

MPRF
(Micro-Processing Research Facility)

Safety Manual
and
Operating Procedures

The University of Tennessee
Knoxville, Tennessee

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Overview of Safety and Operating Procedures Manual

This manual provides information on how to perform research within MPRF safely and considerately. A comprehensive and demonstrated understanding of these procedures and protocols is required of any individual who works within MPRF since it will protect both the individual users and the facility. This manual is split into three distinct sections.

The first section describes GENERAL INFORMATION on how one becomes trained and certified to work within MPRF. It also describes what measures will be taken to ensure compliance with the protocols described in this manual.

The second section describes SAFETY PROCEDURES and protocols. It includes subsections on the responsibilities of users in cases of emergency or accident, on the safety equipment distributed throughout MPRF, and on chemical safety including liquids, solids, gases and cryogenes.

The third section describes OPERATING PROCEDURES covering work performed within MPRF. Examples of these procedures include how to: schedule equipment time and resolve conflicts, become trained and certified to use equipment in MPRF and bring equipment or unusual chemicals into the lab. It also includes subsections on specific personal behavior expectations, what to expect if you break the operating procedures as well as specific information on how to respond to various alarms and situations.

General Information

The following sections on Safety in MPRF and on Operating Procedures for MPRF apply to all users of the facility. Everyone doing research in MPRF must have a comprehensive and demonstrated understanding of these procedures and protocols. They must be followed at all times in order to promote a safe and congenial working environment. Safety is the pre-eminent concern in all situations. Never perform a job that has high risk.

I. How to obtain training and become certified.

A. Training on Safety and Operating Procedures.

MPRF training will be given on a frequent basis to new users of the facility by the MPRF staff. This training will provide new users with MPRF requirements for attire, behavior, safety considerations, standards of cleanliness, and equipment / processing procedures and training. This is mandatory for all users of the lab. All persons working in MPRF must obtain safety-training certification from the MPRF staff before access is granted to the facility. This safety training is considered a minimum for entry into MPRF, but does not constitute training for equipment usage. This training must be obtained separately, but will also be provided on an as needed basis by the designated MPRF staff.

B. Training on Fabrication Equipment

To obtain qualifications to operate any piece of equipment in MPRF the user must first be trained by MPRF staff. Additional training for specific process operations may come from an experienced user already trained by staff.

II. Violations of Safety, Behavior, or Cleanliness Policies

Persons not abiding by the policies and procedures contained herein may present a significant hazard to both the other users and MPRF facility itself. It is hoped that simple violations can be corrected by further training or education of those involved. Persistent violators of these policies will be subject to revocation of MPRF access privileges.

It should be clear that any violation of these standards for safety and operating procedures is inexcusable and the offender can be disciplined by MPRF Management. In addition, all personal behavior is expected to be professional within the lab. Any form of inappropriate personal behavior must be reported and corrected. Such behavior will be met with disciplinary measures appropriate to the violation(s). A violator will ordinarily first be asked to correct their behavior and be trained to do so by the MPRF staff. If they do not, further discipline may be applied by MPRF Management including revoking all MPRF privileges for a specified period of time. MPRF Management need not reinstate privileges if it is deemed unsafe to allow the repeat violator to re-enter the facility.

MPRF: Safety Manual

I. Emergency Procedures / Protocols.

A. Life-Threatening Emergency Procedures.

The **prime concern is for the safety of all personnel.**

1. **Quickly assess** the emergency as to best response, and then follow that response.
2. **Notify emergency personnel** immediately (fire, paramedics, police), **THROUGH the UTK police emergency number.**
 - a. **UTKpolice** can be reached at **911** from a UTK phone.
 - b. UTK police can be reached by cell phone at (865)974-3114.
 - c. **Notify a MPRF staff member.**
3. **Evacuate (leave)** any dangerous areas (process bay, entire lab, and/or building).
4. **Warn others.** If you must evacuate, make sure that others are notified and comply with the evacuation.
5. **Do not re-enter** the dangerous area until an authorized official (UTK police or fire personnel) gives the all clear notification.
6. **Subsequent MPRF reentry will be authorized by MPRF Staff.**

B. Non-Life-threatening Accident / Emergency Procedures.

The **prime concern is for the safety of all personnel,** and equipment.

1. **Quickly assess** the incident / emergency as to best response and then follow that response.
2. **Immediately notify available MPRF staff**
3. **Contain Chemical spills** as quickly as safely possible. Put chemicals into their safe storage location. For large spills, notify MPRF Staff and exit the area.
4. **Shut down electrical power** to malfunctioning devices using the Red EMO button.
7. **Evacuate (leave)** any dangerous areas (process bay, entire lab, and/or building) immediately after . (See specific evacuation procedure.) Remember that the recirculation of clean room air can quickly spread dangerous vapors throughout the entire clean room in MPRF.
8. **Warn others.** If you must evacuate, make sure that others are notified and comply with the evacuation.

C. Fire / Emergency-Evacuation Alarm Procedures.

When the Fire / Emergency- Evacuation Alarm sounds: the safety of all personnel, and equipment is the prime concern.

1. **Evacuate MPRF as quickly and as safely possible.**
 - a. Do NOT remove your clean room clothes when working in the MRF clean room. **Immediately exit** according to the emergency evacuation plan.
 - b. Do NOT go looking around to find out why the alarm is sounding, **exit immediately.**

2. **Warn others.** Make sure that others are notified and encourage them to comply with the evacuation.

II. Personnel

A. Access

Access to MPRF is a revocable privilege, and is available only during the hours published by MPRF Management. **Users may not enter MPRF outside normal working hours without permission from MPRF staff.**

B. The “Buddy”

Often we forget the single best safety system available to us in the laboratory, a “buddy.” **Never work alone in any portion of MPRF.** The “buddy” must be a colleague who understands what you are doing enough to competently help you in event of an accident or emergency. It is the responsibility of each user to obtain a “buddy” during their work by verbally notifying the intended buddy that they are their designated buddy. When leaving, notify your buddy that you are leaving. Staff can assist in serving as a “buddy” by advance arrangement with MPRF Management in some circumstances.

C. External (Non-UTK) Users of MPRF

External (Non-UTK) users, such as companies or other educational institutions, may be granted access MPRF in accordance with approved agreements, policies and regulations by MPRF Management and the UT-System. In addition, the following conditions must be met:

1. An approved, signed agreement must be on file with MPRF Management.
2. A list of all user employees must be provided by the external user upon agreement execution and renewal, as well as with any changes in employees.
3. No currently enrolled student may work as an employee or contractor of an external user in MPRF.
4. External users must adhere to all policies and procedures for MPRF.

III. Safety Equipment

Users must know how to use the following safety equipment and their locations.

A. First Aid Kit

The First Aid Kit is located in MPRF in the gowning room on top of the self in front of the bench. This kit will have band-aids, and standard first aid bandages for small abrasions or burns.

B. Fire Extinguishers

There is a fire extinguisher located **behind stainless steel doors in the wall at the vestibule columns**. Familiarize yourself with the location of this equipment. **Use these only to contain small fires – i.e. trashcan fires, or wipe on a hotplate, etc. and after help has been summoned.**

C. Chemical Showers and Eye Wash Stations

There is a shower in the hall outside of MPRF and an eyewash station located against the wall at the area between the thermal CVD facilities and N2 tanks inside MPRF.

1. Chemical Spills on your clothes / body

Use the shower if you spill dangerous chemicals on your clothes / body. Speed is essential. Do not hesitate. Working together with your buddy, immediately begin flushing with plenty of water and continue to flush for at least 15 minutes. While showering, remove your affected clothing so as to remove the source of chemical danger from yourself. Concerns about modesty must not interfere with avoiding serious injury. A spare blue smock is hung next to each shower for cover after the shower. Do not put contaminated clothing back on after rinsing. Summon appropriate medical assistance as soon as possible and get a thorough medical evaluation.

2. Chemical Splashes into your eyes

Use the eyewash stations located at the end of each bay if chemicals have splashed into your eyes. Call for help so that your buddy can lead you to the eyewash station and assist. Speed is essential. Do not hesitate. Let the water flow over your closed eyes for a few moments before beginning to open them. This will make sure that the water is clear and pure. Wash out your eyes with water for at least 15 minutes after opening them. If you have splashed chemicals both in your eyes and on your body, then you may want to use the shower first and rinse your eyes in the shower. After showering, rinse your eyes using the eyewash station as well. Remove any affected clothing while rinsing your eyes at the eyewash station so as to remove the source of chemical danger from yourself. Concerns about modesty must not interfere with avoiding serious injury. A spare smock is hung next to each eyewash station for cover after the rinse. Do not put contaminated clothing back on after rinsing. Summon appropriate medical assistance as soon as possible and get a thorough medical evaluation.

D. Automatic Fire Sprinkler System

MPRF has an automatic fire sprinkler system activated by heat. Also, any pressure drop sensed in the waterline automatically trips the fire alarms and notifies the UTK police.

E. Chemical spill Clean-up / Containment

Notify MPRF Staff immediately of the spill. Assist in cleaning the spill ONLY if requested by a MPRF Staff member. There are chemical spill absorbing compounds located at each hood in the clean room.

F. Calcium Gluconate Gel for HF Exposure Treatments

Calcium gluconate gel cream (sometimes called “HF antidote”) is available inside the fume hood in a “toothpaste” tube form. Familiarize yourself with the location of this tube of gel. It can be applied to your skin (in a topical cream form) and must always be available and within reach whenever HF is used. Apply the gel all around and on the exposure in lavish amounts immediately. In addition, anyone exposed to HF must go to an appropriate medical care facility for evaluation and treatment as quickly as safely possible. **The exposure must be reported to MPRF Management.**

Calcium gluconate provides extra calcium ions which can bind-up free fluorine ions before they penetrate your body and cause damage. In cases of skin contact, calcium gluconate gel must be applied immediately to the area of contact. In cases where systemic damage is a risk, calcium gluconate can be administered by a healthcare professional using an IV.

See the comments below in the “Acids” section as well.

IV. Chemical Safety

You must **always know the properties** of the chemicals you are using in MPRF. In broad terms, chemicals fall into a few classes: Water, Cyanides, Solvents, Acids and Bases. Other descriptors are often used to describe chemicals as well. These include “toxic,” “flammable,” “combustible,” “cryogenic” and the state of the chemical (solid, liquid or gas). These classes and descriptors may not cover all possible chemical properties, but are nearly always used to characterize our chemicals. The properties of every chemical you use in the lab can be discovered by examining its Material Safety Data Sheet (MSDS). You must be familiar with the MSDS information before using any chemical. **All chemicals must be physically transferred into the clean room facility by MPRF staff – no exceptions.**

A. MSDS sheets

MSDS information is contained in notebooks located on the table just inside the clean room gowning room.

B. De-Ionized Water

De-ionized water is provided for fabrication process purposes only, is not considered potable water, and must not be ingested.

C. Cyanides

Cyanides are generally highly toxic compounds that can release a highly toxic gas (for example, Hydrogen Cyanide, HCN) if they come into contact with an acid. Use of these materials is restricted and only done with **prior approval** of MPRF Management in a hood following the safety restriction of the MSDS sheet completely.

D. Solvents

Solvents may only be used in the fume hoods and an inventory of typical ULSI grade solvents is provided. They are often very volatile - (they evaporate very quickly and therefore could get into your lungs and poison you) - many are known carcinogens, and many are flammable or combustible. Examples include: Acetone, Isopropyl Alcohol, Ethyl Alcohol, Methyl Alcohol, Methylene Chloride and Benzene. Clearance for all solvents must be secured from MPRF Management prior to their introduction into the clean room. Note that in general solvents target the central nervous system and especially the female reproductive organs.

E. Acids

Acids may only be used in the acid hoods and a supply of typical etchants is provided as standard stock by the clean room. Acids can cause severe body damage on contact: they can chemically burn the body, they can be toxic, they can cause rapid heating through exothermic reactions (and thermally burn the body) and they can even initiate explosions. Examples include: Hydrofluoric (HF), (Hydrochloric) HCl, (Sulfuric) H₂SO₄, (Nitric) HNO₃, (Ammonium Fluoride) NH₄F, (Perchloric) HClO₄, (Acetic) C₂H₄O₂ and (Buffered Oxide Etch) Mix of water, NH₄F and HF. Note that some acids require special precautions. For example, perchloric acid cannot be used in a standard acid hood. Clearance for all etchants must be secured from MPRF Management prior to their introduction into the cleanroom.

1. Special Word about HF (Hydrofluoric Acid)

Concentrated HF is considered “extremely” toxic – (4 on the health hazard scale of 0-4). This is because it is a source of free fluorine ions. Any solution containing a source of free fluorine ions is also hazardous to your health. A concentrated ammonium fluoride solution is “very” toxic (3 on the health hazard scale) and becomes “extremely” toxic when made more acidic, such as in Buffered Oxide Etch (BOE) mixtures. Consequently, BOE presents the same level of toxic hazard to your body as 49% HF even though 20:1 BOE has much less “HF” in it (about 7% of volume) than “pure” HF (about 49% of volume). It is equally hazardous because it also has about 38% NH₄F, and is acidic.

On contact, fluorine ions (from the HF) easily pass through skin and tissue. Because HF’s action can be delayed for many hours, it can distribute throughout your body. The negatively charged fluorine ions bind very easily and tightly to positively charged calcium and magnesium ions to form insoluble salts (CaF₂ and MgF₂ salts form some natural gemstones). In the body, Ca and Mg ions mediate a variety of physiological processes, such

as muscle movement and body chemistry. Calcium is also a chief component in bone. The result can be several severe forms of damage to your body and even death!

- Local tissue damage (at the point of contact) results from free hydrogen ions which cause corrosive chemical burns and free fluorine ions which cause deep tissue damage including erosion of your bones.

- Systemic conditions include hypocalcemia (loss of calcium) and hyperkalemia (too much potassium). Since calcium and potassium regulate the beating of your heart, an irregular heartbeat and cardiac arrest can result. “Deaths have been reported from concentrated acid burns to as little as 2.5% of body surface exposed to skin contact.” That is the equivalent of a single hand.

- Even dilute HF must be treated with extreme caution. It is highly dangerous to your body because it can poison you without your knowledge. Dilute HF may not cause a visible and painful skin burn (or tissue burn), and you can be fooled because you do not feel any pain. Even so, the fluorine ions can soak through the skin and upset your body’s Ca and K balance as well as etch away your bones. The result may only become extremely painful hours after the exposure.

Calcium gluconate gel cream (sometimes called “HF antidote”) is available near the acid hood in a “toothpaste” tube form. Familiarize yourself with the location of this tube of gel. It can be applied to your skin (in a topical cream form) and must always be available and within reach whenever HF is used. Apply the gel all around and over the exposure in lavish amounts immediately. In addition, anyone exposed to HF must go to an appropriate medical care facility for evaluation and treatment as quickly as safely possible. **The exposure must be reported to MPRF Management.**

Calcium gluconate provides extra calcium ions, which can scavenge free fluorine ions (to form CaF_2) before they penetrate your body and cause damage. In cases of skin contact, calcium gluconate gel must be applied immediately to the area of contact. In cases where systemic damage is a risk, calcium gluconate can be administered by a healthcare professional using an IV. Anyone exposed to HF must go to an appropriate medical care facility for evaluation and treatment. The exposure must also be reported to the clean room management.

Note also that Hydrogen Fluoride gas is extremely toxic as well. It very easily dissolves in water to become Hydrofluoric Acid. Gaseous HF can easily become liquid and liquid HF can easily become a vapor; so HF- and NH_4F - containing solutions give off toxic HF fumes. If you breathe these fumes, you are bringing HF into your lungs where it is rapidly absorbed by the blood stream and distributed throughout your body. Therefore, HF containing chemical containers may only be opened and used in an appropriately vented Acid hood with all required safety gear.

F. Bases (Caustics)

Bases (also referred to as caustics) can only be used in an approved hood and a supply of typical caustics is provided. They can cause severe burns, severe irritation, pain, nausea, vomiting, diarrhea, deep skin ulcers, coughing, breathing difficulty, shock, blindness, possibly even coma and death. Examples of bases include: (Potassium Hydroxide) KOH, (Sodium Hydroxide) NaOH, (Ammonium Hydroxide) NH_4OH , and Photoresist Developers. Clearance for all caustics must be secured from MPRF Management prior to their introduction into the clean room..

G. Flammable and Combustible Chemicals

Users must obtain approval **prior** to introduction into the clean room for any flammable or combustible chemicals from MPRF Management. These chemicals must be used in approved hoods with appropriate fire extinguishers/suppression systems.

H. Toxic Chemicals

Many chemicals are toxic in one form or another. See the MSDS sheet for appropriate safety precautions and then follow those precautions. Users must obtain approval from MPRF Management **prior** to introduction into the clean room for any toxic chemicals.

I. Photoresist and Developers

Most photoresists are a mixture of solvents, novolac resins and photo-active compounds. The resulting chemical can be toxic, flammable and/or irritating. Use these chemicals only in approved ventilated areas, such as solvent hoods or photoresist spinners. As a reminder, do not breathe the vapors given off by photoresist as it bakes on a hotplate. This hotplate can be precisely set to any desired temperature and it has an exhausted cover to capture the escaping vapors.

Most Photoresist Developers are bases. See the Bases section above for further information.

J. Cryogenics (Liquid Nitrogen, Liquid Helium, Solid CO₂)

Liquid nitrogen, Liquid Argon, Liquid Helium and Solid CO₂ (dry ice) are examples of cryogenics. Cryogenic chemicals present a safety hazard due to their extreme cold. Users should be familiar with this hazard and use appropriate cryogen gloves as well as designated personal protective equipment against the freezing effects. Under no circumstances should a user allow to contact LN₂ with their body. Severe injury can result from such contact.

All cryogenics listed above can displace the oxygen in the air your body needs to live as they evaporate. Therefore you must only use nitrogen, liquid nitrogen, helium, liquid helium and carbon dioxide in well-ventilated rooms and after having performed an analysis of the amount of air that could be displaced by the cryogen proposed for use. Provided only a small fraction of the air will be displaced, the cryogen can be used safely. Keep the room especially well ventilated during use.

Filling of all cryogenic vessels shall be done by MPRF Staff. Users should make arrangements in advance for their needs.

K. Waste Disposal

There is a waste bottle labeled with disposed chemicals named in the fume hood. Every users must only pour down the listed chemical wastes into the bottle.

L. Chemical Spills

Notify MPRF Staff immediately of the spill. Clean up of chemical spills (outside hoods) shall be performed only by MPRF Staff. After notifying the MPRF Staff, cordon off the area and have your “buddy” or another user restrict access to the area until the MPRF Staff member arrives to clean the area up. Small volume (< 1liter) chemical spills inside of hoods should be cleaned up safely after consultation with MPRF Staff.

M. Unknowns

Never use unknown/unlabeled chemicals. Report any unlabelled chemicals to MPRF staff immediately. All chemicals should be both labeled and dated at all times. The label should describe the chemical in the container (beaker, flask, bottle, etc.), have an expiration date, the owner contact information, and date.

N. Compressed Gases

Compressed gas cylinders present a significant safety hazard to lab personnel. A broken off valve can cause high-pressure gas to launch the cylinder causing great physical danger and damage. Leaks hooking up the cylinder to system lines can cause chemical injury to lungs, fire hazards, etc.

Only personnel authorized by MPRF Management are allowed to change, replace, or otherwise handle compressed gas bottles. Cylinders are to be properly anchored. Some equipment may require the use of small gas bottles within the machinery – these will be handled on a case-by-case manner. Toxic gas bottles may only be stored and used inside designated toxic gas cabinets appropriate for them. Toxic gas monitors will be employed where necessary for safety. Only authorized personnel may handle these systems. **There are no exceptions.**

V. Safety Guidelines

1. **Never work alone in MPRF.** In addition you must have a spotter “buddy” present for safety.
2. When in doubt, ask questions of experienced personnel before taking any action.
3. Always clean up after yourself and clean the aisles of chairs and other obstructions.
4. Do not work in MPRF if you feel particularly tired or unwell (heavy cold, etc.) or if you have taken even a small amount of alcohol.
5. For safety reasons, do not sit on worktables or lean on benches or equipment.
6. Contact lenses are not allowed when using chemicals, since vapors can be drawn under the lenses by absorption and capillary action and concentrated there. Wear prescription glasses and safety glasses instead.
7. When pouring or refilling liquid N₂, proper goggles and insulating gloves are required
8. Always wear complete safety apparel when handling chemicals and follow all safety instructions. An acid proof apron, face shield, and acid gloves are required when using acids. (Basically, any time you poke your hand inside an acid hood when acid is present, you should have full “acid armor” on! Beware that residual drops or small puddles observed inside the acid hood could very well consist of an acid!!)
9. Do not touch your face, nose, mouth, etc. when wearing acid gloves. Skin damage can result from glove contamination. In addition, skin oils can spoil processes and contaminate samples by transfer from face to glove to sample.

10. Do not leave hazardous equipment/materials unattended when in use (e.g. chemicals on hotplates, liquids in beakers in hoods, etc.) Before starting an experiment, the user must label the containers for his process with all of the following information:
 - a. User name
 - b. How to contact the user (phone number required)
 - c. A complete list of all the chemicals being used or equipment process parameters
 - d. The date/time the user initiated use of the chemicals
11. Please keep chairs pushed out of the aisle ways when you finish so that an obstacle-free escape route is maintained.
12. The following chemical types must be stored in separate storage cabinets and properly labeled: a) acids, b) solvents, and c) bases. Do not place chemicals in the wrong cabinet.
13. When mixing etches, always add acid to water. Never add water to acid. (If you add water to acid, exothermal mixing energy can cause the water to rapidly heat to the boiling point and splatter a mixture of water and acid.)
14. Before removing acid gloves, rinse well with water at a sink to remove any remaining acid. Do not allow water to get inside gloves.
15. Wear goggles and insulating gloves when pouring liquid N₂.
16. Rinse empty chemical bottles 3 times with DI water and label "rinsed."

A. Chemistry Reminder Summary

1. Acids react with cyanides to produce extremely dangerous hydrogen cyanide gas.
2. Concentrated acids react violently with concentrated bases
3. Acids can cause flammables, such as acetone or other solvents to catch fire.
4. Oxidizers, such as hydrogen peroxide, can cause spontaneous combustion of flammables, such as solvents.

MPRF: Operating Procedures

I. General Operations Policy

The following bullets present some of the more general operational policies that all users are expected to follow. Each of these topics is covered in greater detail in the appropriate sections presented later.

1. No food or drink may be brought into any area of MPRF.
2. Regularly wipe down tables and equipment surfaces with DI water and Clean Room Lint-Free towels. Users may be designated by MPRF Management to do this on a regular schedule as well.
3. Always clean up after yourself.
4. No personal items (such as backpacks, makeup, combs, brushes, handkerchiefs, etc.) may be brought into the MPRF Clean Room or the gowning area.
5. No paper should enter the MPRF CRL unless it is MPRF CRL certified lint-free.
6. No spray cans or powdered materials are allowed in the MPRF CRL or gowning area.
7. No cardboard boxes or packages are to be brought into the MPRF CRL.
8. Shoes should be clean and free from dried mud, dirt, etc. before walking over the tacky mat and putting on the booties.
9. Use the tacky mats to do a final clean of your shoe soles before covering with booties. Make sure the tacky mat is clean before stepping on it. Remove heavily soiled tacky mats prior to stepping on them. Dirty mats are a contaminant source.
10. MPRF CRL garments are only to be worn inside the MPRF CRL areas. The only exception to this rule is in an emergency. In that case, the garment may not be worn in the clean room after having been worn outside and must be returned to the designated laundry bin..

II. Proper Attire

Everyone entering the MPRF CRL must be properly attired before proceeding into the lab. Proper attire includes all of the following: appropriate street clothes, including closed toe shoes complete MPRF CRL garments (booties, hoods, MPRF CRL smock and gloves) and approved safety glasses.

A. The Need for Gowning

The primary reason for gowning in clean room attire before entering the facility is to maintain the cleanliness of the facility. Humans are major sources of both contaminants and particulates (dust). The contamination of the facility by exposure to human skin, hair and street clothes must be minimized to promote a reasonable research environment. People shed both particles and chemical contaminants (skin oils, sodium, saliva etc.) that can destroy the ability of researchers to fabricate good devices if not properly contained.

B. The Gowning Order

Everyone entering the MPRF CRL must properly dress in the gowning area before entering. We have adopted new clean room attire to reduce particulate contamination in the clean room. The correct gowning order is as follows:

1. Enter the clean room lobby and walk on the sticky mat.
2. Put on clean shoe covers (blue booties) at the entry bench,
 - a. Check the booties for holes or cuts and discard bad booties.
3. Put on a Face mask and a Hair net ensuring that all hair is contained.
4. Put on the jump suit.
5. Put on clean room gloves (no powder gloves)
6. Put on safety goggles.

The garments are removed in the reverse order when leaving the clean room.

C. Appropriate Street Clothes

The proper attire prior to entering the gowning area includes long pants full length socks and closed-toe shoes with low heels. These are necessary to obtain sufficient protection while working in the lab. Shorts (or some other forms of dress), bare midriffs, bare feet and open-toe shoes including sandals are not allowed. They do not adequately protect the user, nor do they adequately protect the clean room environment from the user. In addition, long flowing garments and jewelry are not allowed. They can inadvertently contact dangerous materials or catch in a mechanical pinch point.

D. Eye Protection

Everyone in the MPRF CRL is required to wear approved eye protection. (This includes visitors to the MPRF CRL.) Contact lenses do not provide adequate eye protection and in fact can be hazardous in the presence of chemical vapors. Therefore, contact lenses are not allowed in the MPRF CRL. Wear corrective glasses instead. Safety glasses must be worn over corrective glasses and are available in the gowning area. Please return your safety glasses to the rack when exiting.

E. Additional Protective Wear

Persons performing specific chemical processes, such as working with acids, must wear additional designated personal protective equipment (PPE) attire. This includes the use of appropriate gloves, face guards, and chemical aprons for protection against spills or splashes. Such attire is stored in the vicinity of the acid hood for convenient access. Its' location is noted during the initial training.

Additionally, workers in the clean room are required to use latex gloves during ordinary handling of their specimens and equipment, to avoid contact with skin. These gloves should be considered contaminated when leaving and must be discarded before exiting the clean room. Office doors or other outside items should not be handled while wearing these gloves, for both your own safety and that of colleagues or visitors to your office areas.

III. Personal Behavior within MPRF

A. Lab Entry and Exit

Entry is only permitted through the main entry door (card reader). Everyone must swipe their vol card on the MPRF entry card reader even if they are following someone through the open door.

B. Inappropriate Behavior

Any violation of these standards for safety and operating procedures is inexcusable and the offender can be disciplined by the MPRF Management. All personal behavior is expected to be professional within the lab. Any form of inappropriate personal behavior must be reported and stopped. Such behavior will be met with disciplinary measures appropriate to the violation(s). A violator will ordinarily first be asked to correct their behavior. If they do not, further discipline may be applied by the MPRF Management, including the revocation all MPRF privileges for a specified period of time. The MPRF Management need not reinstate privileges if it is deemed unsafe to allow the repeat violator to re-enter the facility.

C. Visitors to MPRF

Visitors may be taken into MPRF provided all of the following requirements have been met:

1. The MPRF staff has been apprised of the reason for the visit and has approved the visit.
2. An authorized MPRF user must be present to escort a visitor to MPRF. Only persons who have passed all required training and are authorized to work in the lab are authorized to escort a visitor. The escort will be held responsible for the safety of his/her visitor; consequently, the escort must remain with the visitor during the entire visit.
3. All visitors must be properly gowned in the clean room (clean room garments identifying them as a visitor along with safety glasses).
4. All visitors must abide by the MPRF safety policies and operating procedures. All rules of safety and personal behavior will remain in effect during the visit. The escort will be held responsible for any violations.
5. Visitors are not allowed to operate tools.

D. Specific Behavior Guidelines

1. Before operating any tool, sign-in to the logbook.

2. Always cleanup after yourself AS SOON AS you have finished a process or using a tool.
3. Note any tool malfunctions in the associated logbook and also report them to MPRF staff .
4. Any debris on the floor or at a work station in MPRF is to be picked up and properly disposed. Assume the responsibility for a neat, clean and safe work area. Please return your chair to a safe position out of the aisle way when you get up.
5. Do not operate equipment until first trained by clean room staff.
6. Touching any surface in the MPRF CRL requires wearing appropriate gloves.
7. Touching of quartz ware for furnaces is off-limits unless utilizing it in process. Handling quartz ware in process requires wearing the appropriate PPE, which includes heat resistant gloves when loading and unloading materials from the furnaces.
8. All materials, samples, etc. that are not in the process of being worked on must be stored in a designated covered box. Chemicals will **NOT** be stored in such boxes. **ALL OTHER MATERIALS WILL BE DISPOSED BY MPRF STAFF PERIODICALLY.**
9. All beakers, graduated cylinders, etc., should be emptied, rinsed and dried at the end of their use and stored properly. Rinse out empty chemical bottles (3 times minimum) and label “rinsed”.
10. Do not leave hazardous equipment/materials unattended when in use (e.g. chemicals on hotplates, etc.).
11. Gloves, aprons, safety glasses or face shields are not to be left laying on the worktables or equipment. Return them to their storage locations.
12. Do not touch your face when wearing plastic or rubber gloves.
13. Do not taste, smell or touch any chemical, vapor or gas.
14. Never mix acids and solvents. Keep all solvents away from acid areas and vice-versa. Do not store them together. Use the correct chemical hood for each process.
15. Never store a chemical container on the floor.
16. Small amounts of solvents for individual use may be kept inside appropriately labeled squeeze bottles and stored in the solvent hoods.
17. Use chemicals in well-ventilated chemical hoods.
18. Never work alone.
19. Dispose of wipes in properly labeled red waste cans.
20. Do not use unlabeled chemicals.
21. Broken wafers and glassware are disposed of in a “sharps” trash-container and not in the regular trash bin. Make certain the sharps are free of chemicals before disposal.
22. If you break a wafer or piece of glass, the affected area must also be vacuumed to remove the particles – contact the MPRF Staff for assistance.

IV. Equipment procedures

A. Scheduling Equipment

All equipment is presently scheduled according to MPRF Management procedures. Contact MPRF Management for details.

B. Equipment Etiquette

Each piece of fabrication or characterization equipment in MPRF will have one or more designated modes of operation. These will be detailed in operation manuals accompanying each machine. These modes are the only accepted modes in which each machine may be operated. If users need to operate outside of the standard operational boundaries, they must first obtain permission from the lab staff. The machine must be returned to standard operational conditions and parameters at the conclusion of the special operation.

C. Equipment Manuals

Equipment manuals are continuously being developed by the MPRF staff and are periodically posted on the MPRF web site which is embedded in the general JIAM web site under “JIAM Micro-Processing Research Facility.”

D. Introducing New Equipment

A goal of the lab is to be flexible and provide required capability to all users. It is expected that from time to time, users will want to introduce new equipment into MPRF. Introduction of anything new into MPRF without the approval of the MPRF Management is prohibited. Proposals must be provided sufficiently in advance to the MPRF Management so that its safety and compatibility with other aspects of the lab can be managed and supported in a safe and clean manner. Final decisions on the appropriateness of such new introductions to MPRF rest with the management.

E. Equipment Repair

Only authorized personnel (designated MPRF staff) are permitted to repair equipment. Also, no machines may be altered from their normal operating conditions without the express permission of staff. During the time the special conditions exist, a sign must be displayed to note the conditions. When the experiment is completed with the machine out of its normal condition, the machine must be returned to normal operating conditions.

Report any malfunctioning equipment to MPRF staff as soon as possible. Do not leave it to be discovered by the next user.

V. Chemical Procedures

A. Standard Chemical Inventory and Availability

All chemicals used in MPRF must be approved by the MPRF Management and inventoried. **Chemicals can not be brought into MPRF by users without the explicit approval of the MPRF Management.** Users requiring fresh chemicals which have been depleted in the MPRF stock must contact the MPRF Staff, who will transport those chemicals safely to the MPRF facility for users.

B. Chemical Etiquette

All users are required to follow all established procedures for proper handling of any chemical that they use in the clean room. This includes providing the lab management with appropriate documentation (MSDS required, including an electronic copy mailed to the safety officer), proper storage of the chemicals within the lab or adjacent areas, correct use of the chemicals in their processes, proper disposal of used chemicals.

C. Chemicals and Process Training

Users are responsible for the development of specific chemical processes and recipes for their own needs. Training on these recipes is the responsibility of the user, and details on the training must be provided to the MPRF Management. General safety practices associated with the usage, storage and handling of chemicals is provided during the certification process, but this training is no substitute for the detailed safety training required for user-specific recipes. Certain chemicals are discussed during the annual training and broad classes of chemicals are discussed in the safety manual.

D. Introducing New Chemicals

A goal of the lab is to be flexible and provide required capability to all users. It is expected that from time to time, users will want to introduce new chemicals, or processes into MPRF. Introduction of anything new into MPRF without the expressed knowledge and permission of the MPRF Management is prohibited. Proposals must be provided sufficiently in advance to the MPRF Management so that its safety and compatibility with other aspects of the lab can be managed and supported in a safe and clean manner. MSDS sheets for the proposed chemicals must be included as part of the request. Final decisions on the appropriateness of such new introductions to MPRF rest with the management. Before any new chemical is introduced to the clean room, an electronic copy of the MSDS sheet must be mailed to the staff safety officer. **All chemicals and materials must be transferred into the clean room by MPRF staff – no exceptions.**

AGREEMENT TO FOLLOW MPRF PROCEDURES

I _____ have read and fully understand the MPRF Rules, Safety Manual and Operating Procedures. I acknowledge that my activities in MPRF and associated areas may be monitored electronically. I further agree to abide the content of these documents, and comply with any other instructions provided by the MPRF Management and Staff. I also understand that these documents and instructions can be amended at any time.

Signature _____ Date _____

Printed Name: _____

Title: _____

Company Represented (if applicable): _____