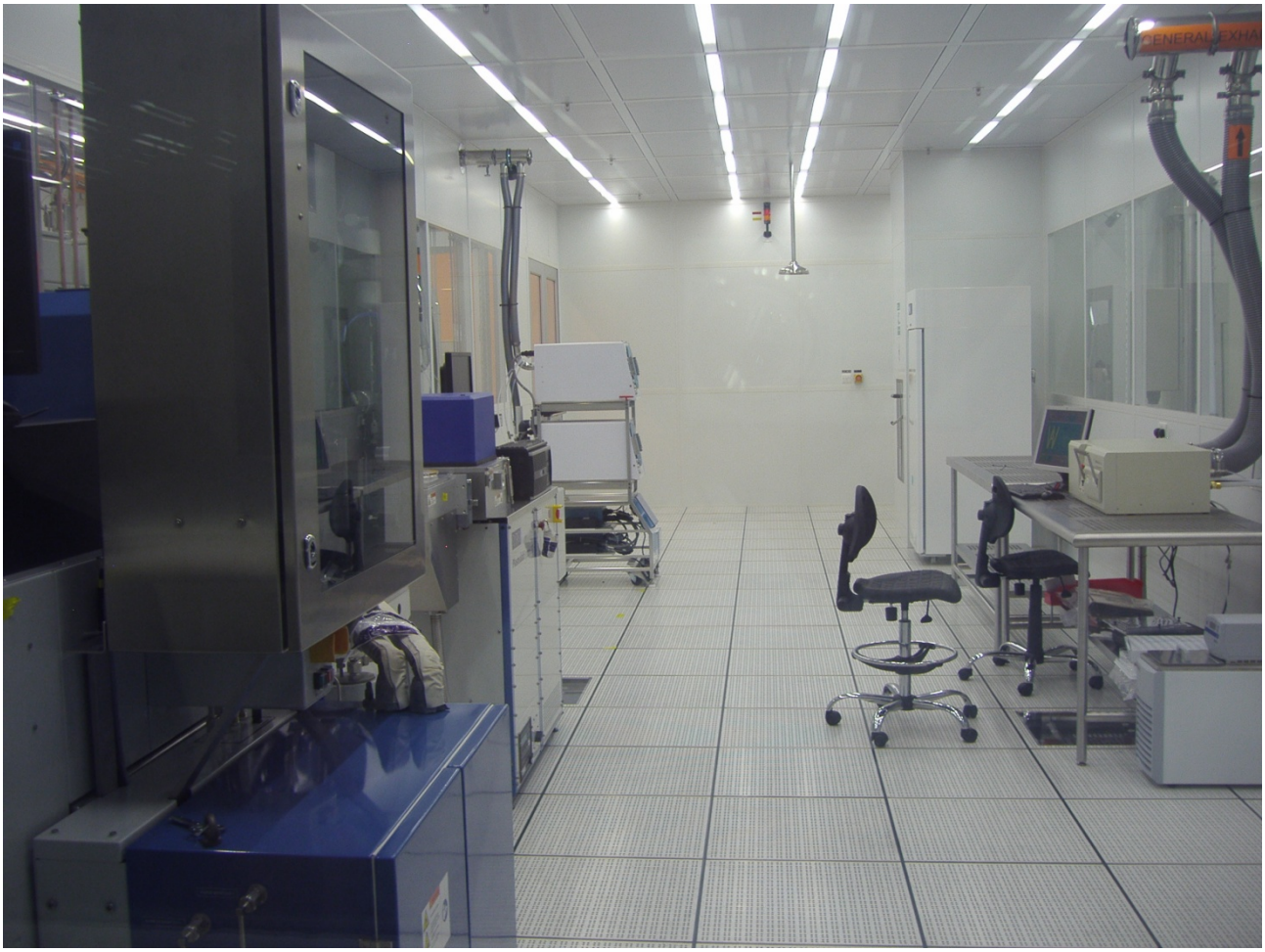
MASDAR INSITUTE FABRICATION FACILITY



CLEANROOM USER MANUAL

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Other EHS References (available on EHS web Portal)

HSP 010	MI Emergency Response Plan
HSP 011	Hazardous Waste
HSG 014	Cryogenic Materials

1 Introduction

Welcome to the Masdar Institute Fabrication Facility (MIFF)

The facility is a shared, open-access cleanroom facility, equipped with a wide array of tools for materials deposition and growth, lithography, metrology, and other instrumentation for device fabrication and Nano scale research. Our lab user community includes researchers from the mechanical engineering, chemical engineering, nuclear engineering and material science departments of the Masdar Institute and from other universities. Their research addresses applications ranging from electronics, MEMS, and optics to new nanostructured materials and biomedical engineering.

The cleanroom is split into 4 working areas:

- 2 x class 1000 bays and
- 2 x class 100 bays.

A cleanroom is an environment typically used in manufacturing or scientific research that has a low level of environmental pollutants such as dust, airborne microbes, aerosol particles and chemical vapors. Each cleanroom has a controlled level of contamination that is specified by the number of particles per cubic meter at a specified particle size. Therefore, the cleanroom for the Institute is a very specialized facility that will be used for both teaching and multidisciplinary research in Material Science, Mechanical Engineering and Microsystems Engineering.

The **Class 100** section of the built-in cleanroom lab will house

- lithography tools - UV mask aligner and electron-beam lithography scanning electron microscopy, photoresist processing benches for applying developing and baking the films, inspection microscope
- high temperature/cleaning stations - stack furnaces for oxidation and annealing and RCA cleaning tools, plasma etchers

The **Class 1000** built-in cleanroom bays will be equipped with

- Metal / Dielectric Deposition tools - atomic layer deposition, ebeam evaporator, pulsed laser deposition, sputterer, plasma enhanced chemical vapor deposition (PECVD),
- Dry processing equipment - deep reactive ion etcher (DRIE) for Silicon/Silicon Nitride, Barrel Asher (for PDMS plasma bonding), 3 reactive ion etchers (RIEs) for both dielectric and semiconductor materials, rapid thermal anneal
- Wet Processes - Wet Benches with spin dryers for acids, solvents and bases, scanning electron microscope, thin film measurement tools, device test equipment, probe station, C-V and I-V Meter and a microfluidic test system

This manual is designed to provide you with an overview of the Facility. It will provide you with information on general lab procedures, where to find further information and resources, and how to deal with emergencies. It will not provide you with detailed information on the chemistry or the actual process steps you will use in the course of your research, and reading it will not authorize you to use any of the equipment in the lab. To become an authorized equipment user, you must first go through equipment-specific training. If you have questions that are not answered in the manual, please come and talk to us. MIFF staff are always ready to help you learn to use the lab.

End of Section

2. General Facility Information

Hours of operation

The MIFF is open 8:30 am to 5:00 pm, 5 days a week (Sunday – Thursday). No access is permitted outside of the above hours. The MIFF is also closed for cleaning every Sunday and Thursday from 8:30-9:30 am.

In addition, the lab may be closed occasionally to address facilities issues or because of safety reasons. Wherever possible, lab users will be notified of such lab closures in advance.

Utilities

The cleanroom is supported by many utilities which control the environmental conditions in the lab, supply the lab with process gases and de-ionized water, monitor hazardous gases, and allow waste to be handled safely. The utilities are described below:

Scrubbers and Make-up Air

The function of a scrubber is to neutralize and in some cases remove volatile process effluents (gases and vapors) from the air stream. The scrubbers are located in the cleanroom chase areas, they use a sodium hydroxide solution as a neutralizer and also remove water soluble chemicals from the exhausted air stream. Areas serviced by two scrubbers include gas and chemical cabinets, wet process stations, spinners, ovens, hoods, furnaces, and vacuum chambers. To compensate for air exhausted from the clean room through the scrubbers, the MIFF uses make up air units. HEPA filters maintain the air quality in the cleanroom facility. In case of an emergency (e.g., a gas release) within the cleanroom envelope, the cleanroom changes from positive pressure to negative pressure by shutting the power on the make-up air unit. This is to ensure the hazardous volatile process effluents (gases and vapors) do not propagate to any other part of the building, in particular the escape routes from the laboratory.

Humidity and Temperature Control

Since many chemical reactions are sensitive to temperature or humidity changes, temperature and humidity control are a critical part of any clean room. One example of a chemical process that is highly impacted by temperature and humidity changes is lithography. If the temperature or humidity are constantly changing then exposure and development times would also change accordingly. This type of variation is not tolerable in a state-of-the-art clean room. The humidity specification is 42.5% ± 2.5% and the Temperature is 21.1º ± 2º. If the humidity or temperature goes out of control a set procedure is followed to bring the lab back into conformance.

De-Ionized (DI) Water

De-ionized (DI) water is a critical component of the semiconductor process due to the ultra-clean requirements of device fabrication. The system supplies ultra-high purity deionized water throughout the facility. The production of DI requires 10 gallons of city water to produce 1 gallon of DI. The DI system is capable of making eight gallons/minute with a resistivity of 18 megaohm-cm. There are 2 x 1,500 gallon storage tanks, which provide for short-term demands that exceed the eight-gallon/minute makeup capacity.

Liquid Nitrogen (LN2)

There is one 9000 gallon tank for gas delivery. The lab consumes more than 3,400,000 cubic feet of nitrogen gas produced from this tank a month. To achieve the same volume using compressed gas cylinders we would need 11,000/month. Gaseous nitrogen is generated by evaporating liquid nitrogen in the vertical heat exchangers on the LN2 pad. The long path length and large surface area ensure we have no liquid in the gas lines. There is another 9000 gallon tank for liquid delivery. This is used for filling LN2 Dewars, (these range in size from 1 liter open top buckets to 160 liter sealed vessels); and supporting cold traps in some vacuum chambers throughout the laboratory. Liquid nitrogen is provided to the lab by a gravity feed system from local reservoirs that are kept filled from the main LN2 tanks. This process eliminates surges and pressure fluctuations in the liquid lines. Gas is plumbed into each process bay, the wet chemistry lab, and satellite laboratories.

Electricity

Standard wall outlets are available in the lab. Special outlets and hard-wired hookups may be installed on request. Phases: 1, 2 and 3 phase 110, 208, and 440 VAC 60 Hz power are available. The electricity is distributed by buss in each service aisle. Circuit breaker boxes can be easily attached to the buss to support new equipment.

House Vacuum

The house vacuum is to be used for non-hazardous waste only. Ports are located throughout the lab. The house vacuum unit and collection vessel are located in the basement. This system is never to be used for chemical cleanup or picking up water from the floor.

Acid/Base Waste Water Neutralization

The acid waste neutralization (AWN) system neutralizes liquid waste from wet process stations. It uses sulfuric acid and sodium hydroxide as neutralizing agents. The neutralization system is located in service area of the cleanroom. This is an automated three-tank system that sequentially brings incoming wastewater to a neutral ph. When the liquid in the third tank has reached pH of between 6 and 8 it is then able to be disposed of via the foul drain system. The AWN makes it possible for lab users to safely dispose of many acids and bases “down the drain” by aspirating them from acid and base hoods in the MIFF.

Note: Solvent waste and wastes containing controlled toxic materials (e.g., lead, arsenic, bromine) cannot go down the drain, since the AWN does not remove the hazardous materials before the wastewater is discharged; therefore, these types of liquid waste must be collected and be sent out for controlled disposal via authorised waste contractors.

End of Section

3. Becoming a Lab User

Onsite lab use

Whether you are from Masdar Institute, another university, a government laboratory, or industry, this is the procedure to follow to become an onsite MIFF user:

1. **Register to become a potential cleanroom user**. Contact the MIFF User Services Manager to discuss your research project and processing plans. This is to ascertain that the requirements of the project match the capabilities of the lab.
2. **Write a one-page description of your overall project** (using the format in the attached Appendix, 1A). The process summary should be sufficiently detailed to allow us to determine if the materials you will be using are compatible with other research being conducted in the lab. It is useful to include a step-by-step process flow (with cross-sectional diagrams of the structure to be fabricated) and all chemicals, materials and tools that you plan to use.
3. **Complete general and lab-specific safety training**. Read this manual and the safety slides and complete the safety quizzes. The quizzes are open book. On completion return answer sheets to the User Services Manager.
4. **Arrange for a Mentor**. A mentor is the person who will take primary responsibility for teaching you how to use the laboratory tools. If you are in a research group with other people who are active MIFF users, then you should arrange with one of those colleagues to be your mentor. Your mentor should be an experienced lab user who has adequate time available to work with you

   Note: The MIFF relies on all experienced lab users to mentor new lab users conscientiously and that it is very important for mentors to teach their students good lab practices. If you are unable to arrange a mentor yourself, discuss this with the User Services Manager, who will arrange for MIFF staff to mentor you.
5. **Complete the MIFF Access Form**. See the appendix (1B).
6. Schedule a meeting with your mentor and the User Services Manager. When you have completed the interview and demonstrated your competence, you will receive access to the facility.

Remote lab use

Most lab users work onsite at the MIFF. However, for users who cannot come to the facility to carry out research themselves, there are several possible options for having process work done in the MIFF.

1. **MIFF staff** : MIFF staff may be available to do processing on a limited basis. This is possible when the process is limited to one or two steps, and the work involves established processes in the MIFF. Staff are not available to do process development for remote users.
2. **Contractors affiliated with the MIFF**: The MIFF employs several users on a contract basis to do processing for remote users when the need arises. They are typically experienced researchers who have worked for many years in the MIFF and may be available, depending on their other work commitments, to do processing or process development.
3. **Private Contractors**: Private contractors may also be available to do processing or process development in the MIFF on a fee basis. They are not affiliated with the MIFF, but the MIFF can provide their contact information.

If you are interested in having remote work done at the MIFF, contact the MIFF User Manager, who will help determine which of these options is most suited to your needs.

Lab user responsibilities

Lab conduct

Remember, the work environment of the cleanroom depends largely on the work habits of lab users. To make the MIFF a safe, pleasant, and productive place to work, please:

- Use common sense and courtesy
- Consistently follow the approved operating procedures and safety precautions outlined in section 5
- Clean up after yourself
- Label anything you leave in the lab
- Fill out equipment logs
- Notify staff about equipment problems
- Cancel tool reservations if you will not use them
- Ensure that you are trained and competent to use equipment correctly and work safely.

Buddy System

Although the MIFF is only open during daytime workings hours, lab users are NOT allowed to work in the facility alone. If you plan to work in the MIFF and you have no research colleagues or mentor available to work with you, check if other users are in the lab or are scheduled to be in the lab before going in.

Use the 'buddy system' if you are working in the lab with only one other person. Make sure that you each know where the other is and check on each other periodically. If you need to leave the lab, make sure the other user knows you are leaving, and plan to leave together. For your own safety, **NEVER** process wafers or handle chemicals when alone in the lab.

Training

All users are required to have a mentor to gain access into the MIFF. If a user cannot find their own mentor, a staff member will be assigned to be their mentor. The mentor is the primary person responsible for the new user's training. Training should include but is not limited to:

1. General Safety Protocols
2. Process Tools
3. MIFF management services

MIFF staff are also available to teach users the operation of specific tools. If you need to learn to use a tool and do not have a mentor or other authorized user available who can teach you, contact the User Services Manager to arrange for equipment training.

End of Section

4. General Policies and Operating Procedures

With the variety of hazardous chemicals and gases, the sensitive and potentially hazardous equipment, the diversity of research projects and the large number of researchers in the lab, it is important for everyone to understand and adhere to the MIFF's policies and procedures. These rules help to ensure everyone's safety. Violations may result in loss of lab access.

Lab Access

1. Only individuals qualified through the Cleanroom Training Programme are allowed to enter the cleanroom.
2. Access cards are to be used **only** by the assigned user.
3. Entry into the lab is through an individual's access card **only**. You **may not** let another person into the lab without express permission of the lab manager.
4. In areas where extremely toxic gases are used by process equipment there must be two people in the immediate area, and at least one additional person in another area of the MIFF.
5. Do not go into the service aisles unless authorized to do so.
6. Visitors are permitted in the lab if they are escorted at all times by a faculty member, staff member, or lab user.

   6.1. Lab users who wish to bring a visitor into the MIFF should first seek authorisation from the User Services Manager. **Visitors are only permitted inside the cleanroom to observe activities. They may not assist in the operation of any equipment or process**.

Standard Operating Procedures

All equipment and chemical processes must have standard operating procedures, approved by the MIFF staff. These procedures should cite protective clothing, chemicals required and masses or volumes necessary, equipment necessary (beakers, graduated cylinders, thermometers, balances, hotplates, etc.), waste disposal procedures, and specific emergency procedures. Current SOP's can be found in the MIFF operations manual in the cleanroom. To ensure consistency, a standard template is available on the EHSS section of the MI web portal.

General Rules on Cleanroom Integrity:

1. No smoking is allowed 30 minutes before entering the cleanroom.
2. Use pens only. Lead pencils are not allowed in the Cleanroom.
3. Unnecessary items are not allowed in the cleanroom. Storage areas are provided in the gowning room.
4. Avoid sneezing and coughing in the cleanroom. Breathing directly on a surface or wafer should also be avoided.
5. Singing and whistling produce air currents and severe contamination and should be avoided.
6. Clients should move slowly and carefully and avoid slamming any doors. These movements create turbulence and can shake the partitions, resulting in contamination.
7. Thoroughly clean and dry work areas after use, along with any tools or equipment.

Appropriate Attire for Cleanroom:

1. No makeup is allowed in the cleanroom.
2. Contact lenses should not be worn. Contacts can absorb vapors or trap chemicals in the space between the lens and the eye. In an emergency, the eye can also spasm, making contacts difficult to get out.
3. Full length trousers must be worn at all times. Skirts and shorts are not allowed.
4. Sandals and open-toed shoes are not allowed. Shoes that completely cover the foot are required.
5. Bunny suits, safety glasses, booties, hair nets, mustache/beard nets and gloves must be worn

General Lab Guidelines

1. Do not work in the cleanroom if you feel tired or sick; have taken any medication that may make you drowsy.

   1.1. No food or drink of any kind is allowed in the MIFF. *Food and drink include such items as: candy, gum, cough drops, coffee, etc.*

   1.2. Personal items are not to be brought into the cleanroom or gowning area. *Personal items include such things like backpacks, makeup, combs, brushes, handkerchiefs, etc.*

   1.3. Most importantly, no client should ever work alone. Every client should have a buddy who has been qualified through the Cleanroom Training program.

2. Only cleanroom paper, notebooks, and lab wipes should be brought into and used in the cleanroom.

   2.1. Notebooks, specifications, memos, schematics, magazines or any form of correspondence are not to be brought into the cleanroom area unless it they are laminated, in plastic covers or on authorized cleanroom paper.

3. For safety reasons, do not sit on lab work tables or lean on benches or equipment. You might accidentally knock something over, turn something on, lean against something hot or sit on something corrosive.
4. Ony approved powdered materials are allowed in the cleanroom or dressing area.
5. Cardboard boxes and packaging are not allowed in the cleanroom or gowning area.
6. Any debris on the floor or at a workstation should be picked up and disposed of. Assume responsibility for maintaining a neat, clean and safe work area. If you walk away from an area and leave it messy you can be cited for violating laboratory rules.
7. Do not use equipment or tools without proper training and authorization. Do not assume that you are proficient on any equipment or tools because you have used something similar in the past. You have to demonstrate your knowledge of the equipment in an authorized checkout with the owner of the tool.
8. Do not take chemicals, equipment, tools, or supplies into or out of the MIFF without permission. If you move test equipment from one building to another you may need to fill out an equipment removal form. This reduces problems with security and the University Properties office.
9. Keep your distance from other workers in the process bays. Do not go into critical areas unnecessarily.
10. Cooperate with room cleaning or decontamination procedures.
11. Report all micro-contamination problems, injuries and safety problems promptly to MIFF staff.

12. Do not take or borrow anything from another user without their permission.
13. Assist MIFF staff if/as needed in the preparation of an Incident Report after safety, equipment, or micro-contamination problem or malfunction.
14. Equipment and supplies should be cleaned before you bring them into the clean room.
    14.1. Use the alcohol wipes in the gowning area to wipe down objects that will be taken into the cleanroom. In general, work from the top to the bottom to allow dust to fall toward areas you have not cleaned. Use a new wipe for each new object.
    14.2. When possible, keep wafer boxes and other items that will go in and out of the cleanroom in plastic zip-lock bags when they are not in the cleanroom.

Equipment

1. All equipment users must initially be trained by MIFF staff or their mentor before being authorized for solo equipment use.
2. In order to use equipment, the individual must have a complete understanding of the equipment and operation and become a certified user. In order to become a certified user, the client must read the SOP and complete training.
3. All equipment bookings must be scheduled for use. If you have any issue with a reservation, or if there was a tool malfunction during your session, please contact the MIFF staff and explain the situation to them. If they decide there is legitimate reason to forgive the charges for the run, they can do so up to 3 business days after the run. After this, no correction can be made.
4. Log-in is mandatory **before** equipment is used. In logbooks, list name, date, process, and any problems encountered.
5. Report all equipment failures immediately.
6. **Do not** use any equipment in a non-approved manner or with non-approved supplies. Standard operating procedures should be posted near the equipment.
7. Equipment parameters are not to be changed without permission from the tool owner.
8. All new processes must be authorized by the tool owner.
9. Each workstation is to be thoroughly cleaned before any work is begun. For acid stations use a DI dampened wipe. Solvent work stations may be cleaned with an IPA (2-propanol, isopropyl alcohol) dampened wiper.
10. Nonessential items (tools, books, etc.) will not be allowed to accumulate and will be removed from the lab at the discretion of the Nanofabrication Lab Manager and the Cleanroom Staff.

Materials

1. The client must have a complete understanding of all the chemicals at the wet bench or equipment that they are using. It is essential to review the Material Safety Data Sheet (MSDS) sheets prior to work starting, so that the hazards, risks, and methods for responding to incidents are clearly understood.
2. The client should check Cleanroom gown and Personal Protective Equipment (PPE) for contamination. The client should eliminate contact between gloved hands and the face, as gloves may be contaminated
3. Handling of wafer boats requires nitrile gloves.

4. Special purpose gloves and safety equipment must be used as required. See PPE policies on the MIFF website.
5. All materials that are not in the process of being worked on must be stored in a covered box.
6. All materials being transported from one workstation to another must be within a covered box or appropriate carrier.
7. All beakers, graduated cylinders, etc. must be emptied, rinsed three (3) times and dried at the end of their use and stored properly.
8. Rinse out acid, base and oxidizer bottles a minimum of three (3) times.

   8.1. When finished label the bottle “rinsed”.
9. All minor chemical spills (drips and splashes) at any etch or cleaning station should be wiped up using DI water dampened wipers immediately after they occur. Solvent spills can be cleaned up with an IPA dampened wiper. Any larger spill is to be cleaned up by a member of the staff. All spills are to be immediately brought to the attention of a member of the staff.
10. Always clean up after yourself. This means you must clean up your glassware and workstation when you are finished with your process, and return chemicals to their storage cabinets.
11. Do not leave hazardous equipment/materials unattended when in use. (E.g. chemicals on hotplates, CVD furnaces, etc.)
12. Put razor blades in the “Used Blade” slot of the yellow packs in which they are stored or else dispose of them in one of the sharps waste boxes located around the lab.
13. Materials, masks, wafers and other supplies no longer needed in the clean room should be removed to make space for current research. Cleanroom space is at a premium, and there are less expensive locations for archival storage.

Reporting Incidents

All safety related accidents and incidents are to be reported to the MIFF staff as follows:

- All accidents (whether they result in injury or not) By phone to the on-call staff member
- Observed unsafe acts or breaches of Lab policy By email to MIFF manager.

You may be asked to complete an formal incident report if you are involved in an accident or find evidence of a violation of lab policy. The lab manager will investigate the issue to establish the root causes and take any action necessary to minimize the likelihood of a recurrence. We treat any incidents seriously, but they are not necessarily going to result in disciplinary action. The important issue is to identify safety problems in order to prevent future injury and equipment damage.

Lost and Found

Lost and found items will be held onto by the staff for a 2 week period and then will be disposed of. If you or anyone else has lost any items in the lab, the lost and found cart should be the first place that you look. An email is sent to all users giving them a two week notice of the removal of all items.

Gowning Procedure for Entering Cleanroom

Pre-gowning (Hallway outside gowning room)

1. In the hallway outside the gowning area, clean your shoes one at a time in the shoe cleaner. Put blue booties on over your shoes. Do not leave coats, backpacks, or other possessions in the hall outside the gowning area or in the gowning room.
2. Pass your user access card in front of the card reader and open the door.
3. Enter gowning area, ensuring that you step on the tacky-mat.

Gowning (Gowning room)

1. If it is your first visit to the cleanroom since the Sunday lab clean, you will need to take a new set of cleanroom garments from the blue bins along the left wall of the gowning room.:
2. Find your garment bag nametag and clip it to an empty garment bag in the gowning room.
3. Inspect your cleanroom apparel to ensure there are no holes, tears or seam separations.
4. Put on your cleanroom attire in the following order. The general rule is to dress from top to bottom to minimize particulate accumulation on the garments:
   - Mask
   - Gloves
   - Bouffant cap
   - Hood
   - Coverall - Try to avoid letting the coverall, especially the sleeves and upper body, touch the floor.
   - Safety glasses
   - Boots
5. Take care to step on the ground only on the “clean side” of the stainless steel benches in front of the cleanroom door. To do this, sit down on a bench, put on one boot, swing that leg over the bench, and put on the other boot.
6. Look in the mirror on the wall to check that your hood is tucked into the coverall and that your hair is fully covered.
7. Enter the laboratory.

Inside Laboratory

1. Put on second pair of gloves (located on rack near entrance). You must wear gloves at all times in the cleanroom.
   - PVC: Use these for all non-process work. (Growth monitoring, thin films, plasma, SEM or test/characterization).
   - Nitrile: Techniglove® nitrile: Use these for wet process work and handling wafers between process steps.
   - Specialty gloves: See Personal Protective Equipment chart in **Safety Equipment** section below.

Never touch your face, nose mouth, etc. when wearing plastic or rubber gloves. This is an easy way to accidentally transfer sodium from sweat and skin oils to wafers. It can also transfer chemicals to your eyes, nose, skin and mouth.

Removing Cleanroom Attire

1. Remove garments in the reverse order they were put on. Dispose of mask and gloves. Dispose of bouffant cap if seems worn out (caps can be re-used several times).
2. Wash your hands, especially if you handled chemicals in the lab.
3. Except in an emergency you should never wear cleanroom garments in non-cleanroom areas.
4. Store your cleanroom clothing in your garment bag (labeled with your nametag clip) in the gowning area.
5. Special purpose gloves, aprons, safety sleeves, goggles and face shields must be cleaned and returned to their proper storage area.
6. Do not remove blue booties until you have left the gowning area. Reuse any booties that are not damaged.

End of Section

5. Safety Equipment

BASIC SAFETY EQUIPMENT

Safety Glasses
Function: For eye protection.
Use: Wear with gowning attire.
Location: In the gowning room inside the safety glasses compartments.

Nitrile Gloves
Function: For hand/skin contamination protection.
Use: Wear with gowning attire.
Location: In the gowning room in the glove compartments.

Safety Showers
Function: For chemical decontamination on a person or their clothing.
Use: Pull lever on the wall under the shower.
Location: On the wall in the service corridors. (see cleanroom layout plan

Eye Wash Station
Function: For a chemical splash in the eye.
Use: Pull out drawer under the shower. Water will immediately begin to flow.
Location: In the pull out drawer under the safety shower.

First Aid Kit
Function: For minor injuries and minor burn pain relief.
Use: As necessary to treat minor injuries.
Location: In the gowning room and wet etch hallway.

Phone
Function: For contacting help in case of an emergency.
Use: Dial 9111 when calling for help during emergency situations.
Location: In the admin room opposite the gowning room.

CHEMICAL SAFETY EQUIPMENT

MSDS Binders
Function: For determining the hazards of chemicals and precautions to use while working with them.
Use: Look up information on all chemicals in the cleanroom by finding them in the binders or online in the MSDS library.
Location: In the gowning room, and service corridor.

Chemical Aprons and Face Shields
Function: For Personal protection against Chemical spills. The items are chemical resistant, NOT chemical proof.
Use: Always wear when working with chemicals, following directions in Section 7 - Personal Protective Equipment.
Location: By the wet etch benches in the wet etch bay and in the lithography bay hung on the wall.

Chemical Gloves
Function: For personal protection against Chemical spills. Do not immerse gloves in chemicals as they are only chemical resistant, NOT chemical proof.
Use: Always wear when working with chemicals, following directions in Section 6. Personal Protective Equipment.
Location: By the wet benches.

Calcium Gluconate "Calgonate"
Function: For hydroflouric acid (HF) burns.
Use: See section - Hydroflouric Acid (HF).
Location: In the First Aid Kit

FIRE AND HAZMAT

Fire Alarm Activation Station
Function: To alert others of a fire in the case that the alarm does not sound on its own.
Use: Break glass. Then evacuate the building immediately and meet in Lutz Hall lobby.
Location: outside the gowning room door and in the service corridor by the emergency exits.

Fire Alarm Enunciator and Strobe
Function: To alert building occupants of a fire or similar emergency requiring immediate evacuation.
Use: Evacuate the building immediately if lights are flashing or the alarm is sounding.
Location: Speakers located in the gowning room, thermal chase and service corridor

HAZMAT Alarm Activation Station
Function: To alert others of a HAZMAT situation in the case that the alarm does not sound on its own. Part of the Toxic Gas Monitoring System (TGM).
Use: Push button. Then evacuate the building immediately.
Location: Push buttons are located in the gowning room, HPM room, service corridor, by the exit doors inside the Cleanroom along the main corridor, loading dock and silane cage.

HAZMAT Enunciator and Strobe
Function: To alert Cleanroom and support area occupants of high and low level emergencies such as chemical release or exhaust failure.
Use: Evacuate the building immediately if lights are flashing or alarm is sounding.
Location: Speakers located in the gowning room, service corridor and inside the cleanroom.

Carbon Dioxide Alarms
Function: Puts out fires at benches by spraying large amounts of carbon dioxide. The Carbon Dioxide fire suppression system requires the user to vacate the area immediately after activation.
Use: Activate in case of a fire in a wet bench or spinner hood if alarm does not start on own. Push down the lever.
Location: On the solvent wet benches and hotplate/spinner combination hood (3 total).

Fire Extinguishers

Function: For fires smaller than a waste paper basket.
Use: Follow instructions on side of extinguisher. Use only if trained.
Location: long the wall of the Cleanroom, in the gowning room, and service corridor.

Toxic Gas Monitoring System (TGM)

Function: To monitor the concentrations of certain gases and exhaust, chemical spills, oxygen concentrations and UV/IR fire detectors in the Cleanroom and support areas in order to insure the safety of personnel.
Use: Watch monitor for HAZMAT alert indications.
Location: Throughout the Cleanroom, service corridor and gas storage areas

End of Section

6. PERSONAL PROTECTIVE EQUIPMENT

PPE – PURPOSE AND USE

Head / Face / Eye Protection

- **Safety Glasses:** Chemical resistant glasses should be worn at all times when in the Cleanroom.
- **Splash goggles**: Worn when running any chemical process or handling cryogenic liquid.
- **UV goggles**: To protect eyes from intense UV radiation used in mask makers or excimer laser system. Note: engineering controls for these systems blocks release of harmful levels of this light during normal operation.
- **Face shield**: Worn in addition to goggles when working at the acid or base wet benches.

Respiratory Protection

Respirators should only be used when general ventilation and fume hoods are not feasible or do not reduce the exposure of a chemical to acceptable levels. Special training is required to use a respirator. Respirator use may be required when cleaning or containing a spill.

- **Respirator/half face**: Worn during routine spill cleanup procedures and during the transfer of solvents from aspirator tank to drums on the loading dock. Not for use in cases where the gas or vapor present exceeds 10 times PEL, is immediately dangerous to life or health (IDLH) or in oxygen deficient environments. Respirator/full face Worn during spill cleanup where the concentration of vapor/gas is up to 50 times the PEL, but not to be used in oxygen deficient environments or at IDLH.
- **Supplied Breathing air**: Used when working with potentially hazardous gases. This includes changed bottles of arsine or phosphine and doing source changes in the growth systems. These can be worn in oxygen deficient environments. As the air is provided via a remote pump the user does not have to wear a 20 kilogram tank while working.
- **SCBA** Used to work in environments that could be IDLH or in gas/vapor concentrations greater than 50 times PEL. Can be worn in oxygen deficient environments. These have air supplies good for 20-30 minutes.

Body

- **Latex overboots**: Worn during large spill cleanup procedures to protect shoes.
- **Chemical Resistant Coverall (yellow-plastic)**: Coveralls designed to protect individual from liquid chemical exposure. Worn during spill cleanup where serious risk exists to personnel from splashes.
- **Level A suit** Worn in conjunction with SCBA to provide complete protection for individual in an environment of extremely dangerous vapor/gas. Can be used where absorption through the skin is a great concern or where corrosive liquids, gases, or vapors are present. Should be only used in a dual buddy system. That is, two people in suits enter a hazardous environment and two other individuals are suited up to support.
- **Full-sleeved aprons:** Worn when working with chemicals or when working at a wet bench.
- **Apron, vinyl:** Worn when working with heated corrosive chemicals (Print “FRONT” on outside to protect subsequent users from incidental exposure)

Hands / Arms

Gloves must be worn to enter the Cleanroom, however if dealing with chemicals, a second layer of gloves or heavy-duty triple gloves must be worn. All gloves should be checked to make sure they are suitable for use (holes, stains and deterioration make gloves unsafe to use). Reusable gloves should be washed and dried frequently if used for an extended period of time. Wash and dry the outside of gloves before removing them.

- Trionic gloves: General purpose chemical resistant gloves. Used for all standard chemical handling activities.
- Silvershield gloves: Broad spectrum chemical resistant gloves. Useful for unknown chemical spill cleanup.
- Cryogenic gloves: Worn when doing any cryogenic liquid handling: vessel fills, vessel to vessel transfer, etc.
- High temperature gloves: Worn when handling hot quartzware and furnace/oven components
- Sleeves, vinyl: Worn when working with heated corrosive chemicals

How to Wear Personal Protective Equipment:

1. Inspect **Apron** to make sure no chemicals, holes or other deformities are present.
2. Slide **Apron** on and tie in back.
3. Use 10% IPA in water on a towel to clean **Face Shield**. Wipe face shield inside and out and place on head. Adjust if necessary using the plastic knob on the back.
4. Put on **Gloves** (chemical resistant or nitrile) over apron sleeves.

to Remove Protective Equipment:

1. Wash and dry chemical resistant gloves using cleanroom wipers. Place in bin. If gloves are stained or otherwise unusable dispose of in waste. If using nitrile gloves, dispose of them in the waste container and put on a new pair for use throughout the rest of the cleanroom..
2. Remove **Face Shield**.
3. Hang face shield.
4. Hang **Apron**.

NOTE: If any piece of protective equipment is damaged beyond safe usage, dispose of the damaged piece!

PPE Rules & Restrictions: Personal Safety Equipment must be worn at all times while working with chemicals at the wet benches. Chemical apron, faceshield and chemical gloves must be removed after leaving the Wet Bench area. No personnel wearing PPE must be found outside the wet bay unless he/she is tending to an emergency situation.

Care of PPE

1. If a splash or drip of chemical is suspected during your work, wipe off or discard your protective gear immediately.
2. Damaged or worn out safety equipment must be replaced.
3. Before you put on your PPE, give it a visual inspection.
4. Trionic gloves are worn on top of the nitrile gloves.

5. Before removing gloves, always wash them well with DI water at the sink to remove any water soluble chemical that may be on them.
   5.1. Wash only the outside of the gloves.
   5.2. Do not allow water to get inside the glove.
   5.3. Dry gloves with cleanroom paper.
6. When gloves are not in use, hang them at the wet station where they were used.
7. Never use gloves when wearing sharp rings or bracelets that might cause a puncture or tear.
8. Concentrate on keeping gloves away from your goggles, facial area, or exposed skin surfaces.
9. If you wear vinyl sleeves ensure they are over the cuff of you glove.
   9.1. Under no circumstances should the sleeve be tucked into your glove. This prevents chemicals from spilling from the sleeves, into the gloves and onto your hands.

End of Section

7. Hazardous Materials

MATERIALS INVENTORY

A central inventory of all hazardous materials held and used in the Cleanrooms, is managed by the MIFF staff and monitored by the EHSS department. A copy of the inventory is held in the hazardous materials folder, along with the relevant MSDS. If you cannot find the material you wish to use on the inventory list, you should inform the MIFF staff, so that it can be added and an appropriate risk assessment carried out.

MATERIAL SAFETY DATA SHEETS

Material Safety Data Sheets (MSDS) should be referred to before using an unfamiliar or new chemical. A binder with MSDS sheets for all chemicals used in the laboratory can be found in the Gowning room. If the MSDS for the chemical a client wishes to use are missing from the file, contact a staff member.

CHEMICAL CLASSES AND HAZARDS

Acids: Acids have a pH of less than 7. Chemicals can be identified as acids if they have a name ending in 'acid' or if their chemical formula is of the form HX(aq) or HaXbOc.

Bases: Bases have a pH of greater than 7. Chemicals can be identified as bases if they contain hydroxide (OH-), carbonate (CO32-), or hydrogen carbonate (HCO3-) anions. Ammonia (NH3) is also a base.

Caustics: Another word for a base. Bases may also be called alkalines.

Corrosives: Corrosives have the tendency to cause deterioration of metal surfaces. Strong acids and bases are corrosives. Corrosives are chemicals which erode the skin and the respiratory epithelium and can be very damaging to the eyes. When inhaled, the vapors of corrosives can cause severe bronchial irritation. Table 2 in the appendix contains a list of some of the corrosive liquids used in the nanofabrication lab.

Flammables: Compounds whose vapors are easily ignitable at room temperature. Flammables can be identified by looking at the MSDS sheet for the chemical.

Halogenated Solvents: Halogenated solvents contain an element from the halogenated (second to last) column on the periodic table. These elements are: Fluorine, Chlorine, Bromine, Iodine, and Astatine.

Non-Halogenated Solvents: Any solvent that does not contain an element from the halogen class (second from last column of the periodic table).

Inorganic Acids: Acids have chemical formulas that do not contain carbon.

Organic Acids: Acids have chemical formulas which contains carbon.

Oxidizing Agents: Materials which gains electrons when they react with other substances. This reaction may result in explosion or fire.

Reducing Agents: Agents which become an electron donor when they react.

Solvents: The component of the solution that is present in the greatest amount and is capable of dissolving another substance.

Toxic: Containing or being poisonous material especially when capable of causing death or serious debilitation. Exposure to chemicals in the laboratory can occur by several different

routes: (1) inhalation, (2) contact with skin or eyes, (3) ingestion, and (4) injection. Toxicity information is available on the material safety data sheet of each chemical.

Chemicals in the Nanofabrication Facility are EXTREMELY HAZARDOUS. The cleanroom contains some of the most dangerous chemical categories including strong acids and bases, corrosives, and flammables.

INCOMPATIBLE CHEMICALS

There are certain chemicals that should not be mixed because a violent reaction may occur. You should know which chemicals and containers are compatible. Some chemicals such as TCE cannot be used with plastic beakers. Some chemicals, such as HF, cannot be used with glass beakers.

Acids must always be separated from bases because a violent reaction may occur. Acids must also be separated from active metals such as sodium or potassium. Further, inorganic acids should be kept away from organic acids.

Bases must always be separated from acids.

Flammables must be kept away from heat, sun, flame, or spark source. Also keep flammables away from oxidizers.

Oxidizers must be kept away from flammables and other organic materials. Oxidizers should also be separated from reducing agents.

GENERAL RULES WHEN WORKING WITH CHEMICALS

To ensure the cleanroom is as safe as possible, the following procedures should be followed when working with chemicals:

1. Read the MSDS before using a chemical in the cleanroom.
2. Be aware of chemicals that must be used in plastic beakers and chemicals that must be used in glass beakers.
3. Always wear appropriate protective equipment in addition to required cleanroom apparel when working with chemicals. This includes: heavy-duty gloves, apron, and a face shield.
4. Do not wear safety apparel outside of wet bench areas unless working under emergency or cleanup conditions.
5. Do not work with acids or bases in the solvent hoods.
6. Do not work with solvents in the acid or base hoods.
7. Always exercise extreme caution. Because most chemicals used in the lab look like water, clients should always assume any liquid is dangerous. Also, clients should always dry water off gloves and beakers after rinsing them with water so that others will not mistake the water for a dangerous chemical.
8. Use the dedicated tanks/baths only and label beakers by their content.
9. Only use one bottle at a time. Do not open a new bottle unless an existing bottle is completely empty. Pour chemical slowly (Do not let it “gulp”).
10. Make sure that gloves are clean and dry before transferring chemicals to or from the bench.
11. When using hot plates, check that their beaker is both suitable for hot plate use and smaller than the area of the plate. Never use a Teflon, Pyrex cookware or plastic beaker on a hot

plate. Always monitor the temperature of the chemicals on a hot plate with a Teflon coated thermometer.

12. When a process requires chemicals to be mixed the following precautions must be taken by the client:
    1. When diluting an acid mixture, clients should be sure to pour the acid into the water.
    2. Clients should never mix acids and solvents - this could result in heat, explosions, or toxic fumes.
    3. Clients should never mix halogenated solvents with non-halogenated solvents.
    4. Clients should label all mixtures with permanent pen on the bottle. They should include the names of all the chemicals in the mixture as well as their percentage proportions. In order to alleviate confusion, clients should not use abbreviations. Clients may request their own storage bottle for this mixture.
13. Do not leave chemicals unattended. If the chemicals will be in use for several hours, clients should arrange with the lab manager or lab technician to leave them. In addition, clients should clearly mark the name of the chemicals, the client's name, where someone would contact the client, and when the client expects to return on a clean wiper. Clients should leave this sign next to the chemicals in use.
14. Do not pour chemicals back into the storage bottle. If you pour too much, you should dispose of it appropriately.
15. Put the cap back on each chemical bottle securely. Rinse and dry the outside of the bottle before returning it to storage.
16. Always define New, Used, and Hazardous Waste chemical bottles. The mixture name must be complete (every chemical should be named and have an approximate percentage of the mixture).
17. Always clean up their work area before they leave. Beakers should be thoroughly rinsed with DI water, dried and stored right-side up in their appropriate location.
18. If users wish to store the mixture for longer than one processing session, they should place it in a bottle with a screw-on cap and store it, properly labeled, in the appropriate chemical cabinet or refrigerator. On the label, they should record their name and the current date. Clients should be sure to label the mixture as "in use" or "hazardous waste". Storage of chemicals in other than approved cabinets will not be tolerated.
19. Ensure that all PPE is clean and dry before returning it to storage areas.

Bottle Transport

1. All chemicals bottles and containers must be moved using either chemical carts or bottle carriers. Empty, unrinsed bottles should be treated as though they were not empty.
2. Never use carts for long-term chemical storage.
3. Chemicals may be moved into and out of the MIFF only with **permission** and on approved carriers.

Bottle Handling

1. Remember to put on chemical resistant gloves before handling bottles.
2. When removing a bottle from cart or carrier support it from the bottom and carefully place it on the wet bench. As the bottom of the bottle may be dirty, place it on a cleanroom wipe to avoid contaminating the wet bench deck.
3. Never lift a bottle by the handle alone as you are likely to clip the bottom of the bottle on the bench and break it.

Bottle Use

1. Never store chemical bottles on the floor.
2. Keep chemical bottles only as long as necessary.
3. Never have an open bottle outside of a chemical bench or fume hood.
4. Carefully support the bottle when pouring the chemical into a beaker or other vessel.

   4.1. Always pour chemicals facing away from your body.

Bottle Disposal

See section below on **Waste**.

Cryogenic Material handling

Always transfer liquid nitrogen in proper containers. Always wear shoes that enclose the foot (No sandals), long trousers, cryogenic gloves and goggles when working with LN2. When you fill large containers 50-160 liters you should wear ear protection as well. Never touch any part of the transfer assembly with your bare hands. The valves, hose and piping will reach 70° Kelvin.

When filling open Dewars be aware of the level in the vessel. Overfilling will result in spilled liquid. Return goggles and gloves to the area near the station. Do not hang goggles from any part of the piping as the extreme cold will damage the elastic.

The large volume of gas produced from evaporating liquid can displace sufficient oxygen in a closed room to be dangerous. Ensure you have adequate ventilation for any operation consuming or transferring liquid nitrogen or helium.

Do not spill cryogenic gas on the floor. The intense cold will cause rapid contraction of the flooring followed by quick expansion as it returns to ambient temperatures. In the clean-air spaces of the lab the resultant particulate/micro-contamination problem will require replacement of the floor.

Further information on safe use of Cryogenic materials can be found in EHS Guidance sheet ***HSG 014 –Cryogenic Materials***

END OF SECTION

8. Waste Disposal

The MIFF generates two categories of liquid and solid wastes - Hazardous and Non-Hazardous. Proper disposal of this waste is essential to maintain safe conditions in the lab and adhere to environmental regulations. Details of MI's Hazardous waste disposal process can be found in EHS Procedure Sheet ***HSP 011 – Hazardous Waste***

The information below describes the standard process for handling the various waste streams generated in the MIFF:

Disposal of non-contaminated solid wastes

1. Use open waste containers located throughout the lab marked "General Waste".
2. Never place any chemicals, or material contaminated with chemicals in "General Waste".

Hazardous waste disposal (General arrangements)

If you generate any hazardous waste you must:

1. Place the waste material in a proper designated container.
2. Place a hazardous waste label on the container.
3. If waste cannot be identified it must be reported to MIFF staff to decide if a chemical analysis on the material is necessary.
4. The most common hazardous waste generated includes:
    - EDP (silicon etchant)
    - Indium-removal
    - Bromine-methanol
    - High temperature boron sources
    - Arsenic soiled
    - Cyanide waste from the gold plating station

Disposal of Acids (Liquid)

1. Use the aspirators in acid benches or pour it down the sink in the acid bench that you are working in.
2. After removing acid from the container rinse it with water and aspirate some water to clean aspirator line.

Disposal of Weak Bases (Dilute Liquid)

1. Use the aspirators in base benches or pour it down the sink in the base bench that you are working in.
2. Run water a short time before pouring base, while pouring base, and a short time afterward.

Disposal of Strong Bases (Concentrated Liquid)

1. Carefully dilute with water and dispose of as a dilute base.

Disposal of Organic Compounds (Liquid)

1. Use aspirators in organic benches.
2. Be sure to aspirate air after emptying container to prevent discarded fluid from leaking out of line.
   2.1. If aspirator tank fills, an alarm will sound. Press alarm silence button and notify staff member immediately. MIFF staff will empty the tank.
3. If you have more than one gallon of organic wastes, notify a staff member and they will help you dispose of it.

Disposal of Acid and Base Waste (Solid)

1. Place any contaminated acid or base materials in the waste container marked “Acid”.
2. When the container is full, remove the lining bag from the “Acid” container.
   2.1. Tie the bag closed.
   2.2. Replace the old bag with a new one.
3. Write “Acid” on the lining bag or attach cleanroom tape labeled “Acid” to the top of the bag so that it is visible.
4. Place the bag by the door next to the “Rinsed/Dried” container.

Disposal of Solvent (Organic) Waste (Solid)

1. Place any contaminated solvent materials in the waste container marked “Organic”.
2. When the container is full, remove the lining bag from the “Organic” container.
   2.1. Tie the bag closed.
3. Write “Organic” on the lining bag or attach cleanroom tape labeled “Organic” to the top of the bag so that it is visible.
4. Place the bag by the door next to the “Rinsed/Dried” container.

Disposal of Photoresist Waste (Solid)

1. Place any contaminated photoresist materials in the waste container marked “Photoresist”.
2. When the container is full, remove the lining bag from the “Photoresist” container.
   2.1. Tie the bag closed.
3. Write “Photoresist” on the lining bag or attach cleanroom tape labeled “Photoresist” to the top of the bag so that it is visible.
4. Place the bag in the “Photoresist Waste” container by the chemical cabinets near the entrance research lab.

Empty Acid and Base Bottles

1. Rinse them with DI water inside and out. Fill half-way, shake, and drain. Repeat this at least two times.
2. Scribble out the name of the acid from the bottle with a marker.
3. After rinsing, cap bottles, label them as rinsed, place them in a plastic bag and place them in the “Rinsed/Dried” container by the chemical cabinets near the entrance research lab.

   3.1. Do not forget to mark the used chemical on the inventory.

4. For more detailed instruction on empty bottles see the EHSS procedure HSP 011 – Hazardous Waste

Empty Solvent (Organic) Bottles

1. Leave bottle uncapped in hood to evaporate all contents. To save time invert bottle on a wiper.
2. Scribble out the name of the organic from the bottle with a marker.

   2.1. After rinsing, cap bottles, label them as dried, place them in a plastic bag and place them in the “Rinsed/Dried” container by the chemical cabinets near the entrance research lab.

   2.2. Do not forget to mark the used chemical on the inventory.

Broken glass (contaminated and non-contaminated)

1. Place the broken glass (including wafers, glass labware, etc.) in the “Broken Glass” container by the chemical cabinets near the entrance research lab.
2. Rinse any contaminated glass as much as possible before placing it into the container.
3. Do not place any paper or cleanroom wipes in the container with the glass.

Arsenic Contaminated Waste

1. Place the arsenic contaminants in the “Arsenic Waste” container.
2. Rinse any arsenic contaminated waste as much as possible before placing it into the container.

Razor blades / Sharps

1. When finished with a blade put it in the ‘used blade’ slot of the package it came from.
2. If the user wants to dispose of the razor blade or other “sharps”, empty them into the appropriate sharps container located in the cleanroom.

End of Section

9. Emergency Procedures

EMERGENCY RESPONSE MANAGEMENT

The overriding policy for management of emergency situations is defined and laid out in EHS document ***HSP 010 – Emergency Response Plan (ERP)***.

The *ERP* is an "all-hazards" document. In other words, it contains concepts, policies, and procedures that apply regardless of the nature or origin of an emergency or disaster, and it is not designed to address unique conditions that result from a particular hazard or event. The plan does, however, provide a framework within which emergency operations staff and other relevant department and agency personnel work together to develop and maintain hazard-specific controls.

Because the ERP is designed as a flexible management system, part or all of it may be activated as appropriate to a situation.

The primary goals of any emergency response plan are:

1 To preserve life and property

2 To ensure continuity of campus operations

3 To provide an organizational framework for the management of emergency situations

4 To seek to minimize the impact of an emergency on surrounding sites and external stakeholders

Lab or Building Evacuation

In the event of a situation within the MIFF that could potentially injure users or staff, any MIFF staff member should use their best judgment to minimize or eliminate exposure to a suspected hazard within the lab.

All personnel are advised to:

- Familiarise themselves with the layout of the building in which they work, paying particular attention to the **emergency escape routes and fire exits**.
- Be thoroughly conversant with all Fire Instructions and Emergency Procedures.
- Remember – Never put yourself in danger

Emergency Contacts

A list of emergency contact telephone numbers is posted in the entrance to the cleanroom and alongside all phones. These lists give contact numbers for MIFF staff and ERP personnel who will attend in the event of an emergency and coordinate any recovery action necessary. The key number that all clients should remember is the MI Security Control Room – 02 810 9111.

This number is manned 24 hours, 7 days a week and security staff will coordinate with local civil defence emergency services such as Ambulance. Police and Fire

Note: if you are calling from a MI landline phone, just dial the extn 9111. If you are calling from a mobile, dial the full number. You are advised to keep this number in your mobile phone address book

The following topics detail the steps to be followed by MIFF users in the event of those cleanroom specific emergencies deemed to be significant risk or likelihood.

FIRE

Action on discovering a fire

On discovering a fire:

- Shout '**FIRE – FIRE - FIRE**' and raise the alarm by breaking the nearest break glass call point;
- If the fire is small, **and only if you have received appropriate training and it is safe to do so**, attempt to put out the fire using the appropriate type fire extinguisher.

DO NOT TAKE RISKS: **IF IN DOUBT – GET OUT**

- If the fire grows, or one extinguisher does not extinguish the fire, evacuate immediately via the nearest fire exit, closing doors behind you if possible.

Action on hearing a continuous alarm

On hearing a continuous alarm:

- Stop what you are doing at once
- Safely switch off any equipment you are operating.
- Leave the building by the nearest fire exit.
- Go immediately to the nearest Fire Assembly Point
- Inform the person in charge of your presence and await further instructions.
- Do not leave the assembly point without permission.

FIRST AID

First Aid Kits are held in the gowning area for the purpose of providing immediate treatment of simple injuries. Any use of items within the first aid kits are to be reported to the MIFF staff so that re-stocking can take place.

Initial response to an injury is dictated by the emergency itself. Cleanroom activities often involve highly hazardous materials and in many cases professional medical treatment will be required when the injury has resulted from contact with those materials. Evaluate any situation before attempting to give assistance. Clients should not expose themselves to hazardous atmospheres, chemical contact or other dangers while attempting to give first aid. **Remember 9111**. People often become so involved in the unfolding emergency situation they forget that help is a phone call away.

Responses to some common potential laboratory injury incidents are described below.

CHEMICAL SPILLS ON SKIN

Note - The following procedures are not for Hydrofluoric Acid (HF). *Contact with HF is listed later in this section*

For minor Spill On Skin:

1. **Place Affected Skin Under Running Water** where it should stay for at least 15 minutes or until help arrives. Do not rinse their skin with solvents since solvents can remove naturally protective oils for the skin and can, in some cases, cause the chemical to be absorbed better by the skin.
2. While the water is running, **Remove Any Contaminated Clothing**.
3. Determine if further medical care is needed. If they decide that further medical care is needed, the buddy should **Call 9111** and demand an ambulance. Where the injury necessitates hospital treatment, the 'buddy' should also contact the on call staff member
4. Buddies should bring the relevant **MSDS Sheet to the Medical staff**

For major Spill On Skin:

Large spills are those that are immediately life threatening, or involve chemicals capable of posing long-term health risks or risk of disfigurement.

1. The cleanroom buddy should **Call 9111** and demand an ambulance.
2. The patient should get under a running cleanroom **Safety Shower**.
3. While under the safety shower the patient (with help from the buddy if needed) should **Remove All Contaminated Clothing**. Clothing may be cut off to prevent additional chemical exposure. Clients should stay under the safety shower for at least 15 minutes or until help arrives.
4. Buddies should a**ccompany the patient to the medical clinic** and take the **MSDS** sheet.
5. Report incident to the lab manager immediately.

For Flammable Solids on Skin:

First brush off as much of the solid as possible, then treat as a small spill on the skin. Remember, some flammable solids may react with water. Be sure to consult the chemical's MSDS if you are unsure of the proper course of action.

For Chemical Splash In Eyes:

1. The Buddy should **Call 9111**.
2. The client should **Flush Eyes in Eyewash Fountain** for at least 15 minutes. While flushing, eyelids should be held open with the hands. Patients should rotate their eyeball up down, and side to side to ensure all areas are rinsed. If the client is wearing contacts they must come out first!
3. Go to medical clinic and **take relevant MSDS**.
4. Report incident to the lab manager

For Those Helping a Chemical Contact Victim: When helping co-worker who has had skin contact with a chemical, buddies should:

- Be sure they are wearing appropriate protective apparel.
- **Call 9111** on the phone in the gowning room and ask for an ambulance to take the victim to the medical clinic.
- Check the MSDS for the hazards of the chemical and be sure to keep the MSDS with the victim.
- Inform the ambulance personnel of the substances involved and the immediate actions taken.

HYDROFLUORIC ACID (HF)

HF is used to etch silicon dioxide, glass, and other materials. It is dangerous because of its resemblance to water, it is not painful upon initial contact, it may be absorbed through unbroken skin, it depletes the calcium in the body and destroys tissue and it is potentially lethal. Solutions of less than 10% may take hours before symptoms appear, but any contact is still very dangerous.

If skin contact with HF occurs or is suspected to have occurred:

1. Immediately **Rinse the Affected Skin** with water.
2. **Remove all Jewelry and Clothing** exposed to HF while rinsing in the safety shower for 5 minutes.
3. **Call 9111** and demand an Ambulance. Take the MSDS to give to the doctor and give a report of the proceedings to the lab manager after the incident.
4. After washing, do **NOT** Dry Skin.
5. Patients should (with the help of their cleanroom buddy if needed) **Cover Entire Affected Area with Calcium Gluconate Gel** using a double-gloved hand.
6. Take the gel with you and continuously apply fresh gel on the way to the medical clinic.

FIRST AID FOR OTHER CHEMICAL INCIDENTS

Chemical Inhalation: Clients should first Check the Area for Safety. Clients helping the victim should try to Close Open Containers and Move the victim to an area with fresh air. If the victim has symptoms such as headaches, nose or throat irritation, dizziness, or drowsiness and they persist, the victim should seek medical attention.

Chemical Ingestion: Clients should immediately go to the **Medical Clinic** for advice about poisoning and chemical toxicity. Do not induce vomiting unless directed to do so by a health care provider.

Thermal Burn: Clients should immerse the burned area in cold water or hold under cold running water until the pain stops. If the burn is severe, clients should seek medical attention.

Always call for medical attention for the victim before administering first aid and report the incident to the laboratory manager.

CHEMICAL SPILLAGES

Assessing and Responding to Spills

A **minor spill** is defined as one that does not spread rapidly, is not toxic, does not endanger people or property except by direct contact, and does not endanger the environment outside the building AND is less than a gallon of liquid. The lab occupant should:

1. Check self for contamination. If chemical has been spilled on the lab occupant, follow Section – If There is a Chemical Spill on a Person.
2. Check bench and floor for contamination.
3. Label the spill and leave someone in charge of alerting others about the spill so that accidents can be prevented.
4. Contact the cleanroom staff for supervision of the cleanup. The staff may determine that the cleanroom user is capable of cleaning the spill under staff supervision. However, if the client is unsure of the severity of the spill, he should not hesitate to call the EHS department.

A **major spill** is defined as one that spreads rapidly, is toxic, endangers people or property, endangers the environment outside of the building, is more than 1/2 a gallon of liquid and/or is any amount of Hydrofluoric Acid (HF). The lab occupant should:

1. Check self for contamination. If chemical has been spilled on the lab occupant, follow Section – If There is a Chemical Spill on a Person.
2. Push the HAZMAT Alarm and Call **9111**.
3. Evacuate the cleanroom, following the evacuation procedures.

Safety Measures for Spill Assessment and Cleanup

Clients and staff should remember that cleaning up any spill may be potentially more hazardous than routinely working with the same substance because you have less control over the environment. Personal Protective Equipment should be worn. Additionally, the items below may be used:

- Heavy Nitrile butyl or neoprene gloves, plus a pair of disposable polyethylene gloves.
- Boots or chemically resistant shoe covers
- Respirators or SCBA

Clients should also take the following safety precautions:

1. Always consult the chemical's MSDS or the MIFF EHS before beginning a spill cleanup.
2. At least two people should be present for every clean up.
3. Label the area or leave someone in charge of alerting others about the spill so that accidents can be prevented.
4. If use of a respirator is necessary for the clean-up, contact a member of the Cleanroom staff. If a staff member cannot be reached, it is a high-hazard emergency. Clients should activate the HAZMAT alarm and evacuate the cleanroom.
5. Under staff supervision, turn off any ignition sources in the cleanroom such as burners, motors and other spark-producing equipment. Prevent the spread of contamination and contain any volatile material within a room by keeping doors closed.
6. If needed, use a ph strip to assess the chemical.

7. Neutralize spills of corrosives before attempting to clean spill up.
8. Contain and dispose all spilled material as contaminated hazardous waste. (See section 7)

Spills Involving Mercury and Mercury Containing Compounds

Currently the laboratory is free of any mercury containing thermometers, however, there are mercury containing compounds used in some processes and some tools. Mercury and its compounds are a severe health hazard and can be absorbed through the skin. Furthermore, some mercury compounds can penetrate various protective gloves. This section is intended to address mercury spills in the event that they occur.

Compromised Mercury Arc-Lamp Envelope

In the event that a mercury arc-lamp quartz envelope should rupture, the laboratory is to be evacuated immediately to minimize the risk of mercury exposure. The laboratory is to remain evacuated for a minimum of 30 minutes. The on-call staff member should be contacted immediately to provide for a coordinated response. Tools with mercury arc lamps are:

- Karl Suss MA / BA 6 Mask Aligner
- Karl Suss MA-45 Aligner #1
- Karl Suss MA-45 Aligner #2
- EVG 620 Mask Aligner
- EVG 420 Mask Aligner
- MJB 3 Mask Aligner
- Quintel Mask Aligner
- Interserv Mask Maker
- GCA AS200 stepper

HAZARDOUS GAS LEAKS

The MIFF incorporates a life safety system that monitors for gas, as well as other hazards, throughout the laboratory. The system provides state-of-the-art monitoring thereby providing the highest level of protection for the laboratory, surrounding environment, and the personnel occupying these areas.

All changes of gas supply bottles is carried out by the Gas Supplier and as part of the supply contract, they also provide emergency response for the investigation and recovery from all hazardous gas emissions. A copy of the ERP for handling toxic gas leaks is found in **Appendix 3**

MIFF users and staff act as the first line of response and are responsible for ensuring effective evacuation of the area and containment of the incident site, until the emergency response team arrives.

The following sections detail the immediate actions that MIFF users should take to ensure their safety and evacuate the affected areas.

If the HAZMAT (TGM or Toxic Gas Monitoring) System Alarm Sounds

1. **EXIT** the building immediately through the nearest door.
2. Do not try to finish an experiment. Clients should not try to figure out why the alarm is sounding.
3. Do not attempt to de-gown.
4. **WARN** others in their vicinity of the need to evacuate the building immediately.
1. After evacuating, go to the designated assembly point.

Types of Gas Alarm

Low-Level Toxic (Vented Enclosure) Gas Leaks A leak of Toxic, Breathing air, non-flammable gas, inside a vented cabinet greater than the threshold limit value (TLV) and max ½ IDLH.

No evacuation is necessary. In the event of a low-level toxic gas leak in a vented enclosure:

1. Call or have someone call the MIFF on-call staff member.
2. Report the incident details and your participation to the on-call staff member in writing after the MIFF has stood down from the incident.

Low-Level Gas Leaks A leak of Toxic, Breathing air, non-flammable gas, greater than ½ the threshold limit value (TLV).

In this case, only a local MIFF alarm will sound evacuating the MIFF only. The following is a summary for a work-hours response (not necessarily in this order):

1. All users are to evacuate the main cleanroom, service aisle, sample prep room, microscopy suite room immediately.
2. If it can be done without risk to you, assist any personnel who need help evacuating.
3. Call or have someone call the MIFF on-call staff member.
4. Report the incident details and your participation to the on-call staff member in writing after the MIFF has stood down from the incident.

High-Level Gas Leaks A leak of Toxic, Breathing Air, non-flammable gas, equal to or above the TLV threshold and max 1IDLH.

In the case of a high level gas leak, both the local MIFF and building alarms will sound evacuating the MIFF and the 1A undercroft. The following is a summary for a work-hours response (not necessarily in this order):

1. Follow the procedure for *Low-Level Gas Leaks*, except that you must evacuate the building entirely.
2. All users are to assemble at the fire assembly points located on the podium at the Windtower courtyard.
3. Call the Gas Emergency Response Team

If the Carbon Dioxide Alarm Sounds

The carbon dioxide alarm will be initiated if there is excessive heat or if a fire starts in one of the fume hoods. A hazardous amount of carbon dioxide will be automatically generated (or activated using the alarm activator station) to put out the fire and/or to prevent it from spreading. Though the alarm may only be sounding at one of the fume hoods, it is important that clients evacuate the cleanroom as quickly as possible. If the Carbon Dioxide alarm activates:

1. Immediately evacuate the cleanroom.
2. Do not try to finish an experiment, figure out why the alarm is sounding, or attempt to de-gown.
3. **Warn** others as they leave.
4. Assemble in the central lobby of the undercroft.

POWER FAILURES

A major power interruption can be described as a loss of electrical power to an area of the institute's campus resulting from the failure of high voltage switchgear or transmission lines. Such failures could result in the loss of lighting, air conditioning and building management systems that may require evacuation of part or all of the premises.

In the event of a mains power disruption, Fire alarm and life safety systems will continue to be powered by battery back-up for a limited period. The MIFF also has generator backup, however, there may be problems with power sensitive equipment.

Follow tool specific instructions for power failure posted for each tool. For any tool that does not have specific instructions, do the following, if applicable (not necessarily in this order):

1. If power is not restored in less than 10 minutes, call the MIFF on-call staff member.
2. Turn off equipment to prevent damage should the power cycle on and off, or should it come back on suddenly.
3. Carefully shut down all chemical operations.
4. Cap all chemical containers.
5. Completely close all hoods to help contain fumes.
6. Report the incident details and your participation to the on-call staff member.
7. On resumption of power, check systems and equipment to ensure that they have re-started correctly and safely
8. Do not resume operations until the electrical system is stable.

Other Laboratory Emergencies

If a situation arises that you feel may constitute an emergency within the MIFF or its associated labs, call or have someone call the on-call staff member. Do not call the on-call staff member for situations that can wait until the next business day. Tool performance or operational problems are not considered emergencies.

End of Section

Appendix 1A

PROJECT DESCRIPTION FORM

RESEARCHER INFORMATION

Name			Date		
Position	MI Faculty		MI Student		Non MI Researcher
Department/ Company address					
Phone No		Email address			

PROJECT DESCRIPTION

(include a 2-3 paragraph description of your project, including project goals, fabrication needs and attach an additional page of “cross sectional” schematics depicting how your device will be built layer by layer)

Approvals (MIFF office use only)

Project Approved	**YES**		**NO**	

Reasons for rejection / conditions of use.

Approved / Rejected by:		Date	

Appendix 1B

MASDAR FABRICATION FACILITY ACCESS REQUEST

Section 1 – Personal Details

Name				Date			
Position	MI Faculty		MI Student		Non MI Researcher		Visitor
Department/ Company address							
Phone No				Email address			

I wish to use the following rooms:

Cleanrooms	
Sample Prep Room	
Microscopy Suite	
Analytical Suite	

Date Access Required		Expected Duration	

Section 2 – Training and Supervision

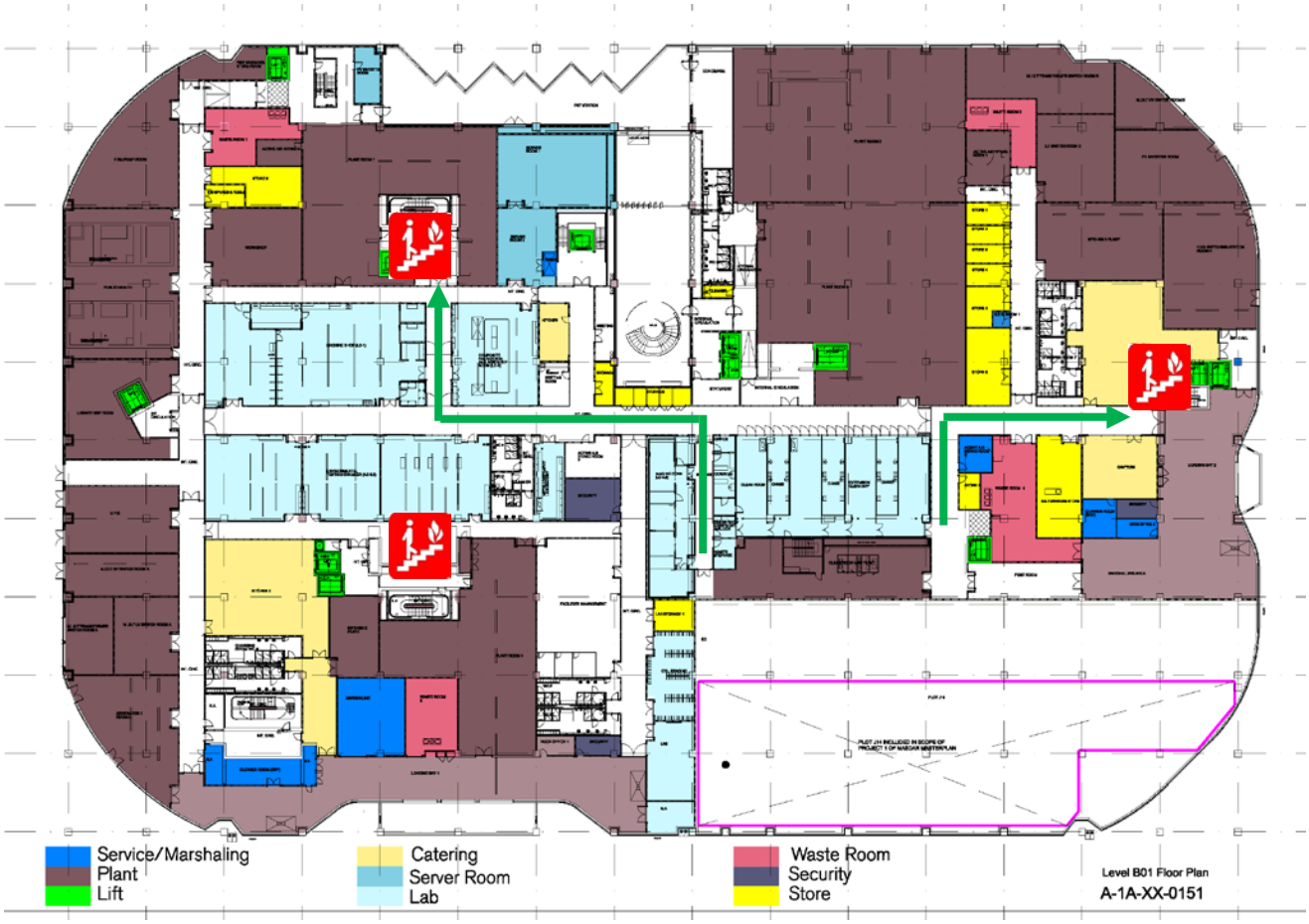
Mentor (Trainer)		Contact No	
Mentor Signature		Date	
Faculty (Technical Supervisor)		Contact No	
Faculty Signature		Date	

Training completed (date)	MI EHSS Safety Induction	
	MIFF Induction	
	MIFF Equipment Competence Test	

Section 3 – Approvals (MIFF office use only)

Access Approved by			
Comments / Restrictions			
Access Card No		Date Issued	

Appendix 2 Undercroft Evacuation Routes



Appendix 3 – Toxic Gas Emergency Response Plan

Insert Air Liquide ERP