



Carleton University
MicroFabrication lab
(4082 Minto Building)
and
FANSSI lab
(5033/5041B Minto Building)

Facility
USER and SAFETY MANUAL

NOTES:

Refer also to the Carleton University Laboratory Health and Safety Manual - posted in the Labs at the MSDS Information sites and on the Web at [Manuals/Environmental Health and Safety](#)

rev Jan 30 2017

USER and SAFETY MANUAL
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Section 1

LABORATORY RULES

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In an emergency – contact University Safety at 4444 and a lab supervisor.

**Lab supervisors: Rob Vandusen -lab manager (ext 5761, Cell 613-791-5761),
Angela McCormick (5771)**

- **Only authorized persons** are allowed to work in the MicroFabrication (4082MC) and FANSSI Lab cleanroom (MC 5033) and wetlab (MC 5041B) Facilities. All visitors to the Microfabrication lab cleanroom must be pre-approved and escorted while in the laboratory.
- Cleanroom suits, boots, hood, safety glasses and vinyl gloves must be worn at all times within the cleanroom facilities. Shorts, open toed or hi-heel shoes or being shoeless is **NOT** permitted.
- In the case of the FANSSI wetlab (MC 5041B) – a labcoat, nitrile gloves and safety glasses must be worn at all times when working in the fumehood or at the lab benches. Whenever working with or pouring hazardous chemicals a chemical splash apron, face shield and appropriate outer protective gloves must be worn.
- **PPE.** The appropriate **Personal Protective Equipment** must be worn when dispensing or working with chemicals and hazardous materials. If unsure refer to the SDS for the material you are using and check with a lab supervisor.
- For safety reasons when working with hazardous materials or equipment a least one other person **must** be present in the lab. **It is your responsibility** to ensure someone else is present before starting a hazardous process.
- **No food or drink** of any kind is allowed in the laboratories.
- All users must have up to date [WHMIS training](#), and must read and follow the safety procedures and policies outlined in the *Microelectronics Laboratory User and Safety Manual* and the [Carleton University Laboratory Health and Safety Manual](#).
- **All chemicals and materials** being brought into the labs must be reported to the lab manager. All new hazardous processes must be reviewed.
- **Know the chemicals** you are going to be working with, and how they react to other materials in the area. **READ** the SDS for each chemical you are using. Supervisors should be notified before working with hazardous chemicals.

- Lab users will **ONLY** use equipment on which they have received training and have signed the appropriate “Record of Training” form. Instruction is given by a qualified member of the laboratory staff. Proof of training must be demonstrated to the Lab supervisor and the “Record of Training” form signed before the equipment can be used.
- **Fabrication Booking System** – Cleanroom Equipment usage and technical help must be booked through the online booking system [:https://www.doe.carleton.ca/fabbooking/](https://www.doe.carleton.ca/fabbooking/) . If you need to cancel a booking you must delete it online and inform a lab supervisor.
- **Rushing and distraction causes accidents.** Work at a safe deliberate pace. Pre-plan your experiments. Be aware that others around you may also be working with hazardous materials. Avoid sudden and fast movements (i.e., **NO RUNNING**). Approach corners and turns slowly, to avoid collisions with others. Be respectful and aware of the work others are doing. – ie Do not talk to or distract someone who working with chemicals.
- **Clean up.** If you make a mess, **clean it up.** Return everything to its original condition, or ideally, leave conditions a little better than you found them. This includes your entire set-up for experiments or projects. Wetbench counters, basins, beakers, etc. must be thoroughly rinsed and washed after use. Test counters with PH paper. The general rule for beaker and bottle rinsing is to dump rinse 3 times, then rinse thoroughly with DI water gun. Wet wipes should be thoroughly rinsed and left to dry before disposing as general waste. If you are not going to have time to cleanup after your work please leave your work for another day.
- **Labeling of chemicals** while in use and in storage is **REQUIRED.** Wetbench label tags are available. Bottles should be identified with your name, date, contents, and any relevant cautions. Proper workplace labels should be firmly attached. Bottles should be stored in the appropriate chemical storage cabinet.
- **All Unattended processes must** be properly labelled with the users name, contact information and chemicals being used. Unattended process forms are available.
- **DO NOT** attempt equipment repairs yourself. In the event that equipment fails to perform correctly, immediately notify the lab staff and note problem in log book. Leave a note on the equipment, including time, date and failure symptoms.

- Most labware (including beakers, tweezers etc.) has been assigned for specific materials and areas. Cross contamination is an ongoing concern. Use accordingly or ask if in doubt. If you need new labware please ask.
- Most processing equipment has log books. Each user will sign in the log giving the date and time he or she uses the equipment and other requested information.
- **Everyone's safety is important. Everyone's work is important.** Remember this is a shared lab. We strive to maintain safe, friendly and accessible environment for all users. Users must show respect and professionalism for all other users and lab supervisors as well as the lab itself.

Enforcement

Although we hope to never have to penalize users for not following the policies outlined above, the user must recognize that the successful operation of the facility depends on strict adherence to these policies. Adherence to these policies is essential for maintaining a safe and clean environment; it is in everyone's best interest to follow them. Unfortunately we must prepare for breaches of cleanroom policy. We reserve the right to invoke the following penalties for the listed transgressions:

- Failure to create an entry in the logbook for a particular piece of equipment and equipment booking misuse (ie failing to cancel bookings etc):
 - First offense: Verbal warning
 - Second offense: Written warning
 - Third offense: Suspension from the laboratory for 3 weeks.
- Failure to properly label chemicals or unattended processes.
 - First offense: Verbal warning
 - Second offense: Written warning
 - Third offense: Suspension from the laboratory for 3 weeks.
- Not wearing proper safety equipment or not following proper gowning/de-gowning procedure (Safety glasses, face shield while working with acids/bases at hoods, cleanroom attire):
 - First offense: Verbal warning
 - Second offense: Written warning
 - Third offense: Suspension from the laboratory for 3 weeks.
- Not cleaning up after use of the facility.
 - First offense: Verbal warning
 - Second offense: Written warning
 - Third offense: Suspension from the laboratory for 3 weeks.

Actions that may result in Immediate suspension from the laboratory for 3 weeks are

- Any blatant disregard for safety.
- Use of any equipment without being an authorized user for the equipment.
- Granting access to an unauthorized user to use equipment. No user can grant access to an unauthorized user to use equipment without his/her **constant** supervision.
- Using equipment when it is undergoing maintenance and is marked not to be used or "Machine Down". Under no circumstances is a user allowed to perform any maintenance on any equipment. Any abnormalities while using the equipment must promptly be reported to Microfabrication staff.
- Installing software on any computers or modifying equipment settings on equipment dedicated computers.
- Removing supplies and/or equipment from the facility, or bringing in unauthorized materials into the facility.

Section 2

Restrictions

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2.1 Gowning requirements for Microfabrication Lab and FANSSI cleanroom.

Shoe covers, cleanroom suits, boots, hood, safety glasses, beard cover (if necessary) and vinyl or nitrile gloves must be worn at all times in the Fablab and FANSSI cleanroom areas. Shorts, open shoes, sandals, hi-heels or being shoeless is **NOT** permitted in the Microelectronics Fabrication Facility (Fablab). Wearing of contact lenses in the lab is discouraged due to the hazard of trapping chemicals in or under your lenses. If you choose to wear contact lenses in the lab, you do so at your own risk and we strongly suggest you wear “chemical splash goggles” at all times when in the laboratory. All laboratory users **MUST** wear protective eyewear at all times when in the Fablab. For reasons of safety, headphones are not allowed in the Fablab. Safety goggles and face shields must be worn while handling hazardous chemicals. Acid resistant smocks must be worn when handling concentrated acids or any Hydrofluoric Acid (HF) solutions. Under certain circumstances, such as the presence of UV sources, further specialized eyewear may be required. Contact the lab supervisor if you anticipate this need. If your suit, boots or gloves become torn – replace them.

2.2 Cell Phone Usage

Cell phones are allowed but should not be used when operating equipment or working with chemicals. Lab members are reminded to be courteous to other members when using a cell phone.

2.3 Working Alone

For safety reasons working alone should be avoided. Someone should always be within call when a laboratory procedure is being performed.

For work with hazardous materials or procedures the supervisor has the right to require that at least one other person be present.

2.4 Use of Equipment

Lab users will **ONLY** use equipment on which they have received training and have signed the appropriate “Record of Training” form. Instruction is given by a qualified member of the laboratory staff. Proof of training must be demonstrated to the Lab supervisor and the “Record of Training” form signed before the equipment can be used. Equipment usage should be booked through the online Fabrication Booking System: <https://www.doe.carleton.ca/fabbooking/>

2.5 Cleanroom practices

- Wood, cardboard, pencils and regular paper are some of the items restricted from the cleanroom. Only pens and special cleanroom paper and cleanroom notebooks are allowed. Any items coming into the lab should be cleanroom compatible (check with lab staff). Everything must be first wiped down in the gowning area

or service bay using a cleanroom wipe and Novaclean or IPA solution. Avoid touching your face with the vinyl or nitrile gloves on – replace your gloves if you do so. Never open your suit while inside the cleanroom area-move to the change-room or service bay.

First Aid

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Injuries, such as minor burns and cuts can be treated with the first aid kit. If you use any items please let the lab supervisor know as soon as possible. The First Aid kits are located on the labeled posts in both the Diffusion Room and the Photolithography Room. The first aid kit can be removed from the wall if necessary. The following people hold St. John Ambulance Certificates in Emergency Level Safety Oriented First Aid:

<u>Name</u>	<u>Telephone</u>	<u>Room No.</u>
Rob Vandusen	520 – 2600 ext5761	4184ME
Angela McCormick	520 – 2600 ext5771	4191ME

Section 3

CHEMICAL SAFETY

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3.1 Chemical Information and Reference Materials

Risk Assessment:

A risk assessment is required in advance of all new laboratory operations to identify and resolve any risk to health, safety and the environment. See the “Procedure for a Laboratory Risk Assessment” (in Carleton University Laboratory Health and Safety Manual, Appendix 3).

A large number of chemicals are used in the Fablab. An inventory of standard chemicals is posted at the SDS display centers. If a chemical you need is not listed in the Chemical and Materials inventory, you must:

- Contact the lab supervisor to get approval to bring the chemical into the lab.
- Make sure an SDS is ordered at the time the chemical is ordered.

Chemicals cannot be brought into the Fablab until they are entered onto Carleton’s online chemical inventory system and a SDS sheet is on file in the SDS binders. SDS sheets should be given to the lab supervisor when received.

All chemicals stored in containers must have proper WHMIS labels (either Manufacturer's or Workplace) stating its contents and dated.

Chemicals for a dedicated user are designated as "special chemicals" and are inventoried separately from standard chemicals. Special chemicals should be ordered in minimum volumes, reducing high disposal costs. Your account will be charged for disposal costs of any special chemicals you bring into the Fablab.

Lab member "formulations" must also bear a "Special Chemical Formula" label detailing contents and percentages.

Lab members should familiarize themselves with the chemicals that they plan to use in their research. Do not use any chemical without first reading the SDS.

Safety Data Sheets (SDS) are required for every chemical in the Fablab. SDS are in binders located with the other chemical reference materials in the main hallway outside the photolithography room and the Diffusion room. Carleton also subscribes to the Canadian Center for Occupational Health and Safety web service which has chemical safety information and SDSs: <http://ccinfoweb.ccohs.ca/>

3.2 Protecting Yourself/PPE

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Prior to working with chemicals, make sure you are properly protected. Read the SDS of the chemicals you're working with first. If working with concentrated acids, any hydrofluoric acid (HF) solutions, corrosive or hazardous chemicals, you **MUST** wear chemically rated gloves, goggles, a full chemical resistant smock and a face shield. If gloves, smocks, or face shields aren't readily available near your location, contact a lab supervisor.

3.21 Gloves:

The vinyl/nitrile gloves you put on when you enter the lab are for the protection of lab surfaces and equipment, and are not of sufficient strength to protect against chemical burns or solvents.

Caution: A common problem with all gloves is dermatitis from the moisture held against skin while wearing gloves. If you have problems with dermatitis please report the problem to the lab supervisor.

Four types of gloves are commonly used in the lab:

- **Vinyl Gloves or Nitrile Gloves**

Located by the door to the lab. These are for the protection of lab surfaces from contamination of oils and salts on your hands and must be worn

at all times in the lab. The Nitrile gloves are more of a cream color and offer a tighter fit than the vinyl gloves.

- **Triple Polymer, Acid Resistant (tan colored), TRIONIC (made by MAPA)**

These are available in the FabLabs for working with etchants and/or corrosives. Always check the manufacturers “Chemical Compatibility/Resistance Chart” (located in the lab) for the chemicals you wish to use. (for more information, see also www.mapaglove.com for the chemical resistance guide for specific chemicals). Look at the Break Through Times (BTT) and Permeation rates for the chemical you wish to use. Check these gloves regularly for wear and replace them when needed. The gloves are chemically rated and must be worn whenever you work with caustics or corrosives. If immersion or exposure of your gloved hands is anticipated, it is required that you leak-check your gloves. This is accomplished by pressurizing them with a nitrogen gun, then immersing them in water. Check for bubbles, a sure sign of a leak. Note for instance (for TRIONIC gloves) that the BTT for concentrated sulfuric acid is 59 minutes and for acetone it is 12 minutes. **NOTE:** If these gloves should come in contact with Acetone they must be discarded because their chemical resistance to other chemicals may have been degraded. **Also Note** that these gloves are quite sensitive to UV light breakdown and need to be replaced often and new ones need to be stored out of the light.

- **AciTek, Acid resistant (orange colored) by Ansell .**

Similar to the Trionic brand. These are made from 100% natural latex polymer, which offers good protection from a wide spectrum of acids, etchants, and solvents. Check the Compatibility/Resistant chart to determine if they suitable for your chemicals.

- **SOL-VEX Gloves (green)**

A Nitrile glove made by Ansell Protective Products.

These are available in the FabLabs and are suitable for eg. Ammonium Hydroxide and Hydrogen Peroxide. They are **NOT** suitable for eg. Sulfuric Acid or Acetone. Always check the Ansell “Permeation/Degradation Resistance Guide” (located in the lab) for the chemical you wish to use. For an extensive “Chemical Application and Recommendation Guide” look up www.ansellpro.com/specware. **NOTE:** If these gloves should come in contact

with Acetone they must be discarded because their chemical resistance to other chemical may have been degraded.

3.22 Eye Protection and Face Protection

Eye protection will be required by all personnel (at all times) inside the Fablabs. There are three types of eye/face protection required:

- **Safety spectacles:**

These are worn to protect the eyes when there is a danger of flying objects or particles. **NOTE:** Spectacles do not offer protection from chemical splash or dust. Willson spectacles are provided in the Lab. They are Willson model “Millennia” and meet ANSI Z87.1-1989 and CSA Z94.3-1992 requirements.

- **Safety Splash Goggles:**

Goggles must be worn whenever chemicals are being used or dispensed. UVEX Model 9301 (Futura) goggles are provided in the Lab. They are a large indirect venting goggle that can be worn over most prescription eyewear. They meet ANSI Z87.1-1989 and CSA Z94.3-1992 requirements.

- **Face Shield:**

Goggles are not “splash proof” and will not protect the face from the effects of a chemical splash. Face shields and goggles must be worn if there is danger of a chemical splash or whenever Hydrofluoric Acids (HF) solutions are used. Double Matrix Face shields made by US Safety are provided in the Lab. They provide protection for the face and neck.

3.23 Acid Smocks:

Long sleeve Neoprene Smock Aprons are provided. These give complete one – piece upper body coverage and provide full front body protection against most acids, caustics and alkalis. These must be worn when using any HF solutions or mixing and dispensing concentrated acids. (eg Caro’s acid).

3.3 Transporting Chemicals Through the Lab

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Chemicals for the Fablab are stored in special cabinets. All FLAMMABLE chemicals are to be stored in the yellow SAFETY Cabinets. All acids are to be stored in the special ACID storage cabinet. Small quantities of acids may be stored under the exhausted WET benches. A list of chemicals is posted on the side of each of the Hazards Awareness Centers in the Photolithography Room and the Diffusion Room. After removing any item from the cabinets make sure the doors are closed. Wet Bench sliding doors must always remain closed for safety reasons. If you cannot locate a chemical listed on these inventory sheets contact the lab supervisor.

Chemicals in 4 L bottles cannot be transported through the lab unprotected. Individual 4L and all glass bottles must be placed in polyethylene safety carriers located in the Photolithography Room, Metallization Room and in Service Bay # Remember to return these safety carriers to the front of the lab when you are done with them.

Be sure to check that there are no bottles of the chemical you need in your area before bringing in and opening new ones.

3.4 Working with Chemicals

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Always work at an Exhausted wet process station! Wet process stations are exhausted, with face velocities greater than 80 feet/minute. Do NOT adjust the back sashes. They are set by Physical Plant Maintenance Department. This assures proper exhaust velocity.

3.41 Dry Chemicals

When measuring out chemicals never pour a chemical back into its reagent bottle. This can contaminate the remaining chemical in the bottle. When removing dry chemicals, pour them out when possible. Scoop only when necessary and use freshly cleaned spatulas. If you pour out too much, instead of throwing the excess away, you might want to store it in a clean, labeled container for your use later.

3.42 Solutions

- When mixing acids with water, remember the triple A rule: **ALWAYS ADD ACID TO WATER** and **NEVER WATER TO ACID!**

An exception to the triple A rule is the wafer cleaning solution called "Piranha". This solution is a mixture of sulfuric acid and hydrogen peroxide. Piranha solution is made by adding H₂O₂ to H₂SO₄ in a pyrex beaker. **ALWAYS** wear goggles, face shield and acid smock when making or using this solution. Add the H₂O₂ **SLOWLY**.

WARNING: Teflon®, a fluopolymer, is one of the few plastics compatible with hot piranha and Caro's Acid. That is, use only Teflon for holding wafers in this solution. **Do NOT use polypropylene** holders, beakers or baskets. Hot "Piranha" will react violently with polypropylene, polyethylene and ordinary plastics.

- **DO NOT** mix organic solvents with inorganic chemicals. This can result in a violent reaction or explosion. Organic solvents should not be used near inorganic chemicals.

- Use appropriate containers for your solutions. Example: **Do NOT** use glassware for HF as glass will dissolve. Always place fuming containers toward the back of the fume hoods where there is maximum exhaust. If you must leave an area with a process in progress, make absolutely sure that you fill in the work sheet **WARNING “UNATTENDED PROCEDURE IN OPERATION”**. These sheets are available in the Fablabs. That is, make sure you leave your process clearly labeled with your name, the date, time, your expected time of return, where you can be reached (if you will be gone more than 10 minutes) and the chemicals involved. Do not leave chemical processes unattended unless absolutely necessary.
- pH strips are available in the Fablab and can be used to identify possible safety hazards from spills or unknown liquids found on or near sink work surfaces. These pH test strips can be found at several locations within the Fablab. Strips are in plastic dispensers located in the large shelves outside the oxidation furnaces...Color charts with reading instructions are laminated and posted on these dispensers. pH test strips are calibrated to read from 0-14 pH. If the unknown liquid is determined to be acidic (pH less than 7) then the “Fluoride (HF) Detection Procedure” **MUST** be followed as described in **APPENDIX B** (attached).

• **Special handling procedures for Piranha and Caro’s acid mixtures:**
Sulfuric / H2O2 mixtures are extremely reactive

- before using- the need and procedures must be reviewed lab technician or lab manager. Dry plasma etching is a safer alternative if possible.
- Whenever you are mixing any solution always verify that you have the right chemical.
- DO NOT** mix organic solvents with inorganic chemicals. This can result in a violent reaction or explosion.
- PPE including apron and face shield must be worn whenever mixing or pouring Caro’s acid
- Pour the chemical slowly.
- No other chemicals should be present on wetbench when Caro’s is being used. Place the “Caution Caro’s in use” sign on front of bench
- After use the Caro’s acid must be left in the beaker in the sink covered by a watchglass or petri dish for a minimum 24hrs to cool and fully outgass. \ The “Caution Caro’s cooling” sign must be put up in front of the sink with

- name/date/time”
- After 24 hours the Caro's can be emptied into a **clean dry** high density poly ethylene(**HDPE**) **bottle** with a **vented cap** (used H₂O₂ bottle or new 1L or 2L HDPE bottles). Waste Caro's solutions **should not** be mixed together.
 - The waste should not be stored in the lab – it should be placed into a secondary containment pail and taken and then notify lab technician to take to the chemical waste storage bunker.

3.5 Chemical Disposal

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When you are through with your process, clean up completely. Chemicals are **NOT** to be dumped down the drain. Proper disposal procedures:

- Acids , Store waste Acids in the empty containers from which they came
- Hydrofluoric (HF) Acid mixtures must be stored separately in properly (WHMIS workplace) labeled bottles. Label with component content including the percentage of each. These solutions must be held for proper hazardous waste pickup and disposal.
- Caro's Acid mixtures [40 mls. Of H₂O₂ (Hydrogen Peroxide) per 1 litre of H₂SO₄ (Sulfuric Acid)]. This waste must be stored separately in properly labeled containers and held for hazardous waste disposal. Use vented caps for all chemical mixtures containing H₂O₂. Vented caps prevent pressure buildup from rupturing the container.
- Dispose of special mixtures when you anticipate that they will no longer be required.
- RCA Cleaning Solutions: These solutions should be neutralized in the lab before disposal
 - SC1 solution : (0.25 parts NH₄OH, 1 part H₂O₂ and 5 parts D.I water)
 - SC 2 solution: (1 part HCl, 1 part H₂O₂ and 6 parts D.I. water.
 - Glassware Cleaning Solution: (1 part NH₄OH, 1 part H₂O₂ and 8 parts D.I. water – this should be neutralized in the lab before disposal.
- **Organic Solvents**, such as Acetone, Isopropanol, and Methanol may be stored together for hazardous waste disposal.
- Chlorinated organic solvents must be stored separately for hazardous waste disposal. Make sure it's a solvent and that waste bottles are not overfilled.

Obtain a WHMIS workplace label and enter the summary of contents to the peel-off label and place it on the bottle.

Using a safety carrier located in the front of the lab, transport the waste bottle to the yellow Chemical Cabinet in the Photolithography room or the Diffusion room.

- Chemical waste being placed in the Chemical Waste Cabinets must be labeled with contents and the name of the lab member placing this waste in the cabinet. It is a violation of Fablab policy to place unlabeled waste in any cabinet.

3.6 Chemical Exposure

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- If you are exposed to chemicals, the first thing you must do is to immediately remove all affected clothing. Flush the affected areas with water for 15 minutes, not less. Use the emergency shower and/or eyewashes as necessary. The location of the safety showers and eyewashes are clearly marked with signs and identified on a map that follows this safety section. Memorize the locations of the safety shower and eyewashes.

Contact a staff member after you have flushed the exposed area with water. All injuries occurring in the Fablab must be reported to the Health and Safety Department office within 24 hours.

Exposure of the eyes requires flushing with water for at least 15 minutes.

As a precaution, all exposures to the eye will require a visit to an emergency room for a check up. Contact a staff member as soon as possible for assistance or call **4444**.

If your eyes are exposed to a chemical while working at a wet process station, the DI water deck hose may be utilized to flush your eyes initially instead of trying to make your way to an eyewash station. After a few minutes if possible move to an eyewash station and complete the 15minute flush.

- Hydrofluoric Acid (HF) burns are particularly hazardous. An insidious aspect of HF burns is that there may not be any discomfort until long after exposure. These burns are extremely serious and may result in tissue damage or in extreme cases death. If you contact HF, flush the area well and be sure to work under and around your fingernails. Fingernails and cuticles are the classic area people receive burns, having washed off the HF without washing under their nails. If washed off within a few minutes of exposure, HF will do no harm. Remember, HF may not produce any burning sensation until after it has already done damage. **All HF burns MUST be looked at by a physician.**

First aid for HF burns to skin: (For more details REFER to Ref. 2 and APPENDIX A attached to this document, see also www.hfacid.com for a PDF file on Recommended Medical Treatment for HF Exposure)

- Remove contaminated clothing.
- Flush with cold water for 5 minutes (skin), 15 minutes for eyes.
- Using protective gloves gently massage calcium gluconate ointment into skin.
There is a container of this material at each Fablab First Aid Kits, in the main hallway, and by the sinks where HF is used. Do **NOT** use the ointment on eyes.
- Report any HF burns to the University Health and Safety Department at **4444** and the lab supervisor.
- Seek medical attention.

3.7 Chemical Spills [see APPENDIX B and C (attached) for Chemical Spill Procedures] (from Ref. 3) [Table of Contents](#)

In the event of a chemical spill, the Fablab has an inventory of “spill pillows” and “spill blankets” to clean up and contain wet chemicals. These are located in Service Bay #2 and in our spill cleanup kits. The material used in these pillows and blankets is selected for large moisture retention and its ability to neutralize acids.

Chemical spills will be cleaned up by Fablab staff. Spill Kits are located in each of the labs. These kits contain the needed materials to safely cleanup a spill.

Instructions are included in each spill kit. The following people have been trained on chemical spill clean up. In case of a chemical spill you **MUST** seek help from one or more of the following people:

<u>NAME</u>	<u>Telephone</u>	<u>Room</u>
Rob Vandusen	520 – 2600 ext5761	4184ME
Angela McCormick	520 – 2600 ext5771	4191ME
Rick Adams	520 – 2600 ext5515	4191ME
Prof. Niall Tait	520 – 2600 ext4452	4158ME
Prof. Garry Tarr	520- 2600 ext5758	5160ME

Report all spills to a lab supervisor.

Section 4 DISPOSAL OF HAZARDOUS OBJECTS

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- **Broken Glassware**

Broken glassware should first be rinsed thoroughly if necessary than disposed of by depositing in the stainless steel pail designated for broken glass disposal. This pail is located in the Diffusion Room. Contact a staff member if you need help disposing of broken glass.

- **Wafers**

Check with the Lab supervisor before throwing away whole wafers. They might be recycled or used as dummies for other operations. Wafers and broken wafers are disposed of in the same pails as broken glass.

- **Needles and Razor Blades**

Needles and razor blades should be disposed of in the containers provided throughout the Fablab. If these plastic containers are full, contact a Fablab staff member and they will be emptied. **Do not** dispose of needles or razor blades in the waste cans!

- **Broken Thermometers**

Because of the danger of metallic mercury, broken thermometers should be disposed of properly. Contact a staff member for assistance if you break a thermometer.

Section 5

COMPRESSED GASES

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5.1 Handling Gas Cylinders

Cylinders of both toxic and non-toxic compressed gases are in use throughout the lab. Lab users are not allowed to install or disconnect these cylinders. All compressed gas cylinders are to be handled by trained staff. There are several reasons for this policy. Some gases are toxic. Some gases in these cylinders are at high pressures, some as high as 3000 psi. Regulators are designed to handle specific gases and can explode if not properly chosen. Improper installation or purging will contaminate a full bottle of gas. Some of our etching gases cost hundreds of dollars and their loss or contamination is very costly.

Gas cylinders must be chained and strapped down at all times.

5.2 Toxic Gases

All toxic, flammable or corrosive gases are kept in exhausted steel gas cabinets. Among the toxic gases used in the Fablab are ammonia, phosphine, and dichlorosilane gases used in the Bruce LPCVD furnaces and Trion PECVD system. Examples of corrosive gases are hydrogen chloride, used in the Bruce oxidation/diffusion furnaces. Most of these gases have a characteristic odor. Phosphine smells like garlic or decaying fish, while ammonia has a pungent, acrid odor. Silane, a pyrophoric gas (i.e., it ignites upon contact with air), is used for LPCVD (Low Pressure Chemical Vapour Deposition). Silane has been known to be explosive under some conditions. If a gas leak is suspected, the Fablab **MUST** be evacuated.

If you notice an unusual odor, leave the lab and immediately report it to the staff so an evacuation announcement can be made. If no staff is available, call **4444**.

5.3 Toxic and Flammable Gas monitor and alarm system in 4082MC

Microfabrication Labs – There is a Honeywell “Midas” toxic and flammable gas monitoring system in place in the lab. It is located in room MC4074 (diffusion service bay). It continuously samples air in the gas cabinets, Bruce furnace cabinets, and room ambient for the presence of gas leaks. The alarms are located above the exit doors in each of the lab bays as well as the hallway outside 4074MC.

If the flashing strobe light alone goes off - it indicates that a low level alarm has occurred on one of the gas sensors. A low level is triggered at or above 1/2 TLV

If the flashing strobe and buzzer both go off – it indicates that a high level alarm has occurred on one of the gas sensors. A high level is triggered at or above 1 TLV.

1 TLV represents conditions under which nearly all workers may be repeatedly exposed day after day without adverse health effects. BUT even if it is only the ½ TLV level alarm is triggered there still could be areas with much higher levels.

In both cases everyone must safely leave the lab using the nearest exit (avoid using the diffusion service bay exit, unless you are working in that area). Exit the Minto building and meet in front of the Minto building, or Mackenzie building block 1 fourth floor foyer (inclement weather).

Presently the gas monitoring system is standalone – in case of alarm activate a Minto building fire alarm pull station while exiting to evacuate the building.

5.4 Nitrogen Guns

Nitrogen guns and compressed gas can inflate the skin like a balloon, tearing it away from the tissue underneath. Be cautious and avoid directing nitrogen at your body.

5.5 Cryogenics

Liquid nitrogen or “LN2” is used in the lab in the MRC Sputtering system and the Plasma Therm ECR System. It is stored in vacuum jacketed cylinders called “dewars”. These containers are large and heavy and should be moved with care. LN2’s major hazards are burns from freezing and damage to the lab floor from freezing and cracking. Wear the gloves provided and face shield when installing or filling small LN2 containers (used only on special cases for SEM sample preparation).

Section 6.

FIRE HAZARDS

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6.1 Fire Prevention

Fires in the lab can result from many causes including ignition of flammable gases or solvents, and combustion of materials. Use care when using heat lamps or heating flammable solvents on hot plates. **NOTE:** Acetone (Flash point -20°C) is **NOT** to be heated under any circumstances. Always use a water bath to transfer heat to flammable solvents when using a hot plate. Avoid water around electricity and use common sense when working in the lab.

6.2 Laboratory Fires_ (Ref 1, Pg. 23 of Carleton Lab Safety Manual)

Before using any chemicals you should make yourself familiar with all the potential fire hazards associated with the chemical. This information will be found on the MSDS in the fire and explosion and reactivity sections. The information will include the decomposition products, critical temperatures, and the most applicable type of fire fighting equipment to be used should a fire get started. If a small fire does start in a lab and is contained in a beaker, flask or other small container, you **may** attempt to extinguish the fire with the proper fire extinguisher or by smothering it. Call for help from others in the area while doing this so they are aware of the fire and ready to take action if your attempt is not successful. After the fire is out, immediately report the fire and your action to University Safety at **4444**.

If the fire is not limited to a small area, if volatile or toxic materials are involved, or if you have failed in your attempt to extinguish a small “beaker fire”, or do not wish to try, you should:

- Pull the fire alarm.
 - Inform everyone in your immediate area that there is a serious fire.
 - If possible close all doors that will isolate the fire from the rest of the building.
 - Evacuate the building using the stairs. Do not use the elevators.
 - Meet the emergency service personnel at the entrance of the building and explain the nature of the fire, and the identity of all possible associated hazards such as toxic fumes, explosive potential, fire extinguishing media. Etc.
- c) Fill out an Injury/Incident report (Appendix 2, Ref 1 of Carleton Lab Safety Manual)

Classes of Fire

A Class – ordinary combustibles such as wood, paper, cloth, plastic, etc

B Class – flammable and combustible liquids

C Class – charged electrical fires

D Class – combustible metals”

Fire extinguishers are located in all Fablab rooms at the Emergency Exits. These are Type 5- BC (Carbon Dioxide) extinguishers capable of extinguishing fires of flammable liquids or electrical equipment (**not** paper) without damaging equipment. Use water to extinguish paper fires.

The campus Safety Department regularly checks fire extinguishers. Report any use of a fire extinguisher to that office immediately.

Fablab users are not expected to be fire fighters and should evacuate the building when a fire threatens safety.

For fires, call the Carleton University emergency number **4444** and evacuate the lab. In all cases fill out a Carleton University Injury/Incident report (Appendix 2 of the Carleton University Laboratory Health and Safety Manual)

If your clothes catch fire, use the showers and do not panic. A fire blanket is located at the main lab entrance. MAKE SURE YOU KNOW THE LOCATION OF THE SHOWERS AND EYE WASH STATIONS!

Section 7

ELECTRICAL SAFETY

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All electrical power wiring is to be done by Carleton University Maintenance staff. Learn the locations of the circuit breakers required by the equipment you use. In case of electrocution of someone in the lab, do not touch or grab them. Do not attempt to shut off power on the system, use the circuit breakers or unplug the equipment in the service chases. Report all electrical problems to staff.

Section 8

FABLAB EVACUATION PROCEDURES

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When the building fire alarm sounds, you **MUST** evacuate the FabLabs and the MINTO Building. The Evacuation Procedures is as follows:

- Secure your process and leave the lab quickly.
- Exit out of the Fablabs by the Main Entrance (use the Emergency Exits only if absolutely necessary).

- Once you are out of the Fablab and in the hallway, turn right (note the illuminated **EXIT** sign) and leave the area through stairway Exit Door labeled "C".
- Proceed down the stairway until you reach the outside door and exit the building.
- Once outside meet in Courtyard between Prescott and Renfrew residence buildings. In poor weather the inside meeting location is the Canal building level 2.
- Refer to the Carleton University Fire Prevention website for other building evacuation sites: <https://carleton.ca/ehs/2018/updated-safe-destination-sites/>

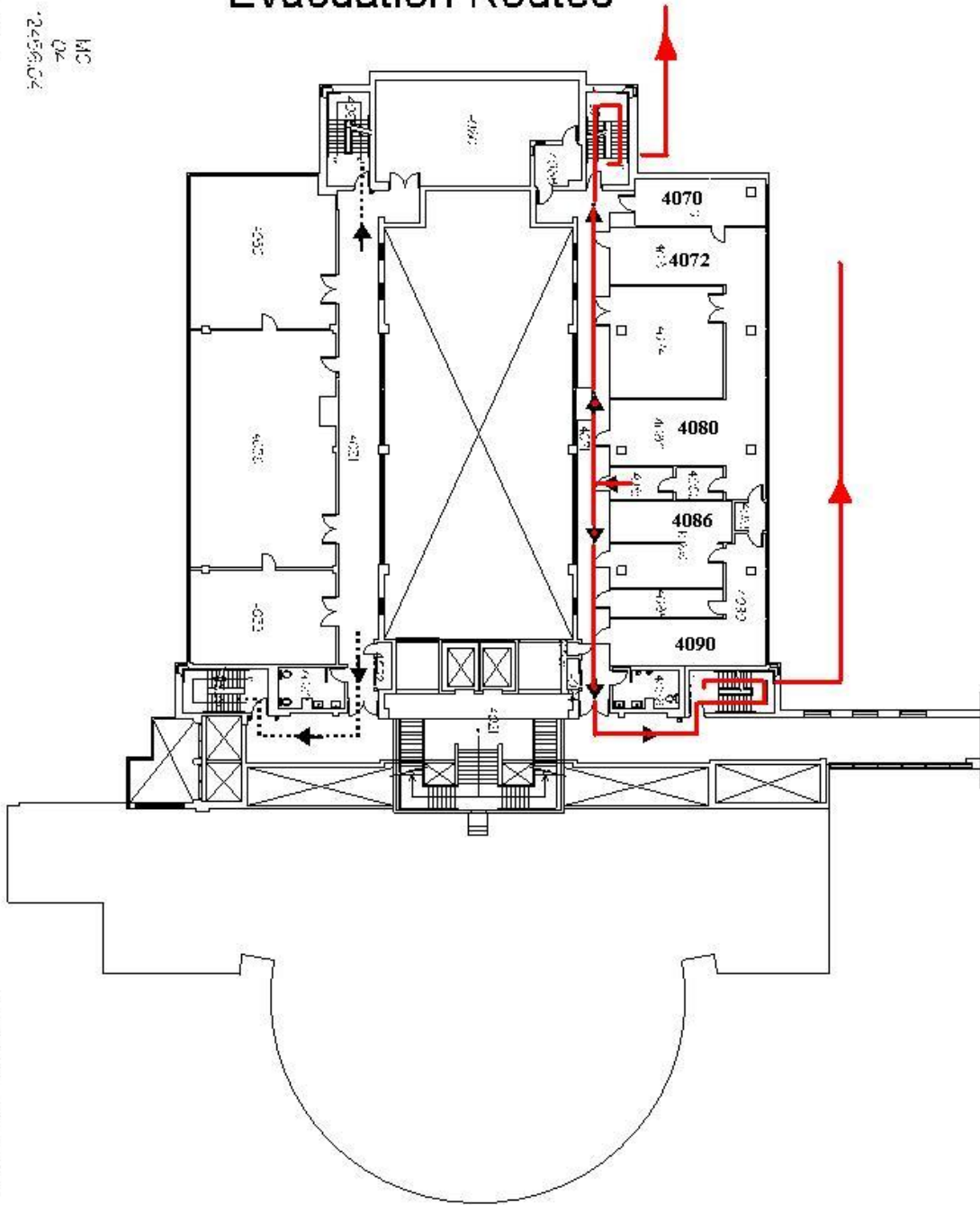
If there is an emergency in the lab (volatile or toxic materials fire or toxic gas leak)

- Evacuate the lab (evacuate other lab users as you leave)
- Place the laminated evacuation sign (located at the lab entrance) on the door glass. The sign reads:
FABLAB HAS BEEN EVACUATED DO NOT ENTER.
- Call **4444** and inform the Safety Office of the situation

Minto 4082 Microfabrication Lab Evacuation Routes

MINTO-CASE
LEVEL 04
24596.04

MC
04
24596.04

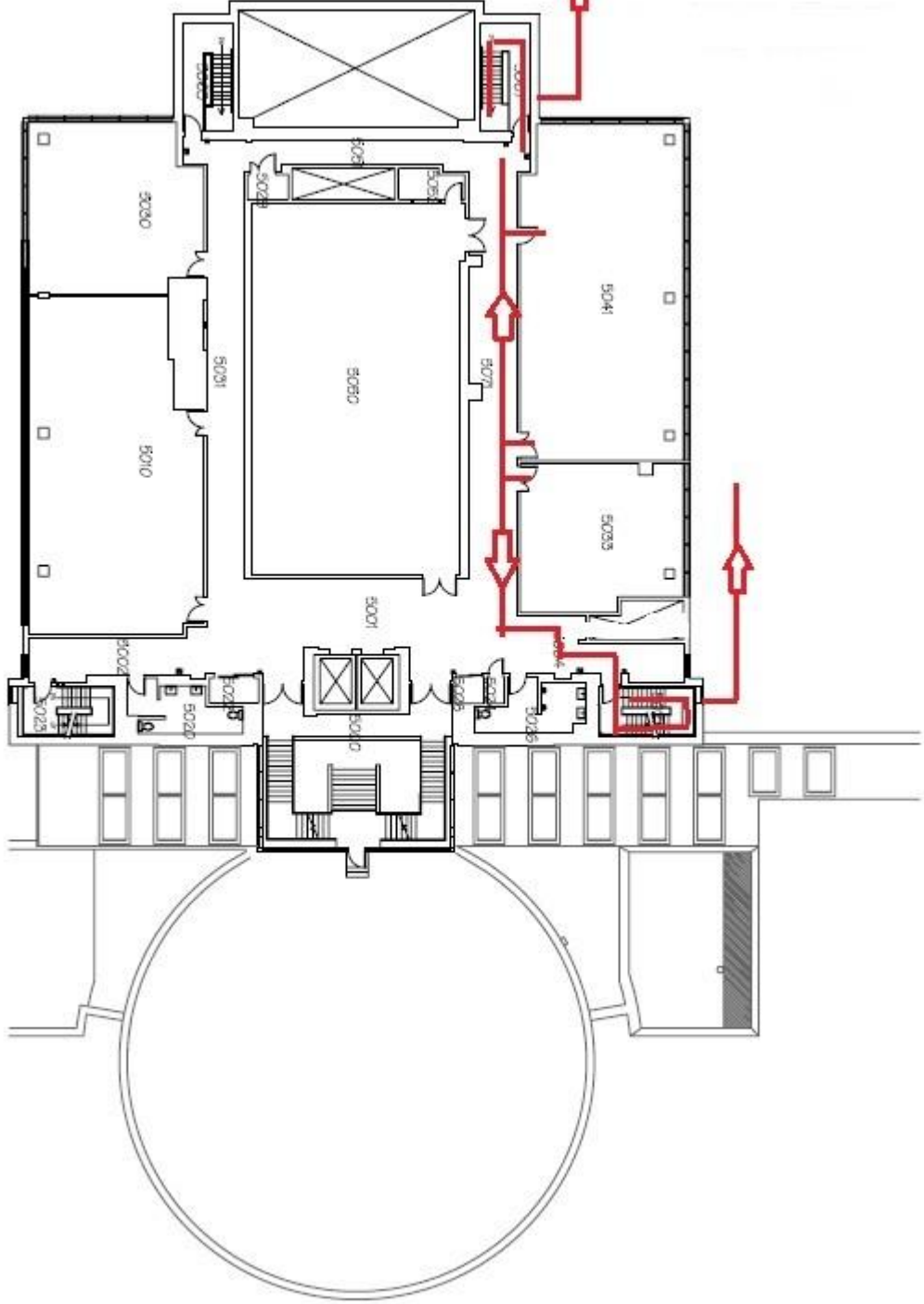


SPACE ADMINISTRATION
Department of Physical Plant
2004 Maintenance Building
Prepared by : M. LeBlond

Minto 5033 & 5041 Evacuation routes

M/C
05
13139,44

MINTO-CASE
LEVEL 05
Dec. 2009



SPACE ADMINISTRATION
Department of Physical Plant
204 Maintenance Building
Prepared by : M. LeBrun

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HF (Fluoride) EXPOSURE TREATMENT GUIDE

QUICK REFERENCE

Quick Reference for the treatment of exposure to Hydrofluoric Acid, Buffered Oxide Etch (BOE), Buffered HF.

Note: FUMES FROM CONCENTRATED HF SPILLS MUST BE AVOIDED - Treatment should be administered away from spill site. Refer to detailed HF medical treatment guide for further treatment.

SKIN CONTACT	EYE CONTACT	INHALATION
<p>FLUSH -Protect yourself while directing casualty to wash, or emergency shower. Start flushing contact area with water. <i>If alone proceed to emergency wash area.</i></p>	<p>FLUSH -Protect yourself while directing casualty to wash. Preferably emergency chemical eyewash. Start flushing eyes with water. <i>If alone proceed to wash area. Preferably an emergency eyewash.</i></p>	<p>FRESH AIR - Immediately remove casualty to a fresh air source. <i>If alone proceed to a fresh air source immediately.</i></p>
<p>HELP! - Call University Safety at 4444 Obtain HF Treatment KIT. <i>If alone continue to call out for help and have someone get the HF kit.</i></p>	<p>HELP! - Call University Safety at 4444 Obtain HF Treatment KIT. <i>If alone continue to call out for help and have someone get the HF kit.</i></p>	<p>HELP!-Call University Safety at 4444 <i>If alone continue to call out for help while getting to fresh air.</i></p>
<p align="center">CONFIRM HF- If possible confirm HF is the chemical, using HF Test Kit Try to determine if solution was concentrated(typ. >40%) or dilute, for later medical treatment.</p>		
<p>5 MINUTES-As showering continues remove and isolate contaminated clothing. Flush area for 5 minutes.</p>	<p>15 MINUTES-Flush eyes for 15 minutes. If contact lenses are involved try to remove and isolate them.</p>	<p>TRANSPORT- transport casualty to Health center,Unless instructed otherwise by university safety.</p>
<p>HF ANTIDOTE - With protective gloves apply the Calcium Gluconate gel. Apply gel frequently and massage continuously until pain and/or redness disappear. (Minimum 15 minutes) <i>If alone do not use protective gloves if hands have been contaminated.</i></p>	<p>DO NOT USE HF ANTIDOTE GEL ON EYES.</p>	<p>OXYGEN-Oxygen should be administered and vitals monitored at health center..</p>
<p>COVER- Cover the affected area with a clean sterile dressing.</p>	<p>COVER- Cover the affected area with a clean sterile dressing.</p>	
<p>TRANSPORT- the casualty to the health center (Daytime), or to any hospital emergency room. Take the detailed HF medical treatment guide (from HF kit) and a copy of the HF incident note sheet with you. <i>If alone proceed to health center with the medical treatment guide.</i></p>		<p>AMBULANCE- 100% Oxygen to be administered in ambulance. Give attendants copies of the detailed HF medical treatment guide and incident note sheet.</p>
<p>Incident/Injury report- Advise manager of the accident and complete the Incident/Injury report form. Copies to go to University Safety and Department Head.</p>		

APPENDIX B

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FLUORIDE (HF) DETECTION PROCEDURE

CAUTION: Non-ventilated spills of concentrated HF (typ. >40%) or heated HF should be avoided – Vapors and fumes are very dangerous.

INTRODUCTION : This procedure was originally developed by the Positive Action Group LTD. for the detection of dangerous Fluoride Ions in chemicals, such as Hydrofluoric Acid, Buffered Oxide Etch (BOE), and Buffered Hydrogen Fluoride (BHF) mixtures. The procedure is capable of giving a qualitative (positive or negative: yes or no) indication in concentrations as low as 0.5%. It must be stressed that this does not give a quantitative or amount value.

DETECTION PROCEDURES:

Step 1: Ensure that no other hazard is present. While wearing the appropriate protective clothing dip the end of the pH test paper in the unknown chemical. If the paper reads 7 or below (acidic), or does not react and the potential presence of dangerous fluoride ions exists – then the results would be treated as a **POSITIVE (YES)**. If the pH paper reads **above** seven (basic) the test result would be considered **NEGATIVE (NO)**.

Step 2: If the result was **POSITIVE** go to step 4, if the result was **NEGATIVE** go to step 3.

Step 3: Since the result was **NEGATIVE** the probability of dangerous fluoride ions has been eliminated. Continue to identify the chemical as one of the other potentials in the area and treat accordingly.

Step 4: Since the chemical has tested **POSITIVE** (Neutral or Acidic), and is known to have products containing dangerous fluoride, take a strip of the MN (machery nagel) fluoride test paper and thoroughly wet the bottom half in the BuCaim solution. Gently shake off excess and wait **10 seconds**, note that the paper has remained rose/pink in colour.

Agitate the tip of the activated strip in the unknown liquid for **10 seconds**. Remove the strip and allow **10 seconds** for the strip to develop.

If dangerous fluoride ions **are present** the strip will **change** from rose/pink to **yellowish white**.

If dangerous fluoride ions are **not present**, the strip will **remain rose/pink** in color.

The stronger the Fluoride concentration the faster the colour change will be.

Step 5: Make arrangements to appropriately dispose of all contaminated materials.

APPENDIX C**[Table of Contents](#)****CHEMICAL SPILL PROCEDURES**

Carleton University Fabrication Lab Aug 2/2002 (Ref. 3)

Occupant Chemical Spill Response Level: Area employees will follow the following procedures in the event of an unplanned chemical release.

- STOP activities and quickly evaluate what has happened. **DO NOT RUSH**
- Determine whether or not this is an occupant chemical spill response level. An occupant level is classified as:
 - Trained personnel are available to complete the clean-up.
 - The spill is under one liter.
 - Not involving chemicals containing HF (Hydrogen Fluoride)
 - Not an unknown chemical, and
 - Occupants feel competent in managing the spill.
- Secure the area and contact the Department of University Safety at **4444** and the lab supervisor. Inform them that you are preparing to manage an occupant chemical spill response. If the spill is not an occupant level cleanup inform them and follow instructions.
- Obtain assistance from another trained employee. Personnel **WILL NOT** cleanup chemical spills, unless another trained employee assists them. Use the buddy system.
- Eliminate all potential ignition sources and secure the area with barrier tape. Ensure an appropriate fire extinguisher is available.
- Designate one employee responsible for containment and cleanup. The other assists but does not contact the chemical. Both employees will suit up as per training.
- Use universal spill socks and absorbents to contain the spill. Use PSI urethane drain cover to cover any floor drains in which the chemical could reach.
- Ensure that local fume hoods are operating to assist in ventilating the area.
- Obtain a reading of the status of the chemical (flammability or pH)
- Obtain the MSDS for the product (hard copy in area or on internet at www.msdssearch.com) or www.msdonline.com – Username: Carleton, Password: carleton, review the physical properties.
- Make sure that all of the appropriate response equipment is present prior to commencing.
- Carefully remove and isolate any contaminated materials.
- Using universal spill materials absorb the chemical and place in the prepared container.
- At least 3 times, apply a light spray of water to the spill area and absorb, placing the absorbents into the prepared container after each time.
- After the last absorbent process has been completed apply a final light spray of water and test the area with pH paper to ensure that no residue of the spill chemical remains. Repeat spray/absorb process as required.
- Place all contaminated materials into the container and fold over the first plastic bag. Vent air away from yourself or anyone else.
- Person that done the cleanup removes all spill clothing and isolates in container.

- Person assisting will fold over the next plastic bag layer, again vent away to a safe area.
- Collect any remaining materials along with personal protective clothing and discard into container. With appropriate gloves fold in the last bag and seal the container.
- Complete the hazardous waste label and attach to side of container.
- Place the container in a safe place for pickup by lab supervisor.
- All personnel involved in the cleanup shall follow appropriate hygiene cleanup procedures.
- Contact Department of University Safety and the lab supervisor and inform them the spill is cleaned up and where the waste has been placed.
- Complete the Carleton University Incident/Injury report and forward copies to the lab supervisor, chairperson and safety department.

WARNING
UNATTENDED PROCEDURE IN OPERATION

PROCEDURE DESCRIPTION/HAZARDS

SCHEDULED START	INSPECTION INTERVALS	SCHEDULED FINISH	SIGNATURE
CONTACT NAME		PHONE NUMBER / EMAIL	

PROCEDURE DESCRIPTION/HAZARDS

SCHEDULED START	INSPECTION INTERVALS	SCHEDULED FINISH	SIGNATURE
CONTACT NAME		PHONE NUMBER / EMAIL	

PROCEDURE DESCRIPTION/HAZARDS

SCHEDULED START	INSPECTION INTERVALS	SCHEDULED FINISH	SIGNATURE
CONTACT NAME		PHONE NUMBER / EMAIL	

PROCEDURE DESCRIPTION/HAZARDS

SCHEDULED START	INSPECTION INTERVALS	SCHEDULED FINISH	SIGNATURE
CONTACT NAME		PHONE NUMBER / EMAIL	

Carleton University

FOR EMERGENCY: CALL 4444 - UNIVERSITY SAFETY

REFERENCES and REVISIONS[Table of Contents](#)

1. Carleton University Laboratory Health and Safety Manual, (May, 2000)
2. "Recommended Medical Treatment for Hydrofluoric Acid Exposure" (Ver. 1)
Honeywell, P.O. Box 1053, 101 Columbia Road, Morristown, New Jersey, 07962-1053.
(see www.hfacid.com for this PDF file)
3. "Chemical Handling Level Two (CH 02), Chemical Spill Response, " a short hands-on course given by: Positive Action Group Ltd., 200-4015 Carling Avenue, Kanata, Ontario, K2K 2A3, Tel. (613)-591-9790

Revised: 03.01.24	02.11.25 L.P.B.
	LPB.
	03.05.13 LPB
	May 3, 2006 R.V.
	Oct 10/2006 RV table of contents added.
	July 11/2008 R.V. minor changes.
	Dec 19/2008 RV. <i>Included Gas monitors and evacuation</i>
	Aug 17/2009 RV – Caro’s acid handling notes added.
	Aug 31/2009
	Hyperlinks added RV
	Sept 17/2010 minor changes RV
	Sept 22/2011 minor rule changes
	April 25 2012 – formatting changes RV
	Sept 10/2013- evacuation updates RV
	June 23/2014 – rules/enforcement update- RV
	March 31 2015-updates,FANSSI lab-RV
	April 29/2015 – minor changes – RV
	Jan 30 2017-minor updates, updated unattended operation sheet, 5 th floor evacuation map.- RV
	Jan7 2019 – new safe destination sites