticle wetbench room. Examples of nanoparticle waste are gloves, absorbent liners, aluminum foil, and/or any items that have or have potentially been contaminated with nanoparticles.

All liquid/chemical nanoparticle waste must be disposed into the appropriate 5L white/translucent container and labelled accordingly. Do not fill beyond the "max. fill line" (75% full). The general waste container for nanoparticle solutions is located underneath Wetbench #9.

6.9.3 Transportation

When transporting nanoparticle solutions and/or materials, the contents must be labelled and placed in secondary containment that either snaps shut or screws on shut.

6.9.4 Weighing Guideline for Dry Nanoparticle Powders

Weighing of dry nanoparticles is recommended to be done inside of a closed chamber that is lightly exhausted.

As with the work area requirements, all work must be done on top of a clean disposable absorbent liner. No absorbent liner is required on or underneath the mass balance, however, all surrounding areas and partially side walls must be protected. Containers/vessels containing nanoparticles must only be opened and closed within the exhausted chamber. Opening/closing nanoparticle containers/vessels outside the chamber is strictly forbidden.

7. Clean Room Policies

7.1 Clean Room Gowning

All users accessing the Clean Room must wear appropriate Clean Room attire before entering. Beneath the supplied gown all users are required to provide long pants (if using a Clean Room wetbench) or knee-length shorts (if using a characterization tool or dry process), a shirt or blouse that is comfortable and non-binding, and closed-toe shoes (no sandals or skirts at any time of the year). Further personal protective equipment (PPE) may be required depending on the work of the user. Safety Glasses are required at all times when working in the Clean Room; prescription glasses are permitted but do require the use of safety goggles instead of safety glasses as the lens are exposed to the Clean Room. Contact lens users must be aware of the extra degree of care needed to prevent entrapment of substances behind the lenses; if possible, these users are encouraged to switch to conventional prescription glasses with safety goggles for their work in the Clean Room.

Proper attire serves several functions in the Clean Room environment. In addition to affording some protection to users, proper attire is designed to minimize shedding of particles from the human body into the Clean Room atmosphere. Safety glasses help to isolate and contain the constant flow of water vapour from the human eye, which is the only commonly exposed mucous membrane on the body. Nitrile gloves serve to contain oils and moisture from the human hand, which can be deposited on samples and process chambers. Face masks help to contain water vapour and droplets discharged from the mouth and nose while breathing and speaking.

7.2 Materials Policy

The only materials that may be brought into the Clean Room are those that have been approved by 4D LABS staff and management. This includes all chemicals, tools, paper goods, and other hardware that a user might wish to use in the Clean Room. The form to request access into the Clean Room for a new chemical must be completed by the user and approved by Clean Room Staff (also requires an electronic and hardcopy of the SDS, which will be kept on file) prior to bringing the chemical into the facility. Materials must be carefully cleaned using isopropanol and Clean Room wipes to minimize particulate contamination before introduction into the Clean Room. Clean Room staff will assist with appropriate instructions and supervision for bringing new materials into the Clean Room.

Please note that purses, notebooks, office pens, conventional paper items, and all outerwear cloth-

ing are not allowed in the Clean Room. Storage for such items is provided in individual lockers outside the gowning room; contact Clean Room staff for access to these lockers. Personal computers are discouraged but may be brought in if absolutely necessary, after thoroughly cleaning it. Personal music players may be used as long as they do not compromise safety. They must be at a volume where the user can easily hear a normal conversation and are not distracted by the device. Mobile phones and cameras may also be brought into the Facility provided that they are properly wiped down with isopropanol. Under no circumstances shall a user take photos of another user's work.

7.3 Power Outages

In the event of a power outage in the Clean Room, users are advised to move to the central corridor within the Clean Room that leads to the gowning area. Emergency lighting and/or flashlights will come on automatically during an electrical power outage, illuminating the way for an orderly evacuation of the Clean Room.

8. Pregnancy

Users who may be pregnant are not restricted from using the Clean Room or Wet Labs, but may want to discuss potential hazards with a SFU Environmental Health and Safety representative, their research group leader, and/or the 4D LABS management team. Some chemicals such as organic solvents and photoresists can be potentially harmful to the unborn fetus.

9. Staff Contact Information

For any questions or concerns that the users may have, contact information for the 4D LABS User Facility at SFU can be found on the Contact Us page of the 4D LABS webpage.