UTAH NANOFAB

LAB USER GUIDE

Revision 7

Table of Contents

1 Purpose

This document is a guide describing the basic operational and safety policies for use of the UTAHNANOFAB. It is applicable to all individuals that enter the lab. It contains information to provide a safe and effective microfabrication research environment through compliance with University procedures and other governing standards organizations. It contains all information necessary to be considered the Chemical Hygiene Plan for the lab.

Although this document is intended to describe acceptable operating behavior and attitude for safe and effective use of the facility, it is impossible to encompass every conceivable situation. Rules and policies are no substitute for common sense. Anyone who fails to act in a professional, safe, and responsible manner while in the facility will face restrictions at the sole discretion of lab management.

This document is required reading for all employees and lab users **prior** to un-chaperoned activity in the lab. In addition, an annual review is required to maintain access to the lab. If you have questions that are not answered in this document, please contact Staff. We are here to help you learn and be successful.

This user guide has the following primary goals:

- Articulate the potential dangers of working in the facility.
- Clarify the appropriate response to any emergency that occurs within the facility.
- Document the process of becoming a lab member – the steps, orientation, training, and various access levels.
- List all important chemical safety information, including how to work with and dispose of all chemicals in a safe and effective manner.
- Review the fundamentals of working in the cleanroom and the protocols expected of all users of the facility.
- Document procedures for violations and disciplinary actions.

1.1 Reference Documents

1.1.1 University Guidelines and Policies

1.1.1.1 Environmental Health & Safety (EHS) Policies

- Chemical Hygiene Plan

1.1.2 ANSI

- American National Standard for Occupational and Educational Personal Eye and Face Protection Devices (Z87.1-2010)

1.1.3 Hazardous Materials Information System (HMIS®), 3rd Edition

1.1.4 International Fire Code (IFC), 2018

1.1.5 NFPA

- NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response

1.1.6 Occupational Safety & Health Administration (OSHA)

- Occupational Exposure to Hazardous Chemicals in Laboratories (29 CFR 1910.1450)
- OSHA Hazard Communication Standard (29 CFR 1910.1200)

2 Summary/Overview

The UTAHNANOFAB is an interdisciplinary, shared access facility supporting innovative education, research, and technology transfer. It is located in the Sorensen Molecular Biology Building at the University of Utah, supported through the College of Engineering. The multi-purpose facility consists of approximately 13,000 square feet of dedicated and managed ISO 5, 6, and 7 cleanroom space with additional capabilities outside the cleanroom. It provides the clean environment, culture, expertise, and equipment necessary to support micro-machining, micro-fabrication, and nano-scale semiconductor materials and device research.

The teaching laboratories strengthen undergraduate micro-fabrication curricula and train graduate students from across the University of Utah campus in the fundamentals of micro-machining, micro-systems design and characterization, micro-sensors and actuators, and micro-electronic devices.

The research laboratories offer an extensive array of process equipment with advanced capabilities in pattern generation, photolithography, LPCVD deposition, thin film deposition and etch. Characterization capabilities include surface analysis and nano-imaging. Researchers from the School of Medicine and Colleges of Engineering, Science, Pharmacy, and Mines collaborate in the research and development of biological and chemical-sensing micro-arrays based on nano-technology, among other applications. Researchers are developing Micro Electro-Mechanical Systems (MEMS), including neuro-prosthetics, devices with optical and micro-fluidic functions, harsh environment sensors, and micro power sources such as fuel cells and solar cells.

These laboratories support the University of Utah mission to stimulate and grow the economy in the state of Utah by innovating and transferring developed technologies into the private sector. The UTAHNANOFAB supports and enables many government/industry/university collaborations.

2.1 Brief History

The University of Utah has a rich background in the development of microelectronics. Shortly after earning a PhD in Physics from the University of Utah in 1962, Frank Wanlass was awarded the patent for the basic CMOS structure. This structure is the building block for modern microprocessor and memory chips. Soon afterward, Frank and another University PhD graduate, Leland Seely, were instrumental in the opening of a modest R & D facility for their employer, General Instruments, in Salt Lake City. After the facility closed operations, much of the equipment was donated to the University and became part of the original equipment in the HEDCO Microelectronics Lab, which was created in 1976 and initially funded by the HEDCO Foundation. Signetics Corp., Fairchild Semiconductor, National Semiconductor, Bell Labs, and others made additional donations for the original equipment set in this lab – some of which is still in use today.

After some substantial facilities services were installed and space remodeled in the basement of the Merrill Engineering Building, the HEDCO Microelectronics Laboratory became operational in 1978. Another major block of funding was made available in the mid-1990's through the National Science Foundation and matching University funds. The $1.5 million provided an upgrade of the clean room and supporting facilities, in addition to the purchase of equipment to enable the fabrication of microstructures – sputtering and e-beam deposition, LPCVD Polysilicon and Nitride, Oxidation and Annealing furnaces, a mask aligner, PECVD Oxide and Nitride deposition, and a reactive ion etch tool.

The Microfabrication facility has continued to grow since that time in size, equipment, activity, staffing, research funding, expertise, and intellectual property. It has been a valued contributor to the University's reputation of creating new inventions and business opportunities. Due to this

continued success, the state-sponsored USTAR program championed the design and construction of a purpose-built facility in the new Sorenson Molecular Biotechnology Building. The new facility, named the **UTAH**NANOFAB, is generally designed in a bay/chase configuration with 9000 ft^2 of classified cleanroom working space and 4000 ft^2 of equipment chase. It is capable of supporting well over100 active researchers and a similar number of students in lab-based courses. The facility began operation in the summer of 2013 and will enable increased success and improved research capabilities for many years to come.

2.2 Mission

The **UTAH**NANOFAB advances leading edge research, and facilitates economic growth by providing world-class nanofabrication facilities, infrastructure, and staff to academia and industry.

2.3 Vision

The **UTAH**NANOFAB will become a recognized leader in innovation and a premier nanotechnology center with an interface to biomedical sciences. Through the efforts of the **UTAH**NANOFAB, the frontiers of research will be expanded, the next generation of engineers and leaders will be educated, and economic growth will be supported by the sustainable transfer of technology into meaningful commercialization outcomes.

2.4 Core Values

Empowering, Serving, and Safeguarding the Nanofab Community.

2.4.1 Empower

We believe exceptional quality and accessibility reinforce our commitment to serve as a core facility. We support collaboration by building partnerships across academic disciplines, business, and industry. We create an environment that is conducive to learning, innovation, and success. We serve as a catalyst for economic development in Utah and beyond. We enable the academic and local industrial community with a strong commitment to excellence in research and innovation.

2.4.2 Serve

We seek effective and efficient ways to better serve our lab members. We strive to provide quality tools, technologies, processes, and facilities for learning, understanding, and developing new technology. We anticipate the needs of those we serve and offer proactive and flexible solutions. We are motivated to initiate and adapt to change for improving our work and community.

2.4.3 Safeguard

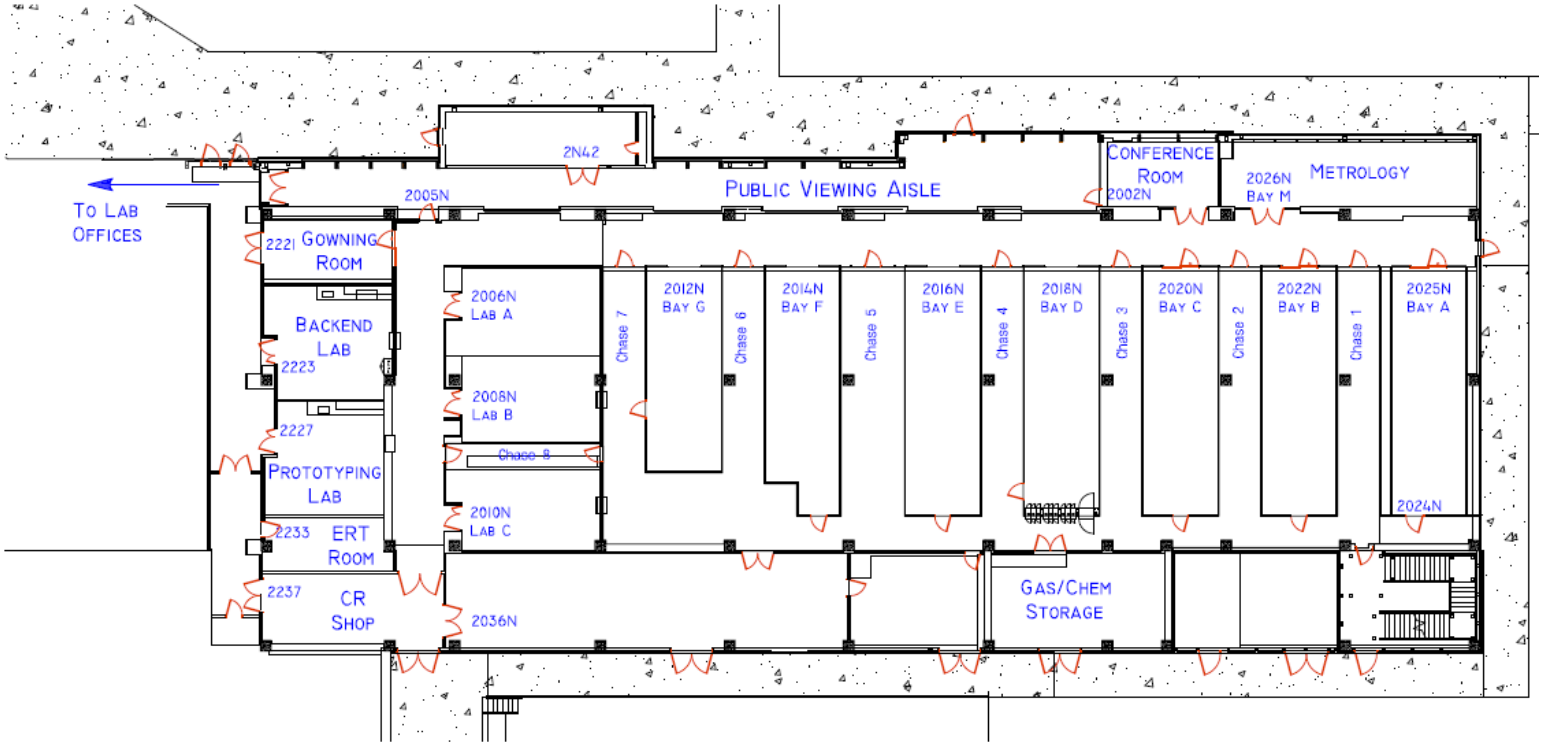
We instill a discipline of safety throughout our facility and in all aspects of our work. We are committed to providing a safe work environment through training, communication, and quality resources.

2.4.4 Focus

We are committed to sustaining credible, reliable, and trusted professional staff. We honor commitments and take pride in our work. Lab members are treated with courtesy, respect, appropriate confidentiality, and dignity. We believe teamwork provides the foundation for continuous improvement to our systems for the benefit of both lab members and employees.

2.5 Rooms/Labs

The **UTAH**NANOFAB is located in the Sorenson Molecular Biotechnology Building. The cleanroom facility is located in the North wing on the 2nd Floor (ground level) of the building.



Cleanroom. This is the primary area of the facility. It has specifically designed and controlled systems to maintain the cleanliness and environment of the space. Working areas of the cleanroom are classified as ISO 5, 6, or 7 and include all Process Bays, Service Chases, and Enclosed Lab Rooms. Access to the cleanroom is through the Gowning Room. To maintain the cleanliness of the cleanroom, specific gowning and other protocols are required.

Backend Micromachining Lab (2223). This is an isolated room adjacent to the cleanroom. The dicing saws, laser micromachining tools, micro-wire EDM tools, and a fume hood are located in this room. Card access ensures that only authorized persons may enter this room. Cleanroom gowning protocols are not required. There is a pass-through available to transfer samples to/from the cleanroom.

Clean Conference Room (2002N). A conference room located at the north end of the public corridor is available for use as study or discussion area, when not needed by staff or scheduled meetings. This room also contains some supply cabinets and measurement tools. The Clean Conference Room is also accessible through the cleanroom. Card access ensures that only authorized persons may enter from the public corridor. In addition, all persons entering from the public corridor must put on shoe covers, a bouffant cap, a face mask, and blue nitrile gloves before entering.

CR Shop (2237). The Cleanroom (CR) Shop is located at the southeast corner of the lab facility. This room is accessible to lab staff only and is used for lab maintenance activities. New equipment and large lab supplies are brought into the lab through this room after a thorough wipe-down.

Enclosed Lab Rooms. There are three (3) separated lab rooms at the south end of the cleanroom facility. These rooms are classified as ISO 7 and are used for less critical processing and teaching functions. A card reader on each room can be used to control authorized entry.

Gas/Chem Storage (2032N). This room is used primarily for storage and delivery of hazardous gases and chemicals. It is adjacent to the cleanroom on the east side. It is designed as H2,3,4 Occupancy Class and is considered separate from the cleanroom occupancy. Chemicals and gases are transported by Staff from this room to the cleanroom. Lab members are not allowed access.

Gowning Room (2221). The Gowning Room is used to prepare to enter the cleanroom. Card access ensures only authorized persons may enter. Specific rules for entry into this room are found in sections 4.11.1.1 through 4.11.1.7.

Lab Offices. The lab offices are located in Suite 2500, near the atrium grand stairway in the main building.

Metrology Bay (2026N). A separate room at the northwest of the cleanroom. It is classified as ISO 6, where most measurement/metrology tools for the cleanroom are found. This room is accessible through the Clean Conference Room.

Microfluidics and Prototyping Lab (2227). This is an isolated room adjacent to the cleanroom. It is used as a prototyping lab with microfluidic, laser welding, and laser micromachining tools. The parylene coater is also found in this room. Card access ensures that only authorized persons may enter this room. Cleanroom gowning protocols are not required. There is a pass-through available to transfer samples to/from the cleanroom.

Process Bays. There are seven (7) primary processing areas in the cleanroom. Two (2) of the bays are ISO Class 5 (Class 100), while the remaining five (5) are ISO Class 6 (Class 1000).

Public Viewing Aisle. A public aisle borders the west side of the **UTAH**NANOFAB wing. This aisle is outside the cleanroom with large windows allowing a clear view to the interior.

Service Chases. The service chases are located between the processing bays. In addition to housing the primary processing utilities, gases and support tools, the service chases also allow lab staff to conduct maintenance activities on many of the tools without impacting the processing bays. In general, only lab staff is authorized to enter the service chase area.

3 General Lab Information

3.1 Roles and Responsibilities

3.1.1 Administration

- Ensure the Chemical Hygiene Plan is written and regularly updated.
- Appoint the Lab Safety Officer. The individual selected must be qualified through training or experience to provide guidance for all safety-related activities and issues.
- Provide or obtain administrative and financial support, as needed, for implementation and maintenance of the Chemical Hygiene Plan and all associated requirements.
- Provide the necessary resources of staff, equipment, materials, and inventory control to ensure that all persons working in the facility are protected from injury and illness hazards.

3.1.2 University of Utah Environmental Health & Safety (EHS)

- Establish overall safety policies and procedures for the entire University of Utah campus.
- Perform routine lab safety inspections, including testing of shower and eyewash stations.

- Monitor and track progress for resolving any identified deficiencies.
- Assist the facility to meet the requirements of the various local, campus, state, and federal regulations.

3.1.3 Principal Investigators/Supervisors

- Support full training of the student researchers as lab users.
- Support Lab Staff by insisting student researchers follow all safety and lab protocols, and notifying student researchers of consequences when administered.
- Support legal requirements for regulated substances as managed by Lab Staff.
- Properly cite the support of the **UTAH**NANOFAB in all publications and presentations made possible by work performed therein.
- Inform Lab Staff of all changes in personnel or funded projects.
- Ensure new processes or activities involving hazardous materials are carefully pre-planned with necessary hazard information, safety equipment, and Standard Operating Procedures (SOP's) available before beginning.
- Ensure the proper and timely disposal of all unwanted or excess supplies or hazardous materials.

3.1.4 Chemical Hygiene Officer (CHO)

The Chemical Hygiene Officer is a member of University of Utah EHS Department who is responsible to provide technical guidance for the development and implementation of the Chemical Hygiene Plan. A summary of responsibilities include:

- Assist PI's and **UTAH**NANOFAB Staff employees with the development and implementation of appropriate chemical hygiene procedures and practices, including consultation.
- Maintain knowledge and understanding of all legal requirements relative to controlled substances and communicate any changes to **UTAH**NANOFAB Staff and associated PI's.
- Seek ways to improve the overall chemical hygiene program.
- Ensure routine inspections of the laboratory are conducted and documented.

3.1.5 Director/Associate Director

- Responsible for all aspects of the vision, operation, and safety of the facility.
- Supervises Lab Staff personnel and activities.
- Establish facility budget.
- Coordinate all outreach activities for the facility.
- Expand the user-base for the facility.
- Continually improve and update the resources available, including training for staff, systems for lab members, and tools, techniques, and metrics for all operations.

3.1.6 Lab Safety Officer

The Lab Safety Officer is a member of the **UTAH**NANOFAB Staff who is responsible for the overall safety systems in the facility. These responsibilities include:

- Know and understand the requirements of the governing regulatory standards.
- Develop, implement, maintain, and enforce the safety guidelines established in this document.
- Interact with personnel and departments outside the facility regarding safety issues.
- Serve as the point-of-contact for any safety-related questions.
- Advise Principal Investigators or Supervisors concerning adequate facilities, controls, and procedures relative to any hazardous materials.

- Participate in the investigation of all safety-related incidents, acting as liaison to EHS.
- Ensure periodic exposure monitoring requirements are met and records are maintained.
- Plan for accidents and ensure that appropriate supplies are in place and procedures established for emergency response, including chemical spills.
- Report all safety incidents involving people to EHS.
- Serve as contact point for arranging special studies or support from EHS.
- Develop and implement corrective action to prevent safety incidents from recurring.
- Ensure the proper disposal of all unwanted or excess hazardous materials.
- Maintain all records related to the Chemical Hygiene Plan.
- Approve all written procedures and training of all chemical processes performed in the lab.
- Review and provide timely response to all requests for the use of new materials in the lab.
- Maintain emergency response supplies.

3.1.7 Lab Staff

- Ensure lab users are fully trained in safety hazards and emergency response procedures.
- Ensure all necessary protective and emergency equipment is available, in working order, and that appropriate training for use has been provided.
- Know current legal requirements for regulated substances.
- Ensure that periodic laboratory self-inspections are completed.
- Ensure tools and equipment are operational, and provide technical support for research activity.
- Provide written standard operating procedures (SOP's) for all process, equipment, and general activities conducted in the lab.
- Enforce the policies and guidelines established in this document and other lab SOP's.
- Review and evaluate the effectiveness of all **UTAH**NANOFAB safety guidelines at least annually and update as necessary.

3.1.8 Lab Members

- Plan and conduct all activities within the **UTAH**NANOFAB in accordance with the guidelines defined in this document.
- Use equipment only for its designed purpose.
- Be familiar with emergency procedures, including location and use of emergency equipment and how to obtain additional help.
- Know the types of protective equipment available and its proper use.
- Understand the hazards within the lab and the signs and symptoms of excessive exposure.
- Be alert to unsafe conditions and activities and report them to Staff as soon as possible.
- During an emergency, be prepared to provide emergency response personnel with all pertinent information, including location, cause, current conditions, materials involved, and all persons directly affected.
- Participate in an annual review of all safety practices and guidelines of the **UTAH**NANOFAB.
- Pass the Facility Safety and Protocol Exam annually.
- Properly cite the support of the **UTAH**NANOFAB in all publications and presentations made possible by work performed therein.
- Remove all items from the lab that are no longer needed – especially prior to ending their lab membership.

3.2 Facilities/Utilities

3.2.1 Acid Waste Neutralization (AWN)

The acid waste neutralization (AWN) system is a multiple-stage system collecting, mixing, and treating the bulk liquid waste prior to leaving the facility. This waste is pumped into a treatment stage that constantly measures the pH and applies the necessary neutralizing agent until the waste can be safely discharged into the city sewer system. This system allows disposal of most acids and bases through the drains and aspirators in the wet benches. Solvent or toxic waste CANNOT be drained into the AWN system and must be collected for proper disposal.

3.2.2 Air Filtration

A primary purpose of the cleanroom is to maintain an environment that is low in airborne particulates. Various parts of the cleanroom are certified to defined standards. The use of high-efficiency particulate attenuation (HEPA) and ultra-low penetration air (ULPA) filters are used to achieve these standards. The filters are placed in the ceiling and air is forced through the filters into the cleanroom. Much of the air is re-circulated. In addition, the cleanroom maintains a positive pressure compared to surrounding areas to force air out of the lab and prevent dirty, un-filtered air from entering.

3.2.3 Compressed Dry Air

A compressed dry air system is used for many of the pneumatic valves used in the facility. Moisture is removed from the air to prevent water condensation and rusting of the delivery lines.

3.2.4 Electricity

Standard electrical receptacles are available throughout the lab for general use. Many tools require special outlets or hard-wired hook-ups for 110, 208, or 480 VAC. Many of these tools will also be equipped with a nearby electrical disconnect.

3.2.5 Exhaust

Exhaust ventilation is provided throughout the facility. The static pressure and flow rate of the ventilation is continuously monitored and automatically controlled.

3.2.6 House Vacuum

A vacuum system is used to provide vacuum to processing tools, vacuum chucks, vacuum wands, etc. It is not to be used for cleaning or removal of debris – especially liquids.

3.2.7 Humidity Control

Many chemical reactions are sensitive to humidity. This is particularly true of photolithographic processes. To ensure consistency of these processes the relative humidity is controlled to 45 ± 5%.

3.2.8 Make-Up/Supply Air

In general, the cleanroom must remain at a higher pressure than the rest of the building. Negative pressure will pull particles into the clean air space. Since much of the air is removed from the cleanroom through the exhaust systems, make-up or supply air must be supplied to maintain the cleanliness and pressure of the cleanroom.

3.2.9 Nitrogen

A large storage tank for liquid Nitrogen outside the building is used to provide high-purity nitrogen gas throughout the lab. This nitrogen is used in process chambers, dry boxes, N_2 guns, etc.

3.2.10 Process Cooling Water

Process cooling water is provided to many tools and is used to extract heat from sub-components. This water is temperature-controlled and treated to reduce the formation of mineral deposits in the piping.

3.2.11 Telephone System

Telephones are provided for staff and lab members for local, lab-related communication needs. They should not be used for personal calls. Toll or long-distance calls cannot be placed from these phones without a campus long distance authorization code.

3.2.12 Temperature Control

Many chemical reactions are sensitive to temperature. This is particularly true of photolithographic processes. To ensure consistency of these processes the temperature in the cleanroom is controlled to 68 ± 2°F or better.

3.2.13 UPW

Ultra-Pure Water (UPW) is available in wet benches, several fume hoods, and other processing tools throughout the facility. Unless specifically stated otherwise, any lab documentation of chemical solutions requiring water (H_2O) implies UPW. Since it is expensive to produce, its use should be controlled wisely to prevent unnecessary waste. However, to inhibit bacteria growth, many tools and components, such as dump rinsers, spray wands, faucets and glove washers, are designed to constantly overflow or drip.

3.3 Facility Governance and Appeals

Lab Staff makes every effort to interact with all persons with respect and courtesy at all times. Their ultimate responsibility, however, is to ensure safety of all persons and will take immediate action, if necessary. Situations may occur where direct instructions are provided by a staff member, upon request or otherwise. Lab members are expected to follow such guidelines promptly. If at any time you feel you have been unfairly treated by a staff member or strongly disagree with the instructions given, please discuss the matter with Lab Management. The following sequence of appeals can be taken to obtain a satisfactory resolution:

1) Cleanroom Supervisor
2) Associate Director
3) Director
4) University, see Policy 6-400: Code of Student Rights and Responsibilities ("Student Code")

3.4 Hours of Operation

The facility is generally open 24 hours a day, 7 days a week, including most holidays and Campus Closure Days. Certain instruments and/or procedures may have some restrictions.

There are no annually scheduled facility closures, however, unscheduled closures may be required with little or no prior warning due to unplanned facility maintenance issues, chemical spills, and other events. These closures will normally last less than a day. Every effort will be made to provide as much advance notice as possible.

Although the facility is available for use 24/7, Lab Staff is not present at all times. Staff coverage and Non-Staff hours for the facility are:

- Staff Hours: Monday – Friday, 8AM – 5PM (excluding most holidays and Campus Closure Days)
- Non-Staff Hours: All other times.

3.5 Laboratory Rates

All lab members are charged for the use of the lab. Charges include costs of general lab supplies, garment rental/laundering services, precious materials, tool usage costs, etc. University (Academic), Off-Campus Academic, and Industry members are charged different rates. However, Industry rates are chosen to be comparable to commercial suppliers or equivalent services and to cover costs that are not subsidized through other university sources. Industry institutions may not use university employees or students to qualify for Academic rates.

3.5.1 Charges

Monthly charges by user by project accumulate for equipment usage, precious metals, supplies, etc. Charges are applied simply to recover total costs. Since support costs vary by tool, rates also vary by tool. Equipment charges include both the actual time used and unused reservation time. If the cumulative monthly equipment charges reach a threshold, additional equipment charges are billed at a reduced rate. In addition, cumulative equipment charges for the fiscal year will not exceed the annual cap. More complete details can be found on our website at Billing Rates.

3.5.2 Miscellaneous Supplies

Many items such as tweezers, wafers, masks, crucibles, cleanroom notebooks, etc. are stocked in the lab. These items are sold to members, as needed. Rates are adjusted monthly to recover the purchase costs incurred by the lab. Costs are excluded from the fee cap and threshold.

3.5.3 Precious Metals

Precious metals are used in several tools and processes. Since these metals are costly, users will be charged for quantities used. Rates change periodically. Costs for precious metals are excluded from the fee cap and threshold.

3.5.4 Staff Support

Staff provides orientation and training as a service to lab members and will continue provide support by answering questions and providing advice within reason without charge. However, in fairness to all lab users, projects that require substantial assistance (consultation and/or hands-on) will be charged for Staff Support time.

3.5.5 Supplies

Costs for many consumables (such as gowning supplies) are managed through equipment fees. The lab does maintain a supply of regularly used items in the lab. These are available to all lab members. Recovery costs are charged to the project.

3.5.6 Technical Services

Staff is available to process samples through any tool. This is often necessary for external job requests. Lab members may take advantage of this option, also. In fact, this if preferred for lab members that only need one-time use of a specific tool or process. (It is an unnecessary drain on lab staff resources when training is performed and the lab member never runs the tool

or process later.) Charges will be incurred for tool use, precious materials, supplies, and Staff Support time used to complete the task.

3.6 Billing

Project Managers or Non-Academic institutions are billed at the end of each month for all accumulated user and equipment charges. Non-Academic members must provide a Purchase Order and payment authorization before access to lab resources will be made available. In addition, failure to pay charges in a timely manner will result in cancellation of the project.

3.7 HSC Web Client

The lab uses a web-based system, HSC, to manage equipment qualification, access, reservations, availability, and logs. This system is also used to control inventory of consumables. Charges for supplies and tool usage are generated through HSC, so users must log tool usage accurately to prevent erroneous charges.

HSC accounts are for individual use only and are not to be shared with other lab members. Inappropriate use of the HSC system or user accounts will be considered as Computer Abuse and subject to corresponding disciplinary action.

HSC may be accessed on any computer with internet access by using a web-browser (https://resource.cores.utah.edu/#/).

3.7.1 Features

- Equipment reservations to coordinate sharing of lab resources.
- Software unlocking and locking of equipment to ensure use by qualified users only and generate usage logs.
- Maintain a list of qualified users and associated access levels for each tool.
- Provide information of equipment status (up, down, up with problem).
- Provide interface to add new users, projects, and accounts.
- Inventory management for consumable supplies.
- Method for Staff to charge for their time spent in behalf of other users.
- Method to track consumable supplies sold to users.

4 General Lab Policies

Established laboratory policies provide everyone with a safe and effective working environment conducive to high-quality research and learning. Laboratory members are part of a larger community that exists in this shared facility. As such, we expect a commitment from all members of the community (students, staff, faculty, and industrial visitors) to act in a manner based on courtesy, civility, mutual trust and respect. All members of the community should be aware of the potential impact of their actions, and strive to conduct themselves at the highest professional level. Lab Staff reserves the right to restrict, suspend, or revoke the access of any lab member whose actions or behavior do not meet the standards of the lab.

Yes, there are lots of rules – and you are expected to know and follow them. They are for the safety and success of everyone.

4.1 Access Cards

Facility access control is managed through an RFID proximity card. In most cases, this is the UCard issued by the university. In some cases, a separate card can be issued by lab staff. There are multiple proximity readers throughout the building and facility. Lab Staff manages access to

all readers throughout the facility. Access is linked to active, billable projects and may expire with the project(s).

To release the lock, simply place the access card near the proximity reader. As the interlock releases, access is granted. Entry to the facility for each person is only authorized if the proximity reader releases the interlock for his or her own access card. Tailgating is not permitted. Likewise, lab members are not authorized to open doors for another.

Access is granted for the sole use of the person to whom the card is issued. Cards are NEVER to be shared or loaned to any other person. If an access card is lost or misplaced, a replacement must be obtained and activated BEFORE re-entry to the facility is permitted. Persons that have not been granted card access are not allowed in the facility, except for approved visitors (see 4.33 Visitors/Tours).

4.2 Allowed/Prohibited Items

To maintain a safe working environment, many items and practices are not allowed in the cleanroom and other rooms in the facility. Additionally, the cleanroom is a specially-controlled environment dedicated to the fabrication of nano- and micro-scale devices. These structures can be easily damaged by small, microscopic particles and contaminants. For this reason, many items that commonly produce or shed particles are prohibited from the cleanroom. The list below, although long, is not comprehensive and does not cover all potential items. If not specifically mentioned, lab members should obtain PRIOR approval from Lab Staff before bringing an item into the cleanroom.

ALL items are to be wiped-down before entering the cleanroom. Wipes, pre-saturated with a mixture of Isopropyl Alcohol and De-Ionized water, are available in the gowning room. Use these wipes to wipe ALL exposed surfaces of items being brought into the cleanroom. This includes the interior surfaces of totes, tool boxes, etc. that will be opened while inside the cleanroom.

Since every item introduces contamination into the cleanroom, please limit items being brought into the lab to only those that are needed for your research activities. Items that are unnecessary and unused are an avoidable source of contamination.

Users bringing laptop computers, tablets, or other expensive items into the facility do so at their own risk. Items should be labeled and, if possible, password protected.

Prohibited from Cleanroom	
Food and Drink	Gum, Cough drops, Mints, Candy
Chewing Tobacco	Smoking
Lighters and matches	Alcohol and other controlled substances
Headphones	Lanyards
Pencils and erasers	Felt-tipped pens (other than Sharpie)
Non-cleanroom paper	Books and magazines
Cardboard	Wood or pressed wood
Tapes (office, masking, etc.)	Styrofoam
Facial tissue	Cosmetics
Baseball caps	Purses, backpacks, and computer bags
Powders	Spray Cans
Mercury thermometers	
Sharp jewelry (bracelets, bands, rings, etc.) that may tear gloves	
Music playing devices including listening to music on a laptop, tablet or cell phone through any in-ear or on-ear device	
Allowed in Cleanroom	
Cell Phones	Camera (still & video)
Laptop computer	Tablet computer
PDA's	Handheld electronic games
Cleanroom paper	Cleanroom notebooks
pens (cap-style only)	Plastic items
Single-ear ear bud or bluetooth device (for telephone use only)	
Paper items in plastic (laminated)	

4.3 Cell Phones

Cell phone usage is allowed in the lab, however reception may vary throughout the facility by location and provider. Cell phones must be wiped down in the gowning room prior to entering the cleanroom and remain accessible (outside the cleanroom suit). Lab members should not be actively using lab equipment or wearing chemical PPE while using a cell phone. After using a cell phone in the cleanroom, change your blue nitrile gloves to prevent spreading contamination from perspiration and skin oils.

Lab members may use a single-ear ear bud or bluetooth device. This enables the member to keep their cell phone inside the cleanroom garment. If used, the bluetooth device or ear bud must remain fully covered by the hairnet and cleanroom hood. It should only be used for telephone communication.

4.4 Communication

The facility has several methods to share information with lab members. These methods include the website, computer displays, and automated emails. However, lab members are responsible to ensure email addresses and other contact information are correct and updated, as necessary.

Lab Staff welcomes comments, suggestions, and input from lab members. Lab members may contact Staff directly or communicate through email.

4.5 Computer Abuse

Computer abuse is a violation of university policy and is subject to disciplinary action by Lab Staff, Campus Authorities, and/or legal authorities. All computers and tablets in the lab are property of the university and are dedicated to uninterrupted service in the facility. Personal use of these computers is unauthorized. Computer abuse includes, but is not limited to:

- Unauthorized use, including using or attempting to use an account not issued to you
- Interfering with the intended operation of any computer, or attempting to do so
- Inspecting, modifying, distributing, or copying any software or data without authorization, or attempting to do so
- Downloading/installing software on lab computers without prior authorization from Lab Management
- Supplying false or misleading information to obtain access to any lab computer, or attempting to do so

4.6 Contact Lenses

Contact lenses are allowed in all areas of the facility. However, be aware that the use of contact lenses increases the potential for damage to the eyes in the event of eye contact with chemicals, powders, fumes, etc.

4.7 Disciplinary Action

We strive to make this shared-use facility accessible, friendly, and safe for all users. We recognize that this promotes success. The policies established in this facility are designed to this end. All lab members are fully-trained to these policies and agree to full compliance. On rare occasions, however, it may be necessary to restrict privileges for a lab member due to non-compliance. Although the following general consequences are listed, Staff reserves the right to impose further consequences at any time.

	Procedural	**Safety**
1st Occurrence	1 week day use only	2 weeks day use only
2nd Occurrence	2 weeks day use only	4 weeks day use only
3rd Occurrence	2 weeks suspension and 4 weeks day use only	4 weeks suspension and 8 weeks day use only
4th Occurrence	Possible expulsion	Expulsion

4.8 Dress Code

4.8.1 Legwear

Legwear (pants) must completely cover all skin on the legs from the bottom of the shirt to the ankles.

Shorts, short pants, capris, skirts, dresses, ripped jeans, etc. are not allowed. However, they may be covered with hospital scrub-style pants, sweat pants, or similar legwear that fully covers each leg.

4.8.2 Shirts

Shirts/blouses must completely cover all skin from the top of the shoulders to the pants (short sleeves are acceptable).

Bare midriffs, tank tops, halter tops, or spaghetti strap tops are not allowed.

4.8.3 Shoes

Shoes must be closed-toe and closed-heel that fully enclose and cover the heel, toes, and top of the foot. Sandals, open-weave shoes, or shoes that expose the top of the foot are not allowed. The shoes must not have a high or small heel, as these can damage shoe covers. Additionally, soles with a deep tread or cleats that may hold a lot of mud or dirt are not allowed.

Socks or stockings are also required.

Shoes must be dry and clean before entering the facility. If weather or seasonal conditions outside the building leave shoes wet, snowy, salty, or muddy, users should provide and change into shoes that are not worn outside. This will prevent contamination of the gowning room and cleanroom.

4.9 Equipment Use

The processing tools and equipment in this facility are accessible to all trained lab members. For each tool in the lab an equipment manager has been identified by Lab Staff. The equipment manager is responsible for all training, documentation, process development, maintenance, and repair activities for the tool.

Since the tools vary considerably in expense, materials, size, and hazards several basic guidelines have been established for their use. Tool-specific guidelines are included in the corresponding SOP's.

- A lab member may only operate a tool without Staff supervision after he/she has been trained and qualified by Staff to use that tool.
- Do not operate a tool unless it is in proper working order and all covers, panels, and components are properly installed.
- Under no conditions may a user perform any modifications or repairs to a tool without specific instructions in the SOP or prior approval from Lab Staff.
- Most tools require prior scheduling in HSC and locking/unlocking the tool at time of use.
    - Only members qualified to use the tool have permission to reserve and lock/unlock the tool.
    - It is unacceptable to use a tool that is reserved or unlocked by another lab member.
- Report all equipment problems and failures promptly to Lab Staff.
    - For emergencies, contact the Tool Owner immediately.
- Do not use any equipment in any manner not approved by the SOP.
- All equipment parameters and settings must be set as defined in the SOP, unless previously authorized by the Tool Owner.
- Clean the work station before and after use.

4.9.1 Training and Certification

Lab Staff provides all training on all equipment. Access to the cleanroom does not authorize a member to use any particular tool. Many of the tools are delicate, complex, and/or expensive. Improper usage can create dangerous conditions that result in danger to human life or

expensive repairs. With few exceptions, hands-on training by a Staff Member is required before a lab member is authorized to use a specific tool without staff supervision.

It is the responsibility of the lab member to initiate all training. However, due to equipment and staff availability, some training sessions may be delayed for several days. Be aware that the time required to complete the training can vary widely, due to the complexity of the tool or process and the capabilities of the lab member. Lab Members should contact the equipment manager for the tool in advance to understand the specific training requirements and schedule the necessary training. Lab members cannot be trained by other lab members.

A typical training plan begins by reading the Standard Operating Procedures for the tool. A hands-on training session is then conducted by the trainer. In this session, the trainer may demonstrate the operation of the tool while the trainee watches. During successive training sessions, the trainee will take a more active role in the tool operation, while the trainer observes.

Once the trainer is comfortable with the ability of the trainee to safely and competently operate the tool, qualification will be given and logged in HSC. Only then is the lab member authorized to use the tool without direct Staff supervision.

Certified users should show knowledge and proficiency of the following:

- The specific hazards of the tool.
- Under what circumstances can they damage the tool.
- Ability to follow the SOP and operate the tool.
- How to recover from simple errors.
- Demonstrate a knowledge of the process(es) performed by the tool.
- Understand the appropriate uses of the tool.

4.9.2 Equipment Interlocks

Many of the tools include built-in interlocks to ensure safety. Additionally, some tools have an interlock box that is used to lock and unlock use of the tool. The interlock box is activated through HSC. The interlock does not turn any tool on or off, but simply prevents unauthorized use of the tool.

Prior to using a tool, a qualified user must reserve most tools in HSC. Reservations can be made several days in advance or on demand.

After the tool has been reserved, the same qualified user must Unlock the tool in HSC when ready to use it. This will release the interlock, enable use of the tool, and begin the usage charges.

NOTE: HSC will only allow the tool to be unlocked by the user holding the reservation.

When the process is complete and the tool has been properly placed in an idle state, the qualified user must then log into HSC and Lock the tool. This will engage the interlock, prevent further use of the tool, and stop the billing charges. It is important to lock the tool in a timely manner to prevent large and erroneous usage charges and make the tool available for other users.

Attempts to bypass established interlocks, whether built-in or HSC, is unacceptable and will be subject to lab consequences.

4.9.3 Equipment Reservations

As a shared use facility, it is important to schedule your use of processing equipment. This shows respect to other lab members and makes it easier for everyone to plan how to get their work done in a timely manner.

Most of the tools with interlocks require reservations prior to use, although some are available on-demand. HSC is used to reserve equipment for your use. In general, reservations are made in 15 minute blocks. When a lab member reserves a tool, only that member can unlock the tool during that reservation block. For some tools there may be limitations on the length of individual reservations, total length of cumulative reservations, and/or the number of reservations. This is done simply to ensure all lab members have a fair opportunity to use the tools.

NOTE: A user must be trained and qualified by staff before HSC will allow that user to reserve or unlock/lock the tool.

Since Non-University members normally only have access to the lab during Staff Hours, they will hold priority for tool reservations during Staff Hours. However, this is managed through Staff assistance and discretion.

In fairness to all users, reservations that are not used may be cancelled. This releases the tool for others to use. However, flexibility by all users should still be encouraged. Everyone should realize that even the best laid plans are rarely executed perfectly. Often a lab member may be late to a reservation because of problems with a previous process or as a result of offering aid to another. Under such circumstances, be considerate and cooperative.

While a tool is reserved, it is only available for use by the lab member holding the reservation. It is unavailable to other users. Consequently, charges will be applied for unused reservations.

Here are some general guidelines for equipment reservations:

- Be judicious with the reservation time. Large errors of insufficient or excessive reservation time should be avoided.
- Cancel unnecessary or unused reservations as quickly as possible.
    - Lab members may only cancel reservations prior to the reservation block.
        - Staff may cancel reservations after the reservation block, but may still charge for some amount of time.
- Do not reserve any tool for another user – especially to avoid reservation limits.
- For any reservation there may be a grace period. If the tool has not been unlocked within the grace period, the reservation may be cancelled and the tool made available for any other qualified lab member.
- Even the best-laid plans have setbacks. Be courteous and flexible when a lab member may exceed his reservation or arrive late. It will happen to you, too.
- In general, most tools can be reserved 28 days in advance.
- To provide tool access to all lab members, many tools have reservation restrictions that limit the total reservation time in a day or week. Higher-demand tools may have additional restrictions.

4.9.4 Equipment Problems

Occasionally, a tool does not perform as expected or fails to work at all. These problems should be reported to Lab Staff as quickly as possible.

- In no cases should a lab member attempt repairs to the tool beyond instructions explicitly included in the tool SOP. Any questions or uncertainty should be directed to Lab Staff BEFORE taking action.
- Lab members should not call staff outside Staff Hours for minor equipment or process problems. Minor issues must wait for the next work day.
- Major issues, such as fire, smoke, floods, or equipment alarms should be reported to staff immediately.

4.10 General Guidelines

- Physical and mental alertness are key to ensure safety. You should not be in the facility if you feel tired or ill, have taken any medication that causes drowsiness, or are impaired in any way from alcohol or other substances.
- Do not transport chemicals into or out of the cleanroom. Contact Staff in advance for assistance.
- NEVER work with an open flame.
- Work in the lab only when others are within shouting distance.
- Chemicals may only be stored in labeled storage locations.
- NEVER place or store chemicals of any kind in a tote.
- Fume hood sashes are to remain down/closed, unless actively using the fume hood.
- Keep chairs out of walking pathways.
- Do not sit on work tables or lean against equipment.
- Maintain the cleanliness of the lab.
    - Always clean the work space when done.
    - Place any debris in waste, whether or not you generated it.
    - Dispose of all waste immediately.
    - Do not leave sharp objects (broken wafers or substrates, razor blades, masks, etc.) lying around.
    - Do not leave tape on tables or other surfaces.
    - Keep wipes in the wipe holders.
    - Do not leave pieces of aluminum foil lying around.
- Do not take equipment, tools, or supplies into or out of the facility without approval from Staff.
- Walk and move slowly within the cleanroom.
- Keep a distance between yourself and other lab members.
- Do not take or borrow anything from another lab member without his or her prior permission.
- Do not disturb the work of any other lab member. If you need the tool, materials, or workspace, contact Staff for assistance.
- All materials not in use are to be stored in a covered box.
- Never open your bunny suit while in the cleanroom.
- Avoid touching your skin with your gloves. If you do, immediately replace your gloves.
- If you turn it ON, remember to turn it OFF.
- All materials being transported, must be in a covered box or other appropriate carrier.
- Any items left unattended must be labeled with your name, your contact number, what the item(s) are, the date and time, and the date and time they will be retrieved. Unlabeled or expired items may be confiscated.
- Materials and items no longer needed for your active research activities should be removed from the facility. Storage space in the cleanroom is limited.
- Do not modify equipment in any way.

4.11 Gowning/De-Gowning

All items – especially people and clothing – brought into the lab bring contamination and particles. To reduce the impact of these items, special precautions and protocols are required. This includes garments that have been specifically designed for cleanroom applications. In our lab, this clothing primarily consists of a cleanroom suit (aka, bunny-suit or coverall) and cleanroom boots.

Specific procedures have been established to minimize and control the contamination brought into the cleanroom. The procedures for entering and exiting the cleanroom are given below.

NOTE: While in the Gowning Room, keep all footwear OFF the benches.

4.11.1 Gowning

4.11.1.1 Ensure you meet all requirements of the Dress Code (see section 4.8).

4.11.1.2 Place all personal items (coats, jackets, backpacks, notebooks, etc.) and other prohibited items in a locker (see section 4.17) or other secure location.

4.11.1.3 Ensure your footwear is clean.

4.11.1.4 Take several steps on the gray Dycem floor mat in the hallway outside the Gowning Room.

4.11.1.5 Place a shoe cover on each foot, ensuring the sole of each foot is completely covered.

4.11.1.6 Put on a bouffant cap, covering your ears and all hair, excluding facial hair.

4.11.1.6.1 Ensure ALL hair is completely covered. Use a second cap, if necessary.

4.11.1.7 Enter the Gowning Room.

NOTE: While in the Gowning Room, it is required to wear – as a minimum – a bouffant cap and shoe covers at all times.

4.11.1.8 Put on a beard cover.

4.11.1.8.1 Ensure that it completely covers the nostrils and extends under the chin.

4.11.1.8.2 Ensure no facial hair is exposed.

NOTE: If preferred, cloth face masks or face veils that snap to the cleanroom hood are available as an alternative to the beard covers.

4.11.1.9 Remove any necessary personal items from your pockets (i.e., pens, cell phones, access card, etc.) that you will need while in the cleanroom and place them on the wipe-down area.

4.11.1.10 Obtain a cleanroom hood.

4.11.1.11 Put on the cleanroom hood and snap it below the chin.

4.11.1.11.1 Ensure the seams and tags are on the INSIDE.

NOTE: The hoods are packaged inside-out.

4.11.1.12 Obtain a cleanroom suit.

4.11.1.13 Keeping the suit off the floor, put it on.

4.11.1.13.1 Ensure all personal clothing (i.e., collars, hoods, scarves, etc.) are completely covered and contained inside the cleanroom suit.

4.11.1.14 Tuck the cleanroom hood inside the cleanroom suit.

4.11.1.15 Zip the cleanroom suit fully and snap it at the neck.

4.11.1.16 Put a cleanroom boot on each foot.

4.11.1.16.1 Tuck the leg of the cleanroom suit into the boot.

4.11.1.16.2 Buckle the strap of the boot around the ankle.

4.11.1.16.3 Pull the end of the strap to tighten the strap snugly around the ankle.

4.11.1.17 Using the snap on the inside at the top of the boot, snap the boot to the cleanroom suit on the leg behind the knee.

4.11.1.18 Tighten and snap the top of the boot around the calf.

4.11.1.19 Clip your ID Badge to the cleanroom suit.

4.11.1.20 Ensure you are wearing approved safety glasses.

4.11.1.21 Put a blue nitrile glove on each hand.

4.11.1.21.1 Avoid touching the fingers of the gloves with your bare fingers to prevent skin oils from contaminating the gloves.

4.11.1.21.2 Extend the cuff of the glove over the cuff of the cleanroom suit.

4.11.1.22 Using the pre-saturated wipes, wipe all items being brought into the cleanroom.

4.11.1.23 Enter the cleanroom.

NOTE: While in the cleanroom, at all times it is important to keep the cleanroom suit fully closed, zipped and snapped with hair, nose, ears, mouth, wrists and personal clothing covered. If you need to open the suit to get something, return to the Gowning Room to do so. Also, it is important to avoid touching your face with your hands.

4.11.2 De-Gowning

4.11.2.1 Exit the cleanroom.

4.11.2.2 Remove the cleanroom boots from each foot.

NOTE: In the Gowning Room both hangers and cubbies are available for storage of the cleanroom garments. You may use either, as you prefer. However, the procedures for de-gowning vary slightly.

4.11.2.3 Hanger Storage

4.11.2.3.1 Remove the cleanroom suit, ensuring it does not touch the floor.

4.11.2.3.2 Place the cleanroom suit on a hanger.

4.11.2.3.3 Zip the suit to the top.

4.11.2.3.4 Remove the cleanroom hood.

NOTE: Do **NOT** remove the bouffant cap.

4.11.2.3.5 Snap the cleanroom hood onto the collar of the cleanroom suit.

4.11.2.3.6 Snap the cleanroom boots to the leg of the suit, just below the knee.

4.11.2.3.7 Ensure your ID Badge remains clipped to the suit.

4.11.2.4 Cubby Storage

4.11.2.4.1 Place the soles of the cleanroom boots together.

4.11.2.4.2 Wrap the cloth of the boots around the soles.

4.11.2.4.3 Place the boots in the bottom of the cubby.

4.11.2.4.4 Remove your ID Badge from the cleanroom suit.

4.11.2.4.5 Clip the ID Badge to the edge of the cubby.

4.11.2.4.6 Remove the cleanroom suit, ensuring it does not touch the floor.

4.11.2.4.7 Carefully fold or roll the cleanroom suit compactly.

4.11.2.4.8 Place the suit on top of the cleanroom boots.

4.11.2.4.8.1 Ensure the soles of the boots do NOT touch the suit.

4.11.2.4.8.2 Ensure the boots and suit remain within the cubby and do not overlap into another.

4.11.2.4.9 Remove the cleanroom hood.

NOTE: Do **NOT** remove the bouffant cap.

4.11.2.4.10 Neatly fold or roll the cleanroom hood.

4.11.2.4.11 Place the cleanroom hood on top of the cleanroom suit.

4.11.2.5 Remove the safety glasses.

4.11.2.6 Place the safety glasses with your cleanroom garments or in the bin of "Safety Glasses to be cleaned".

4.11.2.7 Exit the Gowning Room.

4.11.2.8 Remove and discard the gloves, beard cover, and bouffant cap.

4.11.2.9 Remove the shoe covers.

4.11.2.9.1 If a shoe cover is clean and undamaged, place it back in the dispense bin for re-use.

4.11.2.9.2 If a shoe cover is dirty or damaged, place it in the trash.

4.11.2.10 Wash your hands with soap and water, especially if chemicals were handled while in the cleanroom.

4.11.3 Laundry Service

For lab cleanliness and personal hygiene, used cleanroom garments must be cleaned regularly. Each week Staff will remove all garments stored on hangers or in cubbies and send them to a laundry service for cleaning and any necessary repairs. Users will then need to obtain clean, packaged garments from the garment storage rack.

Any garments that become stained, contaminated, or soiled should be placed by the user in the laundry container in the Gowning Room and replaced with clean garments.

4.12 Horseplay

This facility is for research and education. There are significant hazards in the facility. Horseplay or rough-housing will not be tolerated, as it introduces significant risk to lab members and equipment. Lab members involved in horseplay may be permanently expelled from the lab.

4.13 ID Badges

Each person entering the cleanroom should have an ID Badge clipped to his or her cleanroom suit. All lab users are issued a badge with their name and photo. This improves communication between lab members. There are generic badges for visitors, students, guests, contractors, etc.

4.14 Intellectual Property and Proprietary Research

While much of the work performed in the **UTAH**NANOFAB falls under public scrutiny, a certain amount of proprietary research is also conducted. Neither the University of Utah nor the **UTAH**NANOFAB will attempt to claim intellectual property developed independently by researchers using the lab.

4.15 Lab Access

A set of requirements must be met before any individual is granted access to work in the lab. These requirements include a Setup Fee and may take several days to complete, so planning and patience is needed. Please refer to the Get Access to Our Lab page on our website for details. Generally, a new user is allowed to work in the lab only during Staff Hours. Extended access is only granted after meeting additional requirements.

All lab members must have current Safety Certification and an active project account. Access will be denied any user until either deficiency is resolved.

4.15.1 Process for Obtaining General Lab Access

Successful completion of the following steps does not guarantee lab access will be approved. During the training, Lab Staff will look for evidence that each candidate adequately understands the responsibilities and consequences of working in the lab. Lab Staff may deny or restrict access based on this evaluation.

4.15.1.1 Research Lab Member

4.15.1.1.1 Complete and submit the New Member Signup request from the Get Access to Our Lab page on our website.

4.15.1.1.1.1 If prompted, attach additional documentation.

4.15.1.1.2 Review this document.

4.15.1.1.3 Review the Safety and Protocol videos.

4.15.1.1.4 Complete the Lab Safety Orientation Class by Staff.

4.15.1.1.5 Complete the Lab Safety Orientation Tour by Staff.

4.15.1.1.6 Complete and pass the Safety Test (100%).

4.15.1.2 Course Student (lab-based formal course)

4.15.1.2.1 Enroll for the course through the University.

4.15.1.2.2 Review this document.

4.15.1.2.3 Review the Safety and Protocol videos.

4.15.1.2.4 Complete a Course Lab Safety Session conducted by Staff.

4.15.1.2.4.1 Submit any and all paperwork requested in the session.

4.15.1.2.5 Complete and pass the Safety Test (100%).

4.15.2 Process for Obtaining After-Hours Access

After-hours access is a privilege granted to lab members at the discretion of Lab Staff. Staff will consider authorizing after-hours access to individual lab members after observing the members' technical knowledge and compliance to lab policies over an extended period of time. This may extend into many weeks. Lab members should realize that the more interaction with the staff, the better understanding staff will have of the lab member's practices and attitudes – both positive and negative.

Lab members with after-hours access are expected to have a higher level of safety awareness and practices at all times. Since they may be the only person available to assist another member during an emergency, they must be comfortable, capable, and willing to do so without hesitation. In addition, this privilege may be revoked at any time at the sole discretion of Lab Staff.

This privilege may be revoked at any time at the sole discretion of Lab Staff.

4.16 Lab Member Classifications

Lab members are classified into two different categories: Course Student and Research Lab Member.

A Course Student is a person who is participating in a University-sponsored course. Students are not issued personal ID Badges and are only allowed to use equipment and resources in the facility under the direct supervision of the course Teaching Assistant.

A Research Lab Member is a person who has an active, billable project and is authorized to perform research-related activities in the facility. A member can be associated with the University or a Non-University entity and will be issued a personal ID Badge. Occasionally, a member will also be participating in a University course. Under these circumstances, he/she will continue to be classified as member, but should only use equipment and resources during the course lab time as directed by the Teaching Assistant.

4.17 Lockers

Lockers are available in the hallway between the cleanroom and the microscopy suite. Lockers are for temporary storage of personal items while working in the lab and are not to be used on a permanent basis. Lab members must provide their own locks. Neither the Lab Staff nor the University is responsible for lost or stolen items. Lockers used in violation may be forced open by staff and contents confiscated.

4.18 Lost and Found

All lost and found items are placed on the Lost and Found Table located in the hallway to the Lab Rooms. If you or anyone else have lost any items in the lab, this should be the first place to check. Items will not remain indefinitely. An email will be sent to all users regularly with information of the specific items. Those items remaining two weeks after the email will be discarded or claimed by the lab.

4.19 Personal Conduct

Lab members are expected to treat everyone with respect and act in a professional manner.

4.20 Personal Health and Hygiene

We recommend that all lab users wash their hands with soap and water after leaving the lab, even if no known exposure has occurred. Remember that the nitrile gloves are intended to protect equipment and materials from you, not the reverse.

Avoid sneezing and coughing in the cleanroom. If you must sneeze or cough, do NOT remove or lower the beard cover or cough into the cleanroom suit. Direct your face away from wafers, processing chambers, or other persons and sneeze or cough into the beard cover and your gloved hand (preferably holding a cleanroom wipe). Promptly return to the Gowning Room and replace the beard cover and gloves without touching other surfaces.

If you are experiencing any of the following, you should not enter or remain in the lab until fully recovered. Staff can request users to leave the lab if they feel a user poses a risk to other people's work, health, or safety.

- Ill or not feeling well
- Excessive drowsiness (students and researchers frequently experience lack-of-sleep and must realize that the resulting drowsiness will inhibit judgment and mental alertness, placing themselves and others at risk)
- Taking any medication that can result in drowsiness
- Under the influence of drugs or alcohol
- Any condition that can impair mental clarity and judgment

4.21 Reporting and Acknowledgement

The **UTAH**NANOFAB is supported by various funding sources. It is important to formally acknowledge any and all work made possible by support of the lab. Lab members agree to include citations in all applicable documentation or presentations.

In addition, an annual report is generated that provides a summary of research activities and efforts conducted in the lab. In order to prepare this report, we ask that users provide a general summary of their research activities annually. Reports should describe the status of the work, in addition to any technical obstacles that were met. Such information can be used to plan and justify future spending for infrastructure and equipment.

For papers, a suggested acknowledgement is, "This work was performed in part at the Utah Nanofab. The author(s) appreciate the support of the staff and facility that made this work possible."

For presentations, including the Utah Nanofab in the list of acknowledgements is sufficient. Click here for an authorized logo.

It is requested that Lab Staff be informed of conferences and dates where research is presented that used lab resources. We also request a copy, preferably electronic, of any publications or presentations for inclusion in our library.

4.22 Reproductive Health

Some materials used in the facility can be harmful to an unborn fetus or impact general reproductive health. Lab members who believe they are pregnant or otherwise concerned about reproductive health (male or female) should discuss laboratory use with their supervisor, the Safety

Officer, EHS, and their physician. Lab policies will not directly impose restrictions, however, the lab member should understand and follow any concerns or recommendations expressed by the physician.

4.23 Safety Glasses

Safety glasses with side protection must be worn in the cleanroom. See section 5.13.30 for requirements. Safety glasses may only be removed when using optical microscopes, including aligners.

4.24 Service Chase Entry

Lab members are not authorized to enter the service chases, unless accompanied by staff or in the case of an emergency evacuation. These doors are monitored and unauthorized access will be subject to disciplinary action.

4.25 Service Personnel

Occasionally, it may be necessary to utilize non-staff personnel to service or repair facilities or equipment in the cleanroom. These individuals must be authorized by lab staff and will require basic safety and protocol training prior to initial entry. They will be issued a Contractor ID Badge. While in the cleanroom, they are only authorized to work on the specific equipment designated by staff.

4.26 Staff Support

Staff are willing and able to provide training and technical services. We encourage users to learn the various processing methods throughout the facility. However, training for a one-time event is discouraged. Under these circumstances, resources are better used and success more likely when staff provides assistance through technical services. Lab members will be billed for any applicable staff time, consumables, and equipment fees.

4.27 Standard Operating Procedure (SOP)

A standard operating procedure (SOP) is a written set of instructions that detail the routine actions and safety precautions to be used when conducting a specific experiment or process. They may involve the operation of a piece of equipment, chemical handling, administrative tasks, etc. Variances to the defined SOP's are rare and must be approved by staff in advance.

4.28 Supplies

Many supplies, such as glassware, wipes, some chemicals, etc., are provided by the facility and available for use. Costs for these items are covered through general lab usage fees. Other consumables (masks, tweezers, scribes, wafer trays, wafers, etc.) are available and billed to an applicable project account. Contact a Staff member during Staff hours to obtain any of these items.

4.29 Telephone System

Telephones available in the lab are intended for lab-related use only. Personal use is discouraged, but not prohibited. The phones are part of the campus system. Five-digit campus extensions may be dialed directly. You must first dial a "9" to reach an outside line. An authorization code is required for any long-distance numbers.

4.30 Tobacco Use

The use of tobacco (smoking) generates large quantities of airborne particles. These particles remain in the lungs and airways for hours. The exhaled particles seriously compromise the

cleanliness of the air in the cleanroom. Therefore, it is highly recommended that lab members who smoke drink a large glass of water (or other liquid) and wash their hands and face before entering the cleanroom.

4.31 User Communication

All users must supply Lab Staff with a current phone number and email address. These are used by Staff to inform users of messages related to activities in the facility. Users with invalid information may have their lab privileges suspended.

4.32 User Storage

Cleanroom space is primarily dedicated to processing and research activities. There is only limited space for storage in the cleanroom, primarily along the main aisle. Small totes are available to users for storage of basic items in the cleanroom. The totes can hold wafers, masks, notebooks, tweezers, and other small items for use in the cleanroom.

Totes are generally assigned to users, but are occasionally assigned to research groups. Totes and other items to be stored in the cleanroom should be clearly labeled, indicating ownership. You should never use or borrow a tote that is not assigned to you or your group. Totes that are no longer needed should be returned to Lab Staff for re-assignment.

To conserve space and reduce clutter, users should regularly purge totes of unnecessary items. Lab Staff periodically disposes of items left unlabeled or no longer used by active lab members.

No additional storage containers, such as dry boxes, desiccators, cabinets, etc., may enter or remain in the lab without permission from Lab Staff.

4.33 Visitors/Tours

Anyone that has not been granted card access to the facility is considered a visitor. The public viewing aisle provides a satisfactory means to show the cleanroom to most visitors and is recommended in all cases. Where entry to the cleanroom is appropriate, visitors may enter the cleanroom only with a member of the Lab Staff who will escort the visitor at all times. Prior arrangements should be made. In rare instances, Lab Staff may provide written approval for a lab member as the cleanroom escort (verbal approval is unacceptable).

Tours of the cleanroom may be coordinated with Lab Staff in advance. For safety reasons, tour groups should be limited to 8 people. Larger groups can be accommodated if split into smaller groups.

All visitors entering the cleanroom must follow the Dress Code (see section 4.8). Each visitor will be issued a Visitor ID Badge while in the cleanroom. The cleanroom host is responsible to ensure all policies and rules are always followed by each individual. Visitors are not authorized to touch or operate any processing tools.

4.33.1 Minors

In compliance with Campus guidelines, persons under the age of 18 are not permitted to enter the cleanroom unless ALL of the following criteria are met.

4.33.1.1 Tours

- The parent/legal guardian/school obtains prior written approval by the Cleanroom Supervisor, Associate Director, or Director.
- The minor is accompanied at all times by a member of the Lab Staff.

- The Lab Staff chaperone ensure the minor is NOT placed into a situation where he/she may endanger personal health and safety or that of others.
- The minor is provided all applicable personal protective equipment.
- For group tours, a safety briefing is provided to the group by Lab Staff prior to entering the cleanroom.

4.33.1.2 Membership

- The parent/legal guardian/school obtains prior written approval by the Associate Director or Director.
- The host department has a completed copy on file of an Assumption of Risk, Waiver of Liability and Indemnification Agreement for the specific minor.
- The minor is under the direct supervision of a University Staff member who is trained and knowledgeable of the potential hazards in the cleanroom.
- The minor has been provided appropriate safety training by EHS and receives a score of at least 80% on the quiz.
- The minor has completed all requirements to become an authorized lab member (see section 4.15 Lab Access)
    - Minors will NOT be granted after-hours access.
- The minor is provided all applicable personal protective equipment.

4.33.2 Pets

The **UTAH**NANOFAB promotes a healthy learning and research environment by controlling potential health hazards and nuisances, including prohibiting pets from the facility. The exceptions are dogs required by police or emergency responders.

4.34 Wafer/Substrate Handling

Although the cleanroom and gowning protocols have been designed to protect wafers (and other samples) from particles and contamination, improper handling techniques can easily and quickly result in contamination. The following handling guidelines will help protect your work:

- NEVER touch wafers with your hands – with or without gloves. Use special handling tools such as tweezers, tongs, or vacuum wands.
- Never sneeze, cough, or spit towards a wafer – even while wearing a beard cover or face shield.
- Avoid breathing directly on wafers.
- Avoid moving anything over your wafer that may release particles, including your face or hands.
- Whenever possible, store wafers in covered containers.
- Clean tweezers and vacuum wands regularly with IPA and a cleanroom wipe.
- When transporting wafers, avoid abrupt changes in movement. (Every time you hear a wafer rattle, particles are added.)

4.35 Wafer/Substrate Storage

Users are responsible to store their own wafers and substrates. Totes are available. Wafers that are not properly stored may be immediately placed in the lost-and-found or discarded. Any notes left on wafers will be disregarded and the wafers may be forfeited. It is the responsibility of the user to coordinate with staff in advance for any needed exceptions. Wafers should not be stored inside processing tools, such as lithography ovens.

5 General Safety Information

"No task is so important and no service so urgent that it cannot be done safely." (Chemical Hygiene Plan)

Safety is a dominant factor in the establishment of all lab policies. The primary focus in all lab activities should be personal and community safety – NOT the successful completion of research projects. The safety rules and procedures included in this document must be read, understood, and practiced at all times by all lab members. Think about your actions and how they may affect the safety of yourself and others. Use common sense, consideration, cooperation, and kindness while in the lab. Safety is an ongoing effort. Procedures and rules are continuously evolving based on suggestions, incidents, needs, and learnings.

If you observe an unsafe condition or situation in the lab, notify staff. Use the Report a Safety Concern or Event link on the website, even if you contact staff directly. If you notice another lab member that is not following safe practices, do not hesitate to approach the person and remind him or her.

As a general rule, any lab member that violates a safety rule or otherwise jeopardizes personal safety or the safety of other lab members (present or not) will be subject to consequences. These consequences are at the sole discretion of Lab Staff and may restrict, suspend, or revoke access to the lab. Everyone with access to the lab has agreed to follow all documented lab policies, procedures, and SOP's and is held personally responsible to do so. If uncertain of the proper method, procedure, or rule, the lab member should ask Lab Staff for clarification before proceeding. **There are no acceptable excuses!**

The UTAHNANOFAB incorporates guidelines established by the Occupational Safety and Health Administration (OSHA) Laboratory Standards, the International Fire Code (IFC), and the University Environmental Health and Safety (EHS). This document provides the instructions and information to satisfy compliance to these standards, including the necessary Chemical Hygiene Plan. In combination with mandatory chemical safety training, it satisfies all applicable Right-To-Know regulations.

5.1 Buddy System

The University of Utah College of Engineering mandates that no one may be alone in labs containing hazards. To comply with this mandate the UTAHNANOFAB has established the following policy applicable to the cleanroom.

- Trained Lab Members are those who have received training from lab staff or staff-approved individuals. The training will be appropriate for the specific tools to be used and the level of lab access granted.
- Authorized Lab Members are capable of helping others during a lab emergency and have met the following requirements:
    - Assigned to an approved billing account.
    - Received Lab Safety Training.
    - Passed the Lab Safety Test.
    - Submitted a digitally-signed copy of the UTAHNANOFAB User Policy Agreement, acknowledging the integrity and commitment to comply with all documented rules and guidelines.
    - Authorized to work in the cleanroom during Non-Staff hours.

A “buddy” refers to another Trained and Authorized lab member. This person will be capable of helping in the event of an emergency and aware of his or her responsibility to check on the well-being of his or her counterpart(s) on a regular basis.

- No one may be in the cleanroom (see 2.5) alone during Non-Staff hours.

- At least two (2) Trained and Authorized lab members must be in the cleanroom during Non-Staff hours.
- Each Lab Member is individually responsible to obtain his/her own buddy.
- Buddies may change during cleanroom use.
- Buddies must interact and communicate with each other regularly (at least every 15 minutes).
- Each lab member is responsible to fulfill all commitments to others when acting as a buddy.
- Lab Members that violate the buddy system rules will be subject to disciplinary action by the Lab Staff, College of Engineering, and/or University of Utah.

5.2 Electrical Safety

- Immediately notify Staff of any potential electrical hazard that you notice.
- Do not interfere or bypass any electrical connections containing a lock-out/tag-out device.
- Lab members may insert electrical plugs into standard 120V outlets.
  - Only staff is authorized to insert plugs into receptacles that are not standard 120V outlets.

5.3 Emergencies

5.3.1 Calling 911

Emergencies occur where Fire, Police, or Ambulance services may be required. Under such circumstances, call 911 immediately. They will provide further instructions.

5.3.1.1 Provide the following information:

- ▶ Your name, location, and phone number.
- ▶ Describe the event, including persons affected or involved.

5.3.1.2 Follow all instructions given by the emergency response operator.

5.3.1.3 Do not disconnect the call until directed by the emergency response operator.

5.3.2 Alarms

Two primary alarm systems are used for the lab, the Fire Alarm system and the Hazardous Production Materials system. If either or both of these systems is activated, evacuations are mandatory. Re-entry to the building and/or lab is only allowed after approval by emergency responders – whether or not visual or audible alerts have been cleared.

5.3.2.1 Fire

A Fire Alarm system will alert building occupants to any event requiring evacuation. This system will provide both audio and visual alerts throughout the building. It can be activated automatically or manually.

5.3.2.2 Hazardous Production Materials (HPM)

An HPM system is constantly monitoring the lab for potentially dangerous conditions other than fire-related events, such as hazardous gas leaks, earthquakes, liquid leaks, etc. It will alert occupants through audio and visual alerts for the need to evacuate. It can be activated automatically or manually. It is linked to the building Fire Alarm system and will activate it under many circumstances. When activated, all hazardous gases are automatically shut off at their source.

5.3.3 Facilities

5.3.3.1 For facility problems, such as flooding, electrical, ventilation, etc., that present an immediate danger to people, call 911.

5.3.3.2 For facility problems that do not present an immediate danger to people, call Campus Facilities.

5.3.3.2.1 Contact Lab Staff.

5.3.4 Fire

5.3.4.1 In case of fire, use the red fire alarm pull boxes located at every lab exit and throughout the lab.

5.3.4.2 Evacuate the building.

5.3.5 Medical

5.3.5.1 Call 911 for any serious or life-threatening issue.

5.3.5.2 For other issues, follow the procedures in section 9.15 Medical Emergency and obtain profession medical assistance as quickly as possible.

5.4 Evacuation Procedures

It is critical that all lab members are familiar with evacuation procedures before entering the lab. This includes the various methods of notification, the location of all emergency exits, all exit pathways, the lab assembly location, and how to leave the facility (see Appendix G, Nanofab Assembly Location Map and Appendix H, Emergency Evacuation Map).

5.4.1 When an alarm system is activated or an evacuation announcement is made, you MUST evacuate the lab promptly.

5.4.2 ALWAYS assume alarms or announcements are real.

5.4.3 Do NOT attempt to remove any cleanroom clothing or PPE.

5.4.4 Remain calm.

5.4.5 Quickly secure your process.

5.4.6 Proceed to the nearest emergency exit.

5.4.6.1 If the path to the nearest exit is obstructed or presents physical danger, identify a safe, secondary path to any exit door and proceed.

NOTE: Unless absolutely necessary, do not exit the cleanroom through the gowning room. It is not designated as an emergency exit.

5.4.7 Assist others as necessary.

5.4.7.1 However, do NOT place yourself in danger to provide assistance.

5.4.8 Open the emergency exit door(s).

5.4.9 Exit the building.

5.4.10 Proceed to the Nanofab Assembly Location Point.

5.4.11 Remain at the Nanofab Assembly Location Point until otherwise instructed by Lab Staff or emergency responders.

NOTE: This enables Staff and responders to account for all individuals in the lab at the time of the evacuation.

5.4.12 Provide any pertinent information to emergency responders about the event requiring the evacuation.

5.4.13 While at the Nanofab Assembly Location Point, you may remove all cleanroom clothing and PPE. It must be collected and laundered.

5.4.13.1 New cleanroom clothing must be obtained when re-entry to the cleanroom is authorized.

5.5 First Aid

A first aid kit is available in the Gowning Room. Some injuries, such as minor burns or small cuts, can be treated from this kit. Report any and all use of supplies from the first aid kit through the Safety link on the website. Be sure to list all items used.

Injuries that require treatment by a health care professional are a reportable incident and must be documented. Refer to section 5.8 Incident Reporting.

5.6 Food and Beverages

Food and beverages are not allowed in any part of the cleanroom, gowning room, conference room, CR Shop, Gas/Chem Storage Room, Backend Micromachining Lab, or Microfluidics and Prototyping Lab.

5.7 Housekeeping

5.7.1 Do not block or obstruct access to any safety or emergency equipment such as showers, eyewashes, fire extinguishers, exits, electrical panels, electrical disconnects, hazardous material monitoring or display devices, etc.

5.8 Incident Reporting

Incidents affecting the safety and health of lab members will be minimized, but not eliminated, through compliance to the policies and procedures in this document. When events do occur, it is important to document all pertinent information. This will help us apply better safeguards and practices to prevent recurrences.

5.8.1 If you are affected or involved by a safety incident, complete the following reports as instructed:

- Nanofab Incident Report
- Workers' Compensation Employer's First Report of Injury or Illness (University Employee)
- University of Utah Incident/Accident Report (Student or Visitor)

5.9 Ladders

5.9.1 Occasionally, ladders may be found in the cleanroom. When present, they are for Staff use only. Lab Members may not use a ladder at any time.

5.10 Music

Listening to music through radios, music players, headphones, ear buds, or bluetooth devices is not allowed in the facility. This can prevent lab members from hearing alarms, buzzers, or other sounds that affect personal safety.

5.11 Request for New Materials

Because of the large number of users in the laboratory, the facility closely monitors the chemicals used in the lab. Only chemicals specifically authorized may be used. Most standard materials have been pre-authorized with SDS documentation available. Materials provided by staff are available for the use of all lab members that have been trained to use that material.

You may request approval to use a material that is not provided by staff. This should be done BEFORE ordering the material. The request will be reviewed by the Safety Officer and Safety Committee. The review process can take up to 2 weeks, which will confirm appropriate handling, storage, waste disposal and other requirements. The final decision may result in general approval, approval with modifications, approval with very tight controls, approval for a specific user, or denial. No materials may be brought into facility until AFTER they have been approved!

5.11.1 New Material Request Procedure

5.11.1.1 Obtain a current SDS from the manufacturer for the material(s) being requested.

NOTE: If secondary materials (e.g., a new developer for a new resist) are also new, they may be included in the same request.

5.11.1.2 Create a Standard Operating Procedure (SOP) for use of the material(s).

5.11.1.2.1 Include procedures for storage, handling, use, necessary PPE, waste disposal of the material(s), waste disposal of wipes, gloves and other contacted materials, and any other special considerations necessary for the material(s).

5.11.1.3 Complete the New Material Request Form found on the website.

5.11.1.3.1 With the form, attach the proposed SOP and an SDS for each requested material.

5.11.1.4 Submit the New Material Request Form.

NOTE: The request will be automatically forwarded for review.

5.11.1.5 Wait for a written response.

5.11.1.5.1 Provide any additional information, if requested.

NOTE: WRITTEN approval must be given before the material(s) may be brought into the lab. Verbal approval is unacceptable.

5.12 Safety Awareness

All lab members are responsible to know and follow all procedures, rules, and policies that affect personal or lab safety. If you observe anyone in the lab involved in unsafe activities, do not hesitate to approach them and respectfully remind them of proper methods. However, if you are not comfortable approaching someone, please promptly report the situation to Lab Staff. If you are the one being corrected, express appreciation and kindness, not anger or animosity.

As a staff we are always open to additional comments and suggestions to improve our safety practices. If you need to report a safety problem or have a suggestion, please submit it to staff through the Report a Safety Concern or Event link on the website. This helps us respond to and document the issue. These entries may be submitted anonymously.

With the large variety of materials used in the lab, it is important that all lab members have access to all safety-related information for each item. Information is available in several sources and locations, including this document. It is the responsibility of each lab member to fully understand

the risks and care necessary to properly handle any material BEFORE doing so. This section describes several of the additional sources of information available.

Some information and guidelines may appear contradictory. If uncertain, ask Staff for clarification before proceeding.

5.12.1 Chemical Container Labels

The labels on purchased chemicals are a good resource for information. All containers must have a label attached. Each label must include:

- The common name of the chemical
- The name, address, and telephone number of the company responsible for the product
- Appropriate hazard warning(s), which could be a single word or pictograph

Most labels provide additional safety information to help workers protect themselves from the substance. This information may include protective measures and/or protective clothing to be used, first aid instructions, storage information, and emergency procedures.

Lab Staff is responsible for:

- Inspecting all incoming containers to ensure proper labels are attached
- Reviewing the label of all newly purchased chemicals (manufacturer's occasionally update labels with new information and details
- Ensuring chemical labels are never removed or defaced – except when discarding empty containers
- Labeling any containers (e.g., baths, tanks, storage vessels) in the facility dedicated for use of specific chemicals
- Verifying all containers for used and unwanted chemicals are labeled accurately

5.12.2 EHS website

The University Occupational Environmental Health and Safety Department (EHS) maintains a website that provides additional information for safety and health related issues. The web address is http://oehs.utah.edu/.

5.12.3 Safety Data Sheet (SDS)

NOTE: A Safety Data Sheet was formerly known as a Material Safety Data Sheet (MSDS). Although this change in the name has been adopted by OSHA and other agencies, mandatory compliance by suppliers was not required before June 2015. Even after that date, many older MSDS documents will remain as reference until updated replacements have been published and received.

The Safety Data Sheet (SDS) is a convenient, condensed source of information for any chemical. The SDS is a federally mandated document, which must be provided by the manufacturer or seller of the chemical. It contains a summary of the chemical composition, physical properties, chemical properties, and toxicology data with instructions for handling, spill control, waste disposal, and first aid.

Although all SDS documents provide similar information, the document formats differ. In fact, the SDS documents provided by two different companies for the same material may appear completely dissimilar with noticeable differences in content. However, OSHA does require the following information on an SDS:

Product Identity	Reactivity Hazards
Hazardous Ingredients	Spill Clean-Up
Physical/Chemical Properties	Protective Equipment
Fire and Explosion Hazards	Special Precautions
Health Hazards and Exposure Limits	

It is required to have an SDS on file for any material used in the facility. Physical copies are found in the Gowning Room. Electronic copies are available on our website. Before using ANY material, you must review its SDS.

5.13 Safety Equipment

5.13.1 Alarm Strobe, Fire

Function: Provide visual and audio notification of the need to evacuate the building.

Use: Activated through the Building Fire Alarm system, either manually or automatically. Events that trigger the alarm may or may not be due to a fire.

Location: Multiple locations throughout the building, including each bay and room within the lab facility.

5.13.2 Alarm Strobe, HPM

Function: Provide visual and audio notification of the need to evacuate the building.

Use: Activated through the Nanofab Hazardous Production Material System, either manually or automatically. Events that trigger the alarm may or may not be due detection of a hazardous gas.

Location: Multiple locations throughout the UTAHNANOFAB, including each bay and room within the lab facility.

5.13.3 Apron, Full-sleeve (PPE)

Function: Protect the body and arms from chemical residues. Aprons are chemical resistant, NOT chemical proof.

Use: When working at a wet bench or fume hood.

Location: Located near the fume hoods and wet benches.

5.13.4 Aspirator

Function: Aspirate chemicals from a container for disposal. The aspirator is designed to dilute the chemical with large amounts of water while being drained.

Use: When draining waste acids and bases from a container.

Location: In each wet bench.

5.13.5 Chemical Bottle Carrier

Function: Transport a single, closed chemical container.

Use: When transporting a single chemical bottle from one location to another.

Location: Request from Staff.

5.13.6 Chemical Cart

Function: Transport of closed chemical containers (one or more).

Use: Place container(s) in smallest compartment that will hold the container upright. Hold brake handle while rolling the cart.

Location: 1 Flammables and 1 Corrosives cart each in Cleanroom and Gas/Chem Room.

5.13.7 Chemical Pass-Through Cabinets

Function: Storage of never-opened chemical containers available for cleanroom use.

Use: Place never-opened chemical containers in cabinets based on chemical storage labels.

Location: Bay D

5.13.8 Emergency Exits

Function: Serve as a first means of egress.

Use: Exit the lab through these doors during a Fire or HPM Alarm. It may be necessary to push the panic bar to open the door.

Location: North and South end of the Main Aisle. Other doors are found in the service chases, if necessary. Refer to the Evacuation Map for exact locations.

5.13.9 Emergency Stop Button

Most of the processing tools in the facility have a red Emergency Stop Button that will immediately disable all power to the tool when pressed. This is not an acceptable method to shut down a system, but is a quick one-step solution for an emergency. If a user sees any kind of electrical arcing, notices evidence of smoke, or hears unusual sounds from the tool, they should not hesitate to push the red button. However, since this can be hard on equipment, users are asked to carefully distinguish process instabilities and uncommon runs from emergency situations. Flickering plasma, unusual etch rates, or a system that will not pump down to the expected vacuum, are not emergencies.

Function: Place a tool or piece of equipment in a de-energized state.

Use: Push the red button when the equipment is smoking, shaking, leaking gas, or exhibiting any other unusual, emergency-related condition.

Location: Near the operator panel on most tools.

5.13.10 Emergency Showers

Function: Chemical decontamination of a person or their clothing.

Use: Pull the stainless steel triangle or handle on the wall. Remain under the shower for 15 minutes (5 for HF). Remove all contaminated clothing. Draw the modesty curtain.

Location: Multiple locations throughout the building and cleanroom. Refer to Appendix F, Safety Equipment Map for exact locations.

5.13.11 Exit Sign

Function: Indicate an exit or exit direction from the building.

Use: Find signs posted and follow the directional arrows, if included.

Location: Throughout the building.

5.13.12 Eye Wash Station

Type 1

Type 2

Type 3

Function: Decontamination of chemical exposure or physical materials to the eye.

Use: Hold eyes open with hands and place eyes directly over the wash station. Rinse eyes for a minimum of 15 minutes.

- Type 1 Integrated with the emergency shower. Grab handle on left side and pull door down to horizontal position. Water will turn on when door is horizontal.
- Type 2 Stand-alone. Push handle on right side of bowl until water turns on.
- Type 3 Included in sink. Grab fixture and pull to horizontal position. Water will turn on when fixture is horizontal.

Location: Multiple locations throughout the building and cleanroom. Refer to Safety Equipment Map for exact locations.

5.13.13 Face Shield (PPE)

The face shield is to protect the face from chemical residues. Touching the visor should be avoided, as this will damage the visor over time and decrease visibility.

Function: Protect the face from chemical residues.

Use: Always to be worn covering the face when working with chemicals. Clean the visor using a wipe wetted with UPW followed by a dry wipe before and after each use. Adjust knobs to ensure snug fit of headband.

Location: Near each fume hood and wet bench.

5.13.14 Fire Extinguishers

Function: Extinguish a small fire.

Use: Only to be used by individuals that have received specific training for the use of a fire extinguisher. (Improper use can make the fire worse.)

Location: Several locations throughout the building and lab facility.

5.13.15 Fire Sprinkler System

Function: Spray water over a large area to extinguish a fire.

Use: Automatically activated by sensors.

Location: Sprinklers are mounted in the ceiling at regular intervals and within cabinets for pyrophoric gases.

5.13.16 First Aid Kit

Function: Provide minor first aid supplies.

Use: Apply to minor cuts, scrapes, abrasions, thermal burns, and other minor physical injuries.

Location: Gowning Room.

5.13.17 Fume Hood

Function: Provide an exhausted enclosure to isolate personnel from chemical fumes or reactions.

Use: For activities involving solvents and other authorized tasks. The exhaust may not be in alarm. Never put your head inside the fume hood.

Location: Rooms 2223 (BM Lab), 2227 (MP Lab), 2237 (CR Shop), 2010N, Bay A, Bay B, and Bay C

5.13.18 Gas Cabinet

Function: Exhausted enclosure for hazardous gas cylinders.

Use: Run the automatic purge cycle before and after installing a new cylinder. Two people required for any cylinder change.

Location: Gas/Chem Room and Service Chases.

5.13.19 Gloves, Chemical Resistant (PPE)

NOTE: No single type of glove can protect against all hazards. Different gloves are provided for different applications. If uncertain which glove style to use, consult the Safety Officer or Chemical Hygiene Office BEFORE beginning the task.

Function: Provide chemical protection to the hands.

Use: Always wear over nitrile gloves when working with chemicals. Fingers should be snug to improve dexterity. Cuff should be snug on the outside of the apron. Test for holes prior to each use and avoid touching the inside of the glove.

Location: At each wet bench and in the supply storage cabinet.

5.13.20 Gloves, Cryo (PPE)

Function: Personal protection against cryogenic liquid exposure (e.g., liquid nitrogen).

Use: Any time a cryogenic liquid is being handled, poured, or transported.

Location: Gowning room and typical places of use.

5.13.21 Gloves, Blue Nitrile

Function:	Blue nitrile gloves are primarily used in the lab to protect the lab from hands, not hands from the lab. They are thin and easily torn. However, nitrile does offer limited protection from many chemicals
Use:	Worn at all times in the lab.
Location:	In the gowning room, clean conference room, and various locations throughout the lab.

5.13.22 Gloves, White Nitrile

Function:	White nitrile gloves are worn when working at the fume hoods.
Use:	Placed over the blue nitrile gloves, they provide a second layer of minor protection and a visual reminder that you are working with chemicals and can have chemical residuals on your hands.
Location:	Near each wet bench and fume hood.

5.13.23 Hazardous Material Information Center

Function:	Centralized source of safety-related information, including SDS documents.
Use:	Look up information on chemical use and handling. Look up evacuation procedures.
Location:	Gowning Room.

5.13.24 Hazardous Production Materials (HPM) Monitoring System

Function:	Maintain safety of the facility by monitoring for various hazards such as gas leaks, liquid leaks, smoke, and seismic events.
Use:	The system is always active and will automatically respond to defined events.
Location:	Sensors are located throughout the facility.

5.13.25 HF Antidote (Calcium Gluconate)

Function:	Neutralize fluorine ions in the case of exposure to hydrofluoric (HF) acid.
Use:	Wearing a clean pair of gloves, apply generously to the affected area of skin and gently rub it in. This is to be done only AFTER rinsing copiously for a minimum of 5 minutes. The HF antidote should NOT be applied to the eyes.
Location:	At each wet bench.

5.13.26 Lock-out, Tag-out

Function:	Provide notification that a tool or component is in shut-down mode and to prevent its use.
Use:	Place on tool or component at location of use. Place locks on components (valves, plugs, switches, etc.) to prevent further use of the tool. Only Staff can place or remove a tag or lock.
Location:	Anywhere needed.

5.13.27 Oxygen Monitor

Function:	Monitor ambient oxygen concentration at the Liquid Nitrogen dispense station.
Use:	Automatically shuts off the dispense station when detected concentration is below threshold.
Location:	In Service Chase near Liquid Nitrogen dispense station.

5.13.28 Pull Station, Fire

Function:	To alert others of a fire or similar incident if the Building Fire Alarm does not activate automatically.
Use:	Push the handle in, then pull it down.
Location:	Many various locations throughout the building and lab facility.

5.13.29 Pull Station, HPM

Function:	To alert others of a hazardous gas leak if the Hazardous Production Materials Alarm does not activate automatically.
Use:	Lift and pull the blue handle.
Location:	Many various locations throughout the building and lab facility.

5.13.30 Safety Glasses (PPE)

Function:	Protect eyes against objects and chemicals.
Use:	Safety glasses (prescription or non-prescription) with side protection are required in the cleanroom at all times, except when using a microscope. A variety of styles are available, including those that fit over prescription glasses. All safety glasses must meet the ANSI Z87.1-2012 standard. Safety glasses are never a substitute for a face-shield.
Location:	Gowning room.

5.13.31 Sharps Waste Container

Function:	Contain all unwanted items that pose a laceration or puncture risk.
Use:	Dispose any and all unnecessary items that are sharp or can be broken and become sharp.
Location:	Every bay/room, generally attached to a standard waste container.

5.13.32 Spill Kits

Chemical spills must be contained as quickly as possible. However, different supplies are required for different chemicals. Five (5) types of spill kits are available to use on larger spills, when necessary. However, they should only be used by people who have been properly trained to do so.

Function:	Contain, absorb, and neutralize chemical spills.
Use:	Different chemicals require different spill kits. Five (5) are available for use by those who are properly trained.
Location:	Near the North Emergency Exit Door.

5.13.33 Standard Waste Containers

Function:	Contain all unwanted solids that do not contain solvents.
Use:	Dispose of all unwanted items that do not contain solvents. Cleanroom wipes used to clean up acids or bases are placed in these containers.
Location:	A minimum of one per bay or room.

5.13.34 Telephone System

Function:	Provide telephone for lab-related emergencies and communication.
Use:	Dial the appropriate number for the incident. An emergency phone list is posted at the wired telephone. Be prepared to provide your name, location, and details of the incident.
Location:	A wired handset is found in the Main Aisle near Bay E. Wireless phones are available throughout the cleanroom.

5.13.35 Valve Manifold Box (VMB)

Function:	Exhausted distribution manifold for hazardous gases.
Use:	Automatically managed.
Location:	Service Chases.

5.13.36 Vented Waste Containers

Function: Contain unwanted items that have been used for solvents.

Use: Dispose of all unwanted items used for solvent processing. This includes all cleanroom wipes used to clean up solvents and pre-saturated IPA wipes.

Location: Near each fume hood.

5.13.37 Vesda Monitoring System

Function: Early warning detection for smoke or similar airborne particles.

Use: Automatically monitors.

Location: Detection points in each service chase.

5.13.38 Video System

Function: Live and remote monitoring of the facility. Video is stored for approximately 2 months.

Use: Remote monitoring during an emergency. Also used to investigate safety incidents.

Location: Cameras are located throughout the facility.

5.13.39 Wet Bench

Function: Provide a controlled, exhausted enclosure to isolate personnel from chemical fumes or reactions.

Use: For activities involving most acids and bases. Exhaust must not be in alarm. Use of the dedicated bath is always preferred, but other appropriate containers may be used when necessary. Keep all chemicals at least 6" from the front edge of the bench.

Location: Room 2010N, Bay B, Bay C, and Bay D

5.14 Special Health Considerations

5.14.1 Pacemakers

Equipment in the lab may serve as sources of high voltage, ionizing radiation, ultrasonic interference, or electromagnetic interference, which may affect the normal operation of a pacemaker. Anyone with a pacemaker should consult with your physician before entering the facility.

5.14.2 Human Reproduction/Pregnancy

Some materials in the facility, particularly volatile organic compounds (VOC's) and other process materials can jeopardize reproductive health for both males and females. Lab members who are pregnant or contemplating pregnancy should be aware of such hazards in the lab. The SDS of a material will include known hazards, warnings, and recommended precautions and should be reviewed before use of the material. Lab members (male or female) with concerns should discuss them with their doctor, supervisor, and the Safety Officer.

5.14.2.1 Please refer to the Guidelines for Pregnant Women Working in Laboratories found on the EHS website for additional information.

5.14.3 Chemical and Latex Allergies

Some individuals may have an allergic reaction to latex gloves. The nitrile gloves used in the lab should not have this effect. Other chemicals or materials in the facility may also trigger allergies.

If you suspect an allergic reaction from any source, seek medical attention. Notify Lab Staff and EHS.

5.15 Step Stools

5.15.1 Small step stools are provided by Staff for Lab Member use at certain tools. When used, step stools must remain on the floor. Lab Members should place both feet on the stool.

6 Facility Hazards

No matter where we may be, we are always exposed to hazards. Even the safest environment presents hazards, however, the likelihood of exposure or intensity of effect may be small. In our facility, there are a number of hazards, but many controls and procedures are in place to minimize exposure risk and potential harm. Some of the hazards are inherent with the facility such as electricity, water, fire, or even weather conditions. Other hazards are present due to the processing equipment in the lab such as radio frequency, lasers, ultraviolet light, abrasions, cuts, or crushing. Further hazards are the result of chemicals and other materials used in the lab.

Hazards are generally placed into two general categories: physical and health. Physical hazards may result in immediate physical effects that may or may not be permanent. Health hazards are those that can result in long or short-term health effects. In some cases, it may take years before these effects are noticed. In any case, it is critical that each member of the lab know and understand the hazards in this environment – their sources, effects, correct handling procedures, and appropriate emergency procedures. This section describes such hazards.

6.1 Chemicals

Chemicals, from a regulatory perspective, are defined as any material that is not a common household item. However, the improper use of household items can still be dangerous. Therefore, in addition to the common acids and solvents we traditionally consider as chemicals, industrial grade cleansers, soaps, adhesives, lubricants, powders, etc. are also classified as chemicals. It also includes solid and gaseous items.

Chemicals present a potential risk for injury, since they must be handled (transported, poured, and mixed) as they are used. There is a wide variety of hazards and precautionary measures associated with the different chemicals. The health risks posed by liquid chemicals are physical (fire, explosion), direct contact with the skin and eyes (burns, tissue damage), and inhalation (pulmonary damage or long-term chronic effects). General information about some of these chemicals is included in this document, however, always consult the SDS for detailed information. Know the proper procedures and precautions BEFORE using any chemical.

Lab members are not authorized to bring any chemicals into the facility. Refer to 7.1.7.1 Bringing Chemicals into the Cleanroom.

6.1.1 Incompatible Chemicals

Certain chemicals should not be mixed because a violent reaction may occur. In addition, some chemicals may only be used or stored in plastic containers, while others only in glass. Lab members must know which chemicals and containers are compatible for the chemicals being used. This information will be available in applicable SOP's. If uncertain, ask Lab Staff.

6.1.2 Specific Chemical Hazards

6.1.2.1 Chlorinated Solvents

Chlorinated solvents, such as chlorobenzene and trichloroethylene, are used in various photoresist processes. They pose particular threat to the human body and can cause cancer, organ damage, etc. As with most solvents, they can be easily absorbed through the skin.

Waste from these chemicals should NOT be added to normal solvent waste containers. Waste MUST be managed separately. Rinsing of bottles and other containers must be done very carefully.

6.1.2.2 Cryogenic Liquids

Cryogenic liquids, such as liquid nitrogen, are extremely cold. Contact can cause freezing burns.

6.1.2.3 Flammable Solvents

Flammable solvents, such as acetone, isopropanol, and methanol, have a low flash point. At sufficiently high concentrations, the vapors can easily ignite at room temperature. They present a significant fire hazard. A spilled bottle of acetone could cause a catastrophic fire or explosion.

All solvents should be carefully used inside the fume hoods. Extreme care is necessary when using solvents on or near hot plates, other heat sources, or electrical systems. Hot plates can ignite solvent fumes.

Spilled solvents can react explosively with peroxides, nitric acid, and other chemical oxidizers. They should be contained immediately with spill control pillows. EHS should be contacted immediately for emergency response to assist in the clean up.

6.1.2.4 Glycol Ethers

Commercial photoresists and electron beam resists are dispersed in a variety of solvents. The composition of these mixtures is not generally disclosed on the bottle and may only be found on the SDS.

Photoresists currently used in the lab contain one or more glycol ethers. The two most commonly used are: propylene glycol mono methyl ether (PGME), also known 1-Methoxy-2-propanol and propylene glycol mono methyl ether acetate (PGMEA), also known as 1-Methoxy-2-propanol acetate. Members of this family of chemicals have been shown to be teratogenic. A number of studies funded by IBM and others have found evidence that these chemicals can lead to miscarriage and other reproductive effects.

In addition to teratogenic effects, the liquid and vapor are eye and respiratory irritants and may cause damage to eyes, kidneys, lung, and brain tissue. Primary routes of exposure are inhalation, skin absorption and vapor contact with skin and eyes.

6.1.2.5 HF (Hydrofluoric Acid, Buffered Oxide Etch (BOE), Ammonium Fluoride)

Exposure to concentrated HF is usually very serious, with the potential for significant complications due to fluoride toxicity. Concentrated HF, BOE, or Ammonium Fluoride liquid or vapor may cause severe burns, metabolic imbalances, pulmonary edema, and life-threatening cardiac arrhythmias. Even moderate exposures may rapidly progress to fatality if left untreated.

HF burns require immediate and specialized first aid and medical treatment. Speed is of the essence. Delays in first aid care or medical treatment will likely result in greater damage or, in some cases, may result in a fatal outcome.

Skin contact with acid concentrations between 20% – 50% may not produce clinical signs, pain, or symptoms for one to eight hours. With concentrations less than 20%, the delay may me up to 24 hours. HF concentrations as low as 2% may cause symptoms if the skin contact time is long enough.

HF is similar to other acid in that the initial extent of the burn depends on the concentration, temperature, duration of contact, and size of the burn. Hydrofluoric acid differs, however, from other acids because the fluoride ion readily penetrates the skin, causing destruction of deep tissue layers. Unlike other acids which are rapidly neutralized, this process may continue for many days if left untreated.

Hydrofluoric acid can cause severe burns with destruction or opacification of the cornea. Blindness may result from severe or untreated exposures. Immediate first aid and medical treatment is required.

Because of the strong irritant nature of HF, an individual inhaling HF vapors or fumes will usually experience upper respiratory injury, with mucous membrane irritation and inflammation as well as coughing. All individuals suspected HF inhalation exposure should be observed for pulmonary effects. It has been reported that pulmonary edema (a potentially fatal buildup of fluid in the lungs) may be delayed for several hours, in some cases up to two days. If there is not initial upper respiratory irritation, significant inhalation exposure can generally be ruled out.

HF etches silicon dioxide very well. Therefore, it also etches glass. HF should NEVER be placed in a glass container of any kind – bottle, beaker, dish, etc. Plastic labware resistant to HF is available for this purpose.

HF is to be used ONLY within a chemical wet bench. It is never to be taken out of the bench to be used elsewhere in the lab.

6.1.2.6 Mercury

Mercury is a toxic metal that is liquid at room temperature. Its use in the lab is limited to mercury-based arc lamps found in photolithographic exposure tools.

6.1.2.7 Peroxides

All peroxides are highly oxidizing materials. Considerable energy can be released in their reactions with common materials. Some peroxide compounds are unstable and can

explode. The Hydrogen Peroxide used in the facility has a concentration more than 10 times stronger than that used in medical applications and has a high contact risk. Extreme care must be used when mixing solutions containing peroxides. Peroxides are incompatible with all forms of organic solvents and flammable materials.

6.1.2.8 Piranha

Piranha is a common term used for a mixture of Hydrogen Peroxide and Sulfuric Acid (typically in a 1:3 ratio). The mixture creates an exothermic reaction that can reach 160°C. It is extremely aggressive toward organics materials, such as photoresist or flesh. It is also very corrosive to metallics. It is commonly used in the semiconductor industry for wafer cleaning – especially prior to diffusion processes.

Piranha is difficult to dispose, since the waste continues to react and decompose for a long period of time. It must be cooled before dumping down the drain. In addition, dilution in water will re-initiate the exothermic reaction, further stressing the need for extreme care to be taken.

6.1.2.9 Pyrophorics

Many materials are classified as pyrophoric. They can spontaneously ignite in air. Some are also water reactive, reacting vigorously with water or high humidity, often igniting on contact. These materials must be handled with extreme caution.

6.1.2.10 Tetramethylammonium Hydroxide (TMAH)

Tetramethylammonium Hydroxide (TMAH) is a component in multiple chemicals used in the facility. It's most common use is in dilute (<4%) aqueous solutions for developing photoresists. Since TMAH is a component of such chemicals, it is critical to review the SDS document of any developer to determine if it contains TMAH.

TMAH is highly toxic and there is no effective treatment for exposure. Strong concentrations are not allowed in the facility.

6.2 Compressed Gases

The processing gases used in this facility are generally supplied under high pressure gas cylinders. In most cases, they are housed in special gas cabinets and fitted with a variety of high purity valves, regulators, and flow control devices. Gas cylinders must be treated with respect at ALL times. An enormous amount of energy is contained in the cylinder. Many of the gases are toxic or corrosive which can result in serious health damage. Improper use can result in accidental releases, fires, explosions, contaminated gas, ruined samples, and damaged equipment. Consequently, all components in the facility involved in the delivery of gases are accessible and serviceable by STAFF ONLY.

6.3 Electrical

Electrical shock hazards are present wherever electricity is used. Although equipment is interlocked to prevent operator exposure, you must be aware the electrical hazards for the tool you are using. Burns occur wherever the body completes a circuit connecting the power source with ground. Although the resistance of dry, unbroken skin to electric current is relatively high, the amount of current needed to kill a person is small. It is easy to exceed lethal levels of current, especially if the skin is broken, wet, or damp with sweat.

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

With the exception of most personal electronics devices, any electrical equipment brought into the lab must have prior approval by a Staff Member. The job of the staff member is to ensure that you will be able to use the equipment in a manner that is safe and consistent with laboratory policies. Personal electronics devices that do not require staff approval include: laptops, tablets, cameras, cell phones, and PDA's.

6.4 Light Sources

6.4.1 Lasers

Lasers are intense monochromatic beams of coherent light. In other words, they are beams of a single wavelength of light where all waves are in phase and parallel with each other. This produces a beam that can be very intense where the beam diameter is nearly constant over a long distance. Due to the intensity they can be very damaging to eyes and human tissue.

6.4.2 Ultraviolet Light (UV)

Ultraviolet light (UV) is a radiant energy in the region between visible light and X-ray in the electromagnetic spectrum. The hazards of UV exposure varies upon the wavelength. The various UV sources found in the facility include aligner lamps and plasma systems.

6.4.2.1 Symptoms of overexposure

Overexposure to UV light is generally not observed immediately. Most symptoms increase over time, making it difficult to recognize that overexposure has occurred.

6.4.2.1.1 Severe and mild burns to the skin.

6.4.2.1.2 Skin cancer.

6.4.2.1.3 Painful eyes (similar to grains of sand under the eyelid). UV burns to the eye (actinic keratinitis) can be quite painful, but is generally temporary.

6.4.2.1.4 Accumulative and repeated exposure can result permanent corneal damage.

6.5 Radiation

6.5.1 Ionizing

Not applicable at this time.

6.5.2 Non-Ionizing

6.5.2.1 Lasers

Not applicable at this time.

6.5.2.2 Radio-Frequency

Not applicable at this time.

6.6 Ultrasonic

The use of ultra-frequency sound waves (usually from 20 – 400 kHz) to clean surfaces. This is typically done in a chemical bath where the sound waves create an agitation in the liquid that removes particles from surfaces.

7 Working with Hazardous Materials

7.1 Chemicals

7.1.1 Staff Maintained Chemical Baths

Several chemical baths in the wet benches are maintained by Staff for general use by certified lab members. The chemical, description, location, and change frequency are given in Appendix C, Staff Maintained Chemical Baths. If a lab member suspects the chemical is outdated or contaminated, please contact Staff. Otherwise, Staff will change the chemical at the frequency shown. Lab members may also change the baths, as needed.

7.1.2 General Chemical Use Guidelines

- All chemicals must be labeled (see 7.1.9 Labeling).
- Always read the SDS **before** using a chemical.
  - Understand all handling, storage, use, and safety information.
  - Determine the toxicity and warning properties.
  - Determine the most likely routes of exposure.
  - Determine the required control measures, personal protective equipment, and proper work practices to minimize the risk to exposure.
  - Be prepared for emergencies.
  - If there is any confusion or questions about the SDS, ask Staff.
- Always wear PPE.
- Do not "sniff" to test chemicals.
- NEVER immerse your hands into a chemical.
- ALWAYS empty an opened bottle before opening another of the same chemical.
- NEVER put an empty bottle back into the storage location.
- NEVER place a chemical bottle on the floor.
- Use chemicals only in approved locations, using approved methods.
- Never use acids or bases in a fume hood.
- Never use solvents in a wet bench.
- Don't put your head inside a wet bench or fume hood.
- Keep face away from sink working surface.
- Never store chemicals in the working space of a wet bench or fume hood.
- Don't rest hands/arms on sink.
- In a fume hood, keep all chemicals at least 6 inches behind the plane of the sash.
- Fume hood sashes are to remain down/closed, unless actively using the fume hood.
- Prior to using chemicals in a wet bench or fume hood, PREPARE:
  - Ensure there is adequate exhaust.
  - Obtain and put on all necessary PPE.
  - Obtain all necessary chemical containers.
  - Ensure all chemical containers are properly labeled.
  - Ensure there is adequate space to safely complete the task.
  - If a waste container is necessary, get it BEFORE starting.
  - Finally, obtain the needed chemicals.

- Pour chemicals slowly to prevent "gurgling". This will reduce splashing.
  - Use two hands to support the bottle.
  - Pour chemicals away from your body.
- Never place, move, or transfer an open chemical bottle or container with liquid outside an approved exhausted enclosure (e.g., wet bench or fume hood).
- Clean the work area thoroughly when done.
  - There should be no residual wipes, containers, thermometers, liquids, etc.
  - All items used should be returned to their proper place.
- Chemicals must cool to room temperature before disposal.
- Never move containers with liquids heated above room temperature.
- Chemicals should not be left in hoods or benches for long periods of time.
  - Chemicals that are cooling may remain overnight with an explanatory note.
  - Staff approval is required for any chemicals that need to remain in use overnight.
  - Chemicals to be used frequently throughout the day may remain for re-use.
- Never pour chemicals back into the storage container.
- Do not use cascade rinsers to dispose of unwanted chemicals.
- Always secure the cap on the chemical storage container when not in use.
- Always rinse and dry the outside of a storage container before placing it in a storage location.
- When moving a chemical bottle from a cart, carrier, or within a work space, support it from the bottom.
  - Never lift a bottle only by the handle or neck.
- When placing a bottle on a work surface, it is recommended to place it on a cleanroom wipe to avoid contaminating the work surface from the bottom of the bottle.
- When finished, completely rinse all used glassware or labware.
- Do not use N_2 blow guns near open chemicals.
- Do not use damaged labware.
- Do not attempt to retrieve samples that have slipped or dropped within heated baths.
  - Contact staff for assistance, who will retrieve the sample after the chemical has cooled to room temperature.
- Treat empty, un-rinsed bottles as if they contain the chemical.
- When working with flammable substances, ensure there are NO nearby ignition sources (e.g., electrical equipment, motors, transformers, static electricity, hot surfaces).
- Treat unknown chemicals, even drops on benches and floors, as hazardous.
  - If you cannot identify the chemical, contact Staff for instructions.

7.1.3 Chemical Buddy

When working in a wet bench, ensure there is another lab user in the same bay. Never work alone at a wet bench. A chemical buddy must remain to provide any necessary assistance.

7.1.4 Chemical Mixing

It is often necessary to mix chemicals to create a mixture with specific characteristics. Lab members are only authorized to mix chemicals after according to procedures given in specific SOP's or instructions following approval from Staff. Lab members mixing chemicals without proper training, approval, or compliance to written procedures will be subject to disciplinary action.

7.1.5 Chemical Storage

The lab provides chemical storage in various locations. However, the storage space is limited and must be shared responsibly by the community.

All chemicals are classified into the groups shown in Appendix E, Chemical Category Information. The table includes a storage code. All approved storage locations will include label(s) of allowed classification code(s). In addition, a label of the appropriate classification code(s) will be affixed by staff to every chemical container that enters the cleanroom. To prevent accidental mixing of incompatible materials, every chemical may only be placed in storage locations with the same storage code label.

Chemicals may only be stored in approved locations (those identified with a classification symbol). Chemicals may NOT be stored in dry boxes, desiccators, totes, chemical carts, on benches, or on tables. If you are found to be storing chemicals in non-approved locations, your lab privileges may be suspended or revoked.

NOTE: If you find a container with no classification code label, do NOT use the chemical and contact Staff.

7.1.5.1 Gas/Chem Storage Room

Stock chemicals (those provided by the facility) are delivered to and stored in the Gas/Chem Room. This room is accessible by Staff only. Staff will regularly transport chemicals from the Gas/Chem Room to the Pass-through Storage Cabinets.

7.1.5.2 Pass-through Storage Cabinets

These cabinets are located at the end of Bay D. This is the primary storage location for most unopened chemicals in the cleanroom. There are multiple cabinets, each designated for specific usage. From the service chase, Staff will place needed bottles in the appropriate cabinet.

These pass-through storage cabinets are for unopened containers or bottles only. Containers or bottles that have been opened may not be placed or returned to these cabinets.

7.1.5.3 Refrigerator

The effectiveness of photoresists degrade over time, especially when left at elevated temperatures. It is recommended that photoresists not in use be stored under refrigeration. A refrigerator for this purpose is available in Bay C. Storage space is limited and Staff will regularly purge the refrigerator of expired or unnecessary chemicals.

7.1.5.4 User Supplied Chemicals

In general, the lab cannot provide users with dedicated storage locations for user-supplied chemicals. These chemicals should be stored with other working chemicals with plain and clear labeling showing ownership.

7.1.5.5 Working Chemicals

It is rare that a user will consume an entire bottle of a chemical, so there is normally some residual chemical in the original bottle. We refer to the residual as working chemical.

Space is provided in the wet benches and fume hoods for storage of working chemicals. There are drawers under the wet benches with compartments for specifically labeled

chemicals. There are cabinets under the fume hoods for storage, too. In ALL cases, the screw-top lid must be snuggly tightened before placing the bottle in the storage space.

7.1.6 Chemical Supplies

The facility stocks and supplies those chemicals commonly used for processing. Users are not allowed to provide their own supply of these chemicals or segregate any for private use.

Specialty chemicals, including some photoresists, have specific uses by lab members and are not supplied by the lab. Lab members are responsible to provide these chemicals for themselves – AFTER ensuring they are authorized for use in the lab.

7.1.7 Chemical Transport

Only cleaning chemicals are allowed in the Gowning Room or Conference Room. NEVER bring other chemicals into these rooms. Chemicals may only enter the cleanroom through the Gas/Chem Storage Room and will require staff support. It is also the responsibility of the lab member to ensure that all federal, state, and university regulations are satisfied for shipping, delivery, and storage of the material prior to it entering the facility.

7.1.7.1 Bringing Chemicals into the Cleanroom

NOTE: Lab members are not authorized to transfer liquid materials in or out of the cleanroom. Only Lab Staff may do so.

7.1.7.1.1 Contact Staff in advance to coordinate when to bring the chemical into the cleanroom.

7.1.7.1.2 Following University chemical transport procedures, deliver the chemical to a member of the Lab Staff.

- Secondary containment must be used in order to contain any possible spill of the hazardous material being transported.
- Incompatible chemicals should be separated into different secondary containers.
- Hazardous materials should be transported in carts, not carried.
- All containers should be clearly labeled with content information.
- Materials needed to contain or clean-up a spill, such as sorbent pads, gloves, and eye protection, should be readily available.

7.1.7.1.3 Lab Staff will confirm authorization for the material, affix all appropriate labels, and place the material in the Gas/Chem Storage Room.

7.1.7.1.4 Lab Staff will transport the material from the Gas/Chem Storage Room to the Chemical Pass-Through Cabinet.

7.1.7.1.5 Lab member may then remove the chemical from the Chemical Pass-Through Cabinet and transport it throughout the facility for use and storage.

7.1.7.2 Removing Chemicals from the Facility

✪ ✪ ✪ ✪ ✪ ✪ ✪ **CAUTION** ✪ ✪ ✪ ✪ ✪ ✪ ✪

Removal of chemicals from the facility without written permission is considered theft and will result in the loss of privileges and potential legal action.

✪ ✪ ✪ ✪ ✪ ✪ ✪ **CAUTION** ✪ ✪ ✪ ✪ ✪ ✪ ✪

7.1.7.2.1 Contact Staff in advance to coordinate removal of the chemical from the facility.

7.1.7.2.2 Ensure the lid on the container is secured properly.

7.1.7.2.3 Place the container in the Chemical Pass-Through Cabinet.

7.1.7.2.4 Lab Staff will transport the material from the Chemical Pass-Through Cabinet to the Gas/Chem Storage Room.

7.1.7.2.5 Lab Staff will deliver the chemical to the requestor.

7.1.7.2.6 Following University chemical transport procedures, deliver the chemical to an approved storage location.

7.1.7.3 Transporting Chemicals Within the Facility

Care must be taken when transporting chemicals (wet or dry) within the facility to ensure the safety of yourself and others. All chemicals – even water – pose a hazard in the lab and must be handled with caution at all times.

Any chemical (wet or dry) being moved outside a wet bench or fume hood, MUST be in a bottle/container with a closed, screw-top lid. Chemicals in open containers or containers with unsecured lids may NOT be carried throughout the lab. This includes water! The exception is cleaning chemicals in buckets used by the custodial staff.

7.1.7.3.1 Chemical Bottle Carrier

7.1.7.3.1.1 **If transporting only one bottle,** you may use a chemical bottle carrier (see 5.13.5).

7.1.7.3.1.2 Put a pair of white nitrile gloves over the blue nitrile gloves.

7.1.7.3.1.3 Remove the chemical bottle from the storage location.

7.1.7.3.1.4 Place the bottle in the chemical bottle carrier.

7.1.7.3.1.5 Twist the lid of the carrier until it snaps into the handle.

7.1.7.3.1.6 Holding the bucket with BOTH hands, carry the chemical to the desired location.

7.1.7.3.1.7 Twist the lid of the carrier to unsnap it from the bottom.

7.1.7.3.1.8 Remove the lid from the carrier.

7.1.7.3.1.9 Remove the chemical bottle from the carrier.

7.1.7.3.1.10 Return the carrier to its storage location.

7.1.7.3.1.11 Remove and discard the white nitrile gloves.

7.1.7.3.2 Chemical Transport Cart

7.1.7.3.2.1 If transporting one or more bottles, use a chemical transport cart.

NOTE: There are two types of chemical transport carts. One is made entirely of stainless steel and is used for flammables. The other is made of stainless steel with plastic inserts and is used for corrosives. Chemical category labels are found on each cart. Use only the cart that matches the label for the chemical being transported.

7.1.7.3.2.2 Obtain the chemical transport cart with the chemical classification symbol identical to the chemical(s) being transported.

7.1.7.3.2.3 Put a pair of white nitrile gloves over the blue nitrile gloves.

7.1.7.3.2.4 Remove the chemical bottle(s) from the storage location.

7.1.7.3.2.5 Place the bottle(s) in the chemical cart into a compartment that will securely hold the bottle(s) upright.

7.1.7.3.2.6 Holding the brake release bar of the cart with BOTH hands, roll the cart to the desired location.

7.1.7.3.2.7 Remove the chemical bottle(s) from the cart.

7.1.7.3.2.8 Return the cart to its storage location.

7.1.7.3.2.9 Remove and discard the white nitrile gloves.

7.1.8 Hot Plates

Hot plates are basic pieces of lab equipment, but they pose substantial danger – even when used carefully. Hotplates are used for two primary purposes in the lab – heating chemicals and baking coated substrates. They can pose a hazard for fire and/or chemical exposure. Only use a hot plate for its designated purpose.

Hot plates in use should be regularly monitored. On occasion, it may be necessary to leave a hotplate with chemicals unattended for extended periods of time. It is essential that such chemicals are properly labeled and all necessary precautions applied to prevent overheating or excessive evaporation.

Only pyrex or quartz containers (never plastic or teflon) should be used on hot plates, regardless of the temperatures being used. A thermometer should be used to confirm and control the temperature of the heated chemical.

!!!!!! WARNING !!!!!!

Since Hydrofluoric Acid will etch the pyrex or quartz container, no chemical containing HF may be used on hot plates.

In addition, due to flammability concerns, only solvents with a flash point above 130ºF (54°C) may be heated on a hot plate.

- Do not allow chemicals in glassware to evaporate completely while being heated.
- Solvents may only be heated in a fume hood.
- Do not leave heated solvents unattended.
- Do NOT place hot plates within 6” of the front of the wet bench or fume hood.
- Do NOT place hot plates where they block or interfere with dedicated baths in a wet bench.

7.1.9 Labeling

Labels are required on all containers that are holding chemicals, whether for storage or in use. Contents of any unlabeled containers are considered waste and will be discarded appropriately.

- Labels are to be attached to the container, not the lid.
- Pre-printed labels on stock chemical bottles are acceptable.
- Staff will affix a chemical storage label to each container before it enters the cleanroom.
-

- See Appendix to this Lab User Guide for a Chemical Identification Label.
- Chemical Identification Labels are available at points of expected use for containers containing chemicals that are in use. These labels are to be filled out completely and legibly, then attached to the container – before any chemical is placed in the container.
- Adhesive labels are available for user-supplied chemicals. These labels are to be filled out completely and legibly, then attached to the container before it enters the cleanroom.

NOTE: The label for user-supplied chemicals will include the name of the owner, contact information, chemical or product name, authorized user(s), date of lab entry, and date for removal.

7.1.10 Labware

Clean glassware and plastic ware is available for community use in the cleanroom. Users are not authorized to keep a private stash of glassware for their own use. Labware is washed in a special dishwasher and returned to the storage rack by Lab Staff.

7.1.10.1 Usage

- Inspect all labware for flaws or cracks before use. Discard any damaged labware.
- Do not try to force glass or quartz items into or onto tubing, connections, flasks, etc.
- Do not try to force other items into or onto glass or quartzware.
- For vacuum systems, use only glassware that has been designed for that specific system and purpose.

7.1.10.2 Cleaning

Although Lab Staff will clean the labware in the dishwasher, users are responsible to prepare the labware for cleaning.

7.1.10.2.1 After removing the chemical from the labware, rinse it a minimum of three times.

7.1.10.2.2 Refer to section 8.1 Chemical Waste Disposal for the proper rinsing procedures for the specific chemical(s) used.

7.1.10.2.3 Using cleanroom wipes, remove all liquid residues.

7.1.10.2.4 Place the labware on the "To Be Cleaned" shelf near the dishwasher.

7.1.11 PPE

PPE used when working with chemicals can become contaminated with chemical residues. Caution is to be taken to prevent these residues from spreading to other people or items in the lab. When wearing chemical PPE, never touch items such as phones, notebooks, pens, tweezers, keyboards, etc. Only touch those items necessary for the specific task. While wearing PPE, remain in the bay near the wet bench or fume hood.

NOTE: Other than an evacuation, persons wearing PPE should NOT be in the aisle or bays without a wet bench or fume hood.

7.1.11.1 Wet Bench

7.1.11.1.1 When working at a wet bench, the minimum PPE required is:

- Safety Glasses
- White nitrile gloves (over the blue nitrile)
- Full-sleeve apron
- Face Shield
- Chemical resistant gloves (over the white nitrile)

7.1.11.1.2 Put on a pair of new white nitrile gloves (over the blue nitrile).

7.1.11.1.3 Prior to use, inspect each item for cleanliness, tears, or leaks.

7.1.11.1.3.1 Ensure there is no residual liquid inside the chemical resistant gloves.

7.1.11.1.3.2 Check the chemical resistant gloves for leaks by inflating with nitrogen or air.

7.1.11.1.3.3 Discard and replace any item that is suspected as defective.

7.1.11.1.4 Put on the apron.

7.1.11.1.5 Tie the apron so it is snug around the waist.

7.1.11.1.6 Put the face shield on the head.

7.1.11.1.7 Adjust the headgear for comfort.

7.1.11.1.8 Lower the visor of the face shield to fully cover the face.

7.1.11.1.9 Without touching the inside of the gloves with the other hand, put on the chemical resistant gloves.

!!!!!! WARNING !!!!!!

NEVER immerse hands into a chemical. Gloves are chemical resistant, NOT chemical proof.

7.1.11.1.10 While wearing the PPE, remain at the wet bench. This is important to protect the rest of the lab and others from coming in contact with chemicals that may have splashed.

7.1.11.1.10.1 Do not touch anything unrelated to the task.

7.1.11.1.11 If a splash or drip of chemical is observed on the PPE or any work surface, use a cleanroom wipe to remove it immediately.

7.1.11.1.11.1 Remove, discard, and replace PPE items if damaged.

7.1.11.1.12 While working, keep gloves clean and dry.

7.1.11.1.12.1 Use the glove wash and cleanroom wipes, as necessary.

7.1.11.1.12.2 Ensure liquids do not get inside the gloves.

7.1.11.1.13 When complete, before removing the PPE use wipes to remove all chemical residues and ensure everything is dry.

7.1.11.1.14 Using the glove wash, rinse the outside of the gloves.

7.1.11.1.14.1 Ensure liquids do not get inside the gloves.

7.1.11.1.14.2 Using cleanroom wipes, dry the gloves.

7.1.11.1.15 Remove the gloves first – without touching the inside of the gloves.

7.1.11.1.16 Loosen the headgear of the face shield.

7.1.11.1.17 Remove the face shield and place it in the storage location.

7.1.11.1.18 Remove the apron and place it in the storage location.

7.1.11.1.19 Remove and discard the white nitrile gloves.

7.1.11.2 Fume Hood

7.1.11.2.1 When working at a fume hood, the minimum PPE required is:
- Safety Glasses
- White nitrile gloves (over the blue nitrile)

7.1.11.2.2 Put on a pair of new white nitrile gloves.

7.1.11.2.3 Do NOT touch anything with the white nitrile gloves that is unrelated to the task.

7.1.11.2.4 Complete the necessary activities.

7.1.11.2.5 If white nitrile gloves become contaminated, remove, discard, and replace them immediately. Repeat as necessary.

7.1.11.2.6 Remove and discard the white nitrile gloves.

7.1.12 Respirators

Respirators are not authorized for use in the facility. There are no procedures in the lab that warrant the use of a respirator by lab staff or lab members.

It is possible that emergency personnel may require the use of respirators during an incident. They are trained, certified, and authorized to use them or other gear, as necessary.

7.2 Compressed Gases

7.2.1 Handling Gas Cylinders

Only Staff is authorized to handle, install, or change gas cylinders or adjust regulator pressures.

7.3 Cryogenics

7.3.1 PPE

7.3.1.1 When working with any cryogenic liquid, the minimum PPE required is:
- Cryogenic gloves (over the blue nitrile)
- Face Shield
- Safety Glasses

7.3.2 Precautions

!!!!!! WARNING !!!!!!

Cryogenic materials can cause permanent eye damage.

- Do not overfill a dewar.
- Do not spill cryogenic liquids on the floor or other surfaces.
- NEVER use cryogenic liquids in confined air space.
- When pouring, pour slowly.
- Use only staff-supplied funnels.

7.3.3 Put on safety glasses.

7.3.4 Put the face shield on the head.

7.3.5 Adjust the headgear for comfort.

7.3.6 Put on the cryogenic gloves (over the blue nitrile).

7.3.7 Complete the necessary activities.

7.3.8 When complete, remove the cryogenic gloves.

7.3.9 Loosen the headgear of the face shield.

7.3.10 Remove the face shield and place it in the storage location.

7.4 Light Sources

7.4.1 Lasers

7.4.1.1 The use of lasers requires special training described in an applicable SOP.

7.4.1.2 Never bypass any safety interlocks.

7.4.2 UV Safety Guidelines

Most of the mask and wafer aligners utilize mercury-based UV lamps. These lamps present a hazard for both mercury and UV exposure.

7.4.2.1 Protective eye wear is required. The safety glasses required in the cleanroom will generally provide sufficient protection to minor reflected exposure. They will not protect against direct exposure to the eye.

7.4.2.2 When working with a UV-emitting source, protect yourself and others from direct radiation.

7.4.2.2.1 Signs of potential exposure should be prominently displayed.

7.4.2.2.2 Never look directly at the source.

7.4.2.2.3 Avoid looking at reflections of the source from metal or shiny surfaces.

7.4.2.2.4 Never bypass any safety interlocks.

8 Waste Handling

8.1 Chemical Waste Disposal

Various chemicals are used in this facility. Just as it is important not to mix certain chemicals for use, it is equally important not to mix them as waste. Dangerous reactions or environmental impacts can result from improper waste.

Due to the Acid Waste Neutralization system, most chemicals used in the wet benches may be dumped into the drain. The AWN system will treat the waste stream to ensure it meets local standards before being released into the sewer system. Other chemicals must be collected in dedicated waste containers, generally stored inside the fume hoods. These containers are then delivered to EHS for appropriate disposal.

It is critical that lab members follow the appropriate waste procedures as described below. These procedures and any necessary supplies must be understood and available BEFORE using the chemical. Waste containers are labeled for generic types of chemicals and do not list specific chemical or product names. If there is any uncertainty, contact Lab Staff prior to using the chemical.

Always fill a waste container to the marked full region before using another waste container. If you ever observe any unusual reactions (bubbling, excessive vapors, an expanding container, etc.), **STOP**, notify Lab Staff immediately and keep all lab personnel away from the fume hood and container. Lab Staff will coordinate with EHS for the removal of all full waste containers.

Waste procedures are defined for the chemical classification categories. Refer to Appendix E, Chemical Category Information for the disposal method each category.

✪ ✪ ✪ ✪ ✪ ✪ ✪ **CAUTION** ✪ ✪ ✪ ✪ ✪ ✪ ✪

Never place or pour solvents into a wet bench or drain. Solvents are only to be used in fume hoods labeled for such use.

✪ ✪ ✪ ✪ ✪ ✪ ✪ **CAUTION** ✪ ✪ ✪ ✪ ✪ ✪ ✪

8.1.1 Aspirator

Acids and bases may only be used within the wet benches. All wet bench drains are connected to the AWN system. Acids and bases are discarded into the drains by using an aspirator. Some precautions are necessary to maintain safety.

- Acids and bases may only be removed from usage containers (e.g., beakers, baths) using an aspirator.
- Never pour chemicals directly into the drain.
- Since each bench has a single aspirator, only one chemical can be discarded at a time. Never attempt to discard multiple chemicals simultaneously.

8.1.1.1 Ensure the chemical is at room temperature.

8.1.1.2 Grasping the aspirator handle, remove the end of the aspirator from the storage location.

8.1.1.3 Hold the aspirator handle at all times until the aspirator is returned to the storage location.

!!!!!! WARNING !!!!!!

NEVER leave the aspirator unattended.

8.1.1.4 Turn on the aspirator.

8.1.1.5 Place the end of the aspirator in water for at least 30 seconds.

8.1.1.6 Place the end of the aspirator in the chemical bath and hold it in place.

8.1.1.7 While holding aspirator in place, wait for the chemical to be aspirated from the bath.

8.1.1.8 Using a spray wand, carefully rinse the bath thoroughly.

8.1.1.9 Aspirate the rinse water from the bath.

8.1.1.10 Place the end of the aspirator in water for at least 30 seconds.

8.1.1.11 Turn off the aspirator.

8.1.1.12 Place the end of the aspirator to the storage location.

8.1.2 CS Unwanted Materials Container (Chlorinated Solvents)

Chlorinated solvents do not rinse well from bottles and other glassware. To properly remove the solvent residue from these containers, they should be thoroughly pre-rinsed with acetone, then with water.

8.1.2.1 Remove all heat sources from the solvent.

8.1.2.2 Ensure the chemical is at room temperature.

8.1.2.3 Obtain a waste container labeled "CS Waste Container".

8.1.2.4 Remove the lid from the waste container.

8.1.2.5 Slowly pour the waste into the waste container.

8.1.2.6 Using acetone, thoroughly pre-rinse the labware.

8.1.2.7 Pour the pre-rinse into the waste container.

8.1.2.8 Repeat 8.1.2.6 through 8.1.2.7 at least twice (a minimum of three rinses).

8.1.2.9 Securely replace the lid of the waste container.

NOTE: Fines of $10,000 per day can be levied against the facility for violation of this requirement.

8.1.2.10 Rinse the labware with water, allowing the waste to go down the drain.

8.1.3 GE Unwanted Materials Container (Gold Etch)

8.1.3.1 Ensure the chemical is at room temperature.

8.1.3.2 Obtain a waste container labeled "GE Waste Container".

8.1.3.3 Remove the lid from the waste container.

8.1.3.4 Slowly pour the waste into the waste container.

8.1.3.5 Using water, thoroughly rinse the labware.

8.1.3.6 Pour the rinse into the waste container.

8.1.3.7 Repeat 8.1.3.5 through 8.1.3.6 at least twice (a minimum of three rinses).

8.1.3.8 Securely replace the lid of the waste container.

8.1.4 MS/NS/PR/SO Unwanted Materials Container (Water Miscible Solvents, Non-Water Miscible Solvents, Photoresist, and Spin-On Materials)

The facility does not have a treatment system for solvents. Solvent waste must be collected manually. In addition, some solvents cannot be mixed. Accordingly, there are appropriately labeled multiple waste collection containers.

8.1.4.1 Remove all heat sources from the solvent.

8.1.4.2 Ensure the chemical is at room temperature.

8.1.4.3 Obtain a waste container labeled "MS/NS Waste Container".

8.1.4.4 Remove the lid from the waste container.

8.1.4.5 Slowly pour the waste into the waste container.

8.1.4.6 If the chemical is classified as MS (Miscible Solvent), skip to 8.1.4.10.

8.1.4.7 Using acetone, thoroughly pre-rinse the labware.

8.1.4.8 Pour the pre-rinse into the waste container.

8.1.4.9 Repeat 8.1.4.7 through 8.1.4.8 at least twice (a minimum of three rinses).

8.1.4.10 Securely replace the lid of the waste container.

NOTE: Fines of $10,000 per day can be levied against the facility for violation of this requirement.

8.1.4.11 Rinse the labware with water, allowing the waste to go down the drain.

8.2 Compressed Gas Cylinders

In general, Staff is responsible to return all compressed gas cylinders for reuse. On occasion, lecture bottles or non-returnable cylinders are used. Even if they are advertised as disposable, they must never be placed in the trash. Upon purchase of a cylinder, ensure the vendor agrees in writing to accept its return – even if it is advertised as non-returnable.

8.3 Contaminated Solid Waste Disposal

8.3.1 Acids and Bases

8.3.1.1 All waste of wipes, gloves, or other items that have acids or bases on them should be placed in standard trash cans.

8.3.1.1.1 Any items that have dripping liquids should be thoroughly rinsed with water prior to disposal.

8.3.2 Chlorinated Solvents

8.3.2.1 Allow chlorinated solvents to thoroughly evaporate from wipes, gloves, or other items.

8.3.2.2 After all liquid residues have evaporated, place the item(s) in a standard trash can.

8.3.3 Photoresists

Photoresists contain solvents whose vapors can pose various risks. It is important to keep these vapors from the breathing air and incompatible materials. Special trash cans labeled "Photoresist/Solvent Solid Waste" are located throughout the lab that are connected to the exhaust system to prevent fumes from entering the breathing air.

8.3.3.1 All waste of wipes, gloves, foil, or other items that have photoresist or other spin-on polymers should be placed only in the "Photoresist/Solvent Solid Waste" trash cans.

8.3.4 Solvents

Many solvents release vapors that can pose various risks. It is important to keep these vapors from the breathing air and incompatible materials. Special trash cans labeled "Photoresist/Solvent Solid Waste" are located throughout the lab that are connected to the exhaust system to prevent fumes from entering the breathing air.

Olfactory fatigue is when an odor is no longer noticed after continued exposure. If a solvent odor is noticed, follow the procedures in 9.17 Odors in the Lab.

8.3.4.1 All waste of wipes, gloves, or other items that have solvents on them should be placed only in the "Photoresist/Solvent Solid Waste" trash cans.

8.4 Empty Chemical Bottle Disposal

Procedures for bottle disposal are defined for the various chemical classification categories. Refer to Appendix E, Chemical Category Information for the chemical(s) being used. Some chemicals require an acetone pre-rinse before the bottle can be washed with water. The bottle washer is the preferred and recommended method to wash the bottle. However, the manual wash procedure is also acceptable.

8.4.1.1 Acetone Pre-Rinse

This procedure only applies to those bottles where the Bottle Disposal is shown as "Acetone Pre-Rinse" in Appendix E, Chemical Category Information. (Chemical labels will be white text on black background.)

8.4.1.1.1 Select a matching waste container for the chemical in the bottle (see Appendix E, Chemical Category Information).

8.4.1.1.2 Remove the lid of the waste container.

8.4.1.1.3 Remove the lid of the chemical bottle.

8.4.1.1.4 Pour any residual chemical into the appropriate waste container.

8.4.1.1.5 Using a squeeze bottle, -pre-rinse the inside of the bottle with acetone.

8.4.1.1.5.1 Apply liquid to the inside of the rim for the full 360°, allowing the acetone to run along the inside of the bottle.

8.4.1.1.6 Replace the lid on the chemical bottle.

8.4.1.1.7 While holding the lid and bottle securely, tip the bottle on its side and gently roll the bottle to rinse all interior surfaces of the bottle.

8.4.1.1.8 Remove the lid and pour the pre-rinse into the waste container.

8.4.1.1.9 Repeat 8.4.1.1.5 through 8.4.1.1.8 at least twice (a minimum of three rinses).

8.4.1.1.10 Using a spray wand or faucet, carefully rinse the outside of the bottle and lid.

8.4.1.1.11 Using a cleanroom wipe, dry the lid and bottle.

8.4.1.1.12 Discard the lid.

8.4.1.1.13 Wash the bottle per 8.4.1.2 or 8.4.1.3.

8.4.1.2 Bottle Washer

8.4.1.2.1 Transport the empty bottle to the bottle wash station in Bay D.

8.4.1.2.2 Remove the lid.

8.4.1.2.3 Rinse the lid with water, completely filling it.

8.4.1.2.4 Pour the rinse water down the drain.

8.4.1.2.5 Repeat 8.4.1.2.3 through 8.4.1.2.4 at least twice (a minimum of three rinses).

8.4.1.2.6 Using a cleanroom wipe, dry the lid and discard it.

8.4.1.2.7 Raise the cover to the bottle wash station.

8.4.1.2.8 Invert the bottle and place it in the bottle wash station.

8.4.1.2.9 Lower the cover.

8.4.1.2.10 Start the bottle washer.

8.4.1.2.11 Wait for the wash cycle to complete.

8.4.1.2.12 Raise the cover and remove the bottle.

8.4.1.2.13 Using a cleanroom wipe, dry the outside of the bottle.

8.4.1.2.14 Using a marker, scribble over the name of the chemical on the label and write "Empty/Rinsed".

8.4.1.2.15 Place the bottle in the trash can.

8.4.1.3 Manual Wash

8.4.1.3.1 Transport the empty bottle to a wet bench.

8.4.1.3.2 Remove the lid.

8.4.1.3.3 Using a spray wand or faucet, carefully fill the bottle completely with water.

8.4.1.3.4 Carefully pour the water down the drain.

8.4.1.3.5 Using a spray wand or faucet, carefully fill the bottle at least ½ full.

8.4.1.3.6 Replace the lid.

8.4.1.3.7 While holding the lid and bottle securely, gently shake or roll the bottle to rinse all interior surfaces of the bottle.

8.4.1.3.8 Remove the lid and drain the water.

8.4.1.3.9 Repeat 8.4.1.3.5 through 8.4.1.3.8 at least twice (a minimum of three rinses).

8.4.1.3.10 Using a spray wand or faucet, carefully rinse the outside of the bottle and lid.

8.4.1.3.11 Using a cleanroom wipe, dry the lid and discard it.

8.4.1.3.12 Using a cleanroom wipe, dry the outside of the bottle.

8.4.1.3.13 Using a marker, scribble over the name of the chemical on the label and write "Empty/Rinsed".

8.4.1.3.14 Place the bottle in the trash can.

8.5 Non-contaminated Solid Waste Disposal

8.5.1 All waste that is not described in other sections should be placed in the standard trash cans.

8.6 Sharps Disposal

If not disposed of properly, items that are sharp can injure the cleaning staff or others. Sharp waste should never be placed in the trash cans. Examples of sharps include:

- Broken Glassware
- Glass Slides
- Photomasks, partial or whole
- Razor Blades
- Wafers, partial or whole

8.6.1 Any trash that is sharp or can become sharp should be deposited into a red Sharps Bin located throughout the lab.

8.6.2 Exercise caution when handling sharps or broken glassware to prevent cuts or abrasions.

8.6.2.1 Use a vacuum or brush/dust pan to collect smaller pieces.

8.6.3 As much as possible, rinse any contaminated glass before placing it into the Sharps Bin.

8.7 Thermometers (Mercury)

Mercury thermometers are not allowed in the facility.

9 Emergency Response

While the goal of the lab is zero emergencies, the nature of the facility occasionally results in emergency situations from both internal and external sources. This manual and all lab policies are designed to provide a safe working environment and minimize potential emergencies. Users creating an elevated risk for emergencies will be subject to disciplinary action, which may include expulsion from the lab. All users are expected to appropriately respond to any emergency as documented in this manual.

9.1 General Guidelines

NOTE: Under an emergency, **personal safety is the ultimate priority**. Should the incident occur within the facility, cleanroom and facility protocols or research activities are NOT to interfere with life safety measures or necessary emergency response procedures.

- NEVER place yourself at risk trying to assist others or contain an incident.
- If you call emergency personnel or staff to report an emergency, always give the following information:
  - Your name
  - Exact location of the incident
  - Description of the incident
  - Number of people involved
  - How long since the incident was identified
- If the incident is an immediate hazard to life or health:
  - Evacuate the area immediately.
  - Contact University Police.
  - Report the details of the incident.

9.2 Evacuations

Under various circumstances it is necessary to evacuate the facility. These evacuations may be scheduled or unscheduled. In most cases, it may be necessary to evacuate the facility. In a few cases, the evacuation may be limited to a portion of the lab. Facility evacuations will be announced by light strobes and audible alarms from the Fire and/or HPM Alarm Systems. Limited evacuations will generally be announced by people within the facility.

9.2.1 Limited Evacuation

9.2.1.1 Follow the instructions given by Lab Staff or other qualified lab member.

9.2.1.2 Stay away from affected area until Lab Staff approves re-entry.

9.2.2 Scheduled/Unscheduled Evacuation

9.2.2.1 Without delay determine the status of any equipment or samples you are using in the immediate area.

9.2.2.2 If physical risk exists to equipment, samples, or body, take no more than 2 seconds to eliminate the risk (abort the tool, place samples in water, etc.).

9.2.2.3 Leave all items in the lab.

9.2.2.4 Do NOT remove any cleanroom clothing or PPE.

9.2.2.5 Quickly, but calmly walk to the nearest exit (see Appendix H, Emergency Evacuation Map).

9.2.2.6 Without placing yourself in danger, assist others as necessary.

9.2.2.7 Exit the facility.

9.2.2.8 Proceed to the Nanofab Assembly Location Point (see Appendix G, Nanofab Assembly Location Map).

9.2.2.9 Be prepared to discuss any information you have regarding the incident with Emergency Personnel or Lab Staff.

9.2.2.10 Remain at the Assembly location point until instructed otherwise by Lab Staff or Emergency Personnel.

9.2.2.11 Remove all cleanroom clothing.

9.2.2.12 Cleanroom clothing should be collected and placed in the laundry bin when re-entry is authorized.

9.2.2.13 Do not attempt to re-enter the building until authorized by Emergency Responders or Facilities Management for the building.

9.3 Incident Reporting

In addition to normal emergency response, all accidents involving chemicals and/or personal injury must be reported to Lab Management in writing as soon as appropriate. Explanations should include the nature of the event, the procedures followed or not followed, all individuals involved and suggested actions to prevent similar events from recurring. Under some circumstances, additional paperwork may be required.

9.3.1 Member Responsibility

9.3.1.1 Any lab member who has been (or possibly) injured or exposed to hazardous materials is required to seek medical attention promptly.

9.3.1.1.1 Obtain written approval from the doctor, confirming you are fit, able, and medically authorized to work in the cleanroom.

9.3.1.2 Report the incident to Staff as quickly as possible.

9.3.1.2.1 **If the incident involves fatalities or disabling, significant, or serious injuries,** contact EHS and Staff **IMMEDIATELY**.

9.3.1.3 Follow the procedures in section 5.8 Incident Reporting.

9.3.1.4 Submit originals or copies of the required documents to the Safety Officer or Cleanroom Supervisor.

NOTE: The member(s) will not be allowed to re-enter the facility until this documentation has been provided.

9.3.2 Staff Responsibility

Staff is not responsible to determine if a person has been injured or exposed to a hazardous material. However, Staff is responsible to determine if they ***suspect*** an injury or exposure has occurred.

9.3.2.1 **If, through investigation, Staff determines an injury or exposure may have occurred,** the lab member(s) should seek medical attention as soon as possible.

9.3.2.2 Staff will assist the member(s) to ensure the necessary procedures are completed.

9.3.2.3 **If the incident involves fatalities or disabling, significant, or serious injuries**, contact EHS **IMMEDIATELY**.

9.3.2.3.1 It is the responsibility of EHS to report such incidents to the Utah Department of Occupational Health and Safety within 8 hours of occurrence.

9.4 Bomb Threat

9.4.1 Evacuate the building as per section 9.2.2 Scheduled/Unscheduled Evacuation.

9.5 Broken UV Lamp

When an UV arc lamp breaks, the sound of shattering glass can be heard, thus releasing mercury into the room.

!!!!!! WARNING !!!!!!

Do NOT attempt to open the lamp housing.

9.5.1 Immediately evacuate the bay of all persons.

9.5.2 Contact a Staff Member.

9.5.3 Staff will coordinate clean-up and disposal of the broken lamp.

9.5.4 Do not enter the bay until authorized by Staff.

9.6 Building Alarms

There are two primary alarm systems for the facility – the building fire alarm and the facility HPM alarm. The building fire alarm can be triggered from anywhere within the SMBB and will activate flashing white strobe lights and audible horns. The facility HPM alarm is specific only to the UTAHNANOFAB and can initiate the building fire alarm. The facility HPM alarm will activate flashing blue strobe lights and audible horns. In some cases, both the building fire alarm and the facility HPM alarm may be activated.

Either alarm system will notify university police immediately, who will then dispatch emergency responders. In addition, the fire doors at the south end of the viewing aisle will close automatically to prevent anyone from entering the viewing aisle.

9.6.1 Respond to All Alarms

9.6.1.1 All alarms should be treated as real. Failure to evacuate can result in disciplinary action. Occasional testing of the systems will be clearly announced in advance to avoid unnecessary evacuations. Unless specifically notified in advance, the alarm is considered as real and everyone is required to evacuate immediately.

9.6.2 *Fire and/or HPM*

Evacuate the building as per 9.2.2 Scheduled/Unscheduled Evacuation.

9.6.3 *AWN*

On occasion, there may be a problem with the Acid Waste Neutralization system. Although there are no audible or visual indicators in the cleanroom, Staff will be notified and, in turn, will notify lab members. When this occurs, the use of any wet bench is prohibited. Under this condition, no solutions, including water, of any kind may be aspirated, drained, or poured into the drain of a wet bench.

NOTE: Safety showers and eyewashes may be used, as necessary.

9.6.3.1 In a wet bench, turn off and suspend use all faucets, rinsers, bottle washers, and spray guns.

9.6.3.1.1 Use the glove wash only as necessary to rinse chemical resistant gloves.

9.6.3.2 If a fume hood, do not allow any chemicals or water in the sink.

9.7 Chemical Exposure

9.7.1 *Helping a Chemical Contact Victim*

✪ ✪ ✪ ✪ ✪ ✪ ✪ **CAUTION** ✪ ✪ ✪ ✪ ✪ ✪ ✪

Anyone assisting a victim of chemical exposure MUST wear all necessary PPE to prevent personal exposure. This buddy is responsible to ensure the following procedures are completed.

✪ ✪ ✪ ✪ ✪ ✪ ✪ **CAUTION** ✪ ✪ ✪ ✪ ✪ ✪ ✪

9.7.2 *General*

9.7.2.1 Chemical Splash in Eyes

9.7.2.1.1 Move to the nearest eye wash station.

9.7.2.1.2 Activate the eye wash by pushing the handle or lowering the eye wash fixture.

9.7.2.1.3 Remove the face shield, safety glasses and/or prescription glasses, as needed.

9.7.2.1.4 **If wearing contact lenses**, remove them while rinsing.

9.7.2.1.4.1 The contact lenses should then be discarded.

9.7.2.1.5 Rinse the affected area for a minimum of 15 minutes.

9.7.2.1.5.1 **Using clean gloves**, hold the eyelids open.

9.7.2.1.5.2 Continuously rotate the eyeball in all directions (up and down, side to side).

9.7.2.1.6 Call 911.

9.7.2.1.7 Request an ambulance.

9.7.2.1.8 Provide the emergency responders with a copy of the SDS.

9.7.2.1.9 Notify Staff of the incident.

9.7.2.1.10 Complete an incident report (see section 5.8 Incident Reporting).

9.7.2.2 Small Area of Skin Contact

9.7.2.2.1 Move to the nearest emergency shower.

9.7.2.2.2 Activate the shower by pulling the handle.

NOTE: If the area of contact is small and on an extremity (e.g., hand) a UPW spray wand or faucet may be used for rinsing.

9.7.2.2.3 Rinse the affected area for a minimum of 15 minutes.

9.7.2.2.4 While rinsing, remove any contaminated clothing, jewelry, or other items.

9.7.2.2.5 Request medical attention.

9.7.2.2.5.1 If further medical care is required, take a copy of the SDS.

9.7.2.2.6 Notify Staff of the incident.

9.7.2.2.7 Complete an incident report.

9.7.2.3 Large Area of Skin Contact

9.7.2.3.1 Move to the nearest emergency shower.

9.7.2.3.2 Activate the shower by pulling the handle.

9.7.2.3.3 Rinse the affected area for a minimum of 15 minutes.

9.7.2.3.4 While rinsing, remove any contaminated clothing, jewelry or other items.

NOTE: Although the primary concern is proper treatment of the victim, sensitivity to modesty issues should be maintained.

9.7.2.3.5 Call 911.

9.7.2.3.6 Request an ambulance.

9.7.2.3.7 Provide the emergency responders with a copy of the SDS.

9.7.2.3.8 Notify Staff of the incident.

9.7.2.3.9 Complete an incident report (see section 5.8 Incident Reporting).

9.7.3 HF (Hydrofluoric Acid, Buffered Oxide Etchant (BOE), Ammonium Fluoride)

✪ ✪ ✪ ✪ ✪ ✪ ✪ **CAUTION** ✪ ✪ ✪ ✪ ✪ ✪ ✪

Anyone assisting a victim of HF exposure MUST wear all necessary PPE to prevent personal exposure. This buddy is responsible to ensure the following procedures are completed. Refer immediately to the emergency instructions posted at the wet bench where HF is located.

✪ ✪ ✪ ✪ ✪ ✪ ✪ **CAUTION** ✪ ✪ ✪ ✪ ✪ ✪ ✪

9.7.3.1 HF in Eyes

9.7.3.1.1 Move to the nearest eye wash station.

9.7.3.1.2 Activate the eye wash by pushing the handle or lowering the fixture.

9.7.3.1.3 Remove the face shield, safety glasses and/or prescription glasses, as needed.

9.7.3.1.4 Flush the eyes for at least 15 minutes.

9.7.3.1.4.1 **Using clean gloves**, hold the eyelids open.

NOTE: If the gloves are contaminated, remove them and hold the eyelids open with your bare fingers. It is better to contaminate the fingers than delay rinsing of the eyes.

9.7.3.1.4.2 Rotate the eyeball in all directions.

9.7.3.1.4.3 If wearing contact lenses, remove them, if possible, while continuing to flush the eyes.

9.7.3.1.5 Have your buddy call 911.

9.7.3.1.5.1 Request an ambulance.

NOTE: They will provide further instructions and notify the hospital of your pending arrival.

9.7.3.1.6 Continue to flush until medical personnel direct otherwise.

9.7.3.1.6.1 Ensure that the medical personnel know that this is an HF exposure, not a common acid exposure.

9.7.3.1.7 Notify Staff of the incident.

9.7.3.1.8 Have your buddy accompany you to the Emergency Room with a copy of the SDS.

9.7.3.1.9 Complete an incident report (see section 5.8 Incident Reporting).

9.7.3.2 HF on Skin

9.7.3.2.1 Immediately move to the nearest emergency shower.

9.7.3.2.2 Activate the shower by pulling the handle.

9.7.3.2.3 While rinsing, avoid exposing other parts of the body to the rinse water.

9.7.3.2.4 While rinsing, remove any contaminated clothing, jewelry, or other items.

NOTE: Although the primary concern is proper treatment of the victim, sensitivity to modesty issues should be maintained.

9.7.3.2.5 Thoroughly rinse the affected area for 2 – 5 minutes.

9.7.3.2.6 Do NOT dry the skin.

9.7.3.2.7 Wearing clean gloves, apply Calcium Gluconate gel to the exposed area.

9.7.3.2.8 Have your buddy call 911.

9.7.3.2.8.1 Request an ambulance.

NOTE: They will provide further instructions and notify the hospital of your pending arrival.

9.7.3.2.9 Wearing clean gloves, continue to apply Calcium Gluconate gel until otherwise directed by medical personnel.

9.7.3.2.10 Ensure that the medical personnel know that this is an HF burn, not a common acid burn.

9.7.3.2.11 Notify Staff of the incident.

9.7.3.2.12 Have your buddy accompany you to the Emergency Room with a copy of the SDS.

9.7.3.2.13 Complete an incident report (see section 5.8 Incident Reporting).

9.7.3.3 HF Inhalation

Inhalation of HF vapors can cause damage to pulmonary tissue and burns to skin and mucous membranes. It can cause unconsciousness. Exposure to HF vapors should be treated as exposure to HF liquid. Inhalation of HF vapors should be treated as follows,

9.7.3.3.1 Immediately move the victim(s) to fresh air.

9.7.3.3.2 Evacuate the area.

9.7.3.3.3 Call 911.

9.7.3.3.3.1 Request an ambulance.

NOTE: They will provide further instructions and notify the hospital of your pending arrival.

9.7.3.3.4 Ensure that the medical personnel know that this is an exposure to HF vapors, not a common acid.

9.7.3.3.5 Keep the victim warm, quiet, and comfortable.

9.7.3.3.6 **If the victim stops breathing and you are qualified to administer CPR**, do so immediately.

9.7.3.3.7 Notify Staff of the incident.

9.7.3.3.8 Have your buddy accompany you to the Emergency Room with a copy of the SDS.

9.7.3.3.9 Complete an incident report (see section 5.8 Incident Reporting).

9.8 Chemical Spills

Users are primarily responsible for cleaning up any chemical drips and residues they caused using safe and approved procedures. Training is covered in Chemical Handling Training. Users should not attempt to clean up spills.

9.8.1.1.1 **If during Staff Hours**, report the spill to Nanofab Staff and EHS.

9.8.1.1.2 **If during Non-Staff Hours,** call University Police to report the spill.

9.8.1.1.3 **Without exposing yourself to the chemical(s),** assist any injured or exposed persons.

9.8.1.1.3.1 Remove them from the source of the chemical.

9.8.1.1.4 Follow the applicable procedures for any persons exposed to the chemical(s).

9.8.1.1.5 Evacuate all persons from the area.

9.8.1.1.6 Prevent other persons from entering the area.

9.8.1.1.7 When reporting, include the following information

- Your name
- Location of the spill (building and room)
- What chemical(s) have been spilled
- The approximate volume of the spill
- The nature of any injuries or personal exposure

9.8.1.1.8 Ensure a person knowledgeable of the incident remains available to meet the emergency response personnel.

9.9 Clothing on Fire

If clothing or hair is on fire, it is important to quickly extinguish the flames. However, rapid movement by the victim will increase and spread the flame.

9.9.1 Using any of the following methods extinguish the flames:

- Douse the flames in an emergency shower or other water source
- Smother the fire
- Roll the victim on the floor

9.9.2 After the flames are extinguished, treat the victim per section 9.15.6 Thermal Burn.

9.10 Earthquake

In a major earthquake, the greatest immediate hazard is falling objects. Toxic gases will be shut off automatically at the gas cabinets to reduce any risk. In addition, the HPM alarm system will be activated automatically. The following procedures should be taken.

9.10.1 Immediately take cover in a doorway or under a solid table. Try to stay away from glass or wet benches.

9.10.2 After the shaking stops, evacuate the building per 9.2.2 Scheduled/Unscheduled Evacuation.

9.11 Electrical Exposure

There are numerous sources of electrical exposure in the facility. Normally, proper use will prevent any potential exposure. Should you witness anyone affected by electrical exposure, ensure they are no longer in contact with the electrical source BEFORE touching the victim.

9.11.1 Quickly determine if the victim is still in contact with the electrical source.

9.11.1.1 **If yes,** safely shut off the current source.

9.11.1.2 **If the current source cannot be shut off,** use a non-conductive material to help you break the victim from the source.

9.11.2 Call 911.

9.11.2.1 Request immediate medical assistance.

9.11.3 Keep other persons clear of the area.

9.11.4 Notify Staff of the incident.

9.11.5 Complete an incident report (see section 5.8 Incident Reporting).

9.12 Explosion

9.12.1 Follow the procedures in 9.13 Fire.

9.13 Fire

!!!!!! WARNING !!!!!!

Only those persons who have been trained through the University are authorized to use a fire extinguisher.

9.13.1.1 **If the Fire Alarm has not already been activated**, manually activate the nearest Fire Alarm Pull Station.

9.13.1.2 Evacuate the building as per 9.2.2 Scheduled/Unscheduled Evacuation.

9.13.1.3 **If any people are involved,** without risk to personal safety treat them FIRST.

9.13.1.4 Always maintain a clear exit path.

9.13.1.5 Avoid smoke and fumes.

9.13.1.6 **If it can be done without personal risk**, shut down any electrical equipment that may be involved.

9.14 Gas Leak

The facility has a large number of sensors that are constantly monitoring for levels of hazardous gases. In most cases, this system will detect a leak and prompt an evacuation before it can be observed by a person. However, should you ever observe a leak, do the following:

9.14.1 **If the HPM Alarm has not already been activated,** manually activate the nearest HPM Alarm Pull Station.

9.14.2 Evacuate the building as per 9.2.2 Scheduled/Unscheduled Evacuation.

9.15 Medical Emergency

9.15.1 Bleeding

9.15.1.1 Using a clean gauze pad (from the First Aid Kit), apply hand pressure to the wound.

9.15.1.2 If necessary, elevate the wound and apply pressure to a pressure point to reduce the blood flow.

9.15.1.3 If the bleeding is excessive, does not stop, or is from a deep wound, call 911.

9.15.1.4 Notify Staff of the incident.

9.15.1.5 Complete an incident report (see section 5.8 Incident Reporting).

9.15.2 Chemical Ingestion

NOTE: These are general instructions. Refer to the SDS for the applicable chemical(s) for specific instructions.

9.15.2.1 Call 911.

9.15.2.1.1 Be prepared with a copy of the SDS.

9.15.2.1.2 Follow all instructions.

NOTE: Do NOT induce vomiting unless directed by a health care provider or emergency responder.

9.15.2.2 Notify Staff of the incident.

9.15.2.3 Complete an incident report (see section 5.8 Incident Reporting).

9.15.3 Chemical or Poisonous Gas Inhalation

NOTE: These are general instructions. Refer to the SDS for the applicable chemical(s) for specific instructions.

9.15.3.1 Call 911.

9.15.3.2 **Without risk to personal safety,** remove the victim from contaminated area.

9.15.3.3 Loosen clothing on the victim, if necessary, to facilitate breathing.

9.15.3.4 **If victim is not breathing,** use CPR (if qualified).

9.15.3.5 Request medical assistance.

9.15.3.5.1 **If further medical care is required,** take a copy of the SDS.

9.15.3.6 Notify Staff of the incident.

9.15.3.7 Complete an incident report (see section 5.8 Incident Reporting).

9.15.4 Fracture

9.15.4.1 Call 911.

9.15.4.2 **If the victim can be moved,** carefully and gently move the victim from the cleanroom.

9.15.4.3 Notify Staff of the incident.

9.15.4.4 Complete an incident report (see section 5.8 Incident Reporting).

9.15.5 Not Breathing

9.15.5.1 **If you are qualified to administer CPR,** do so immediately

9.15.5.2 Have someone call 911.

9.15.5.3 Notify Staff of the incident.

9.15.5.4 Complete an incident report (see section 5.8 Incident Reporting).

9.15.6 Thermal Burn

9.15.6.1 Minor (1st and 2nd degree)

Minor burns are those that exhibit redness or minor blistering to a small area of the body.

9.15.6.1.1 Flush affected area with cold running water until the pain stops.

9.15.6.1.2 Apply a burn cream from the First Aid Kit to the affected area.

9.15.6.1.3 Cover with a sterile dressing from the First Aid Kit.

9.15.6.1.4 **If necessary,** seek medical help.

9.15.6.1.5 Notify Staff of the incident.

9.15.6.1.6 Complete an incident report (see section 5.8 Incident Reporting).

9.15.6.2 Major (3rd degree)

Major burns are those with charring that penetrates the skin or moderate to severe blistering, regardless of the size of the affected area. Redness or blistering that affects a large cumulative area of the body should also be treated as a major burn.

9.15.6.2.1 Call 911.

NOTE: Do NOT rinse or cover the wound unless directed by medical personnel.

9.15.6.2.2 Notify Staff of the incident.

9.15.6.2.3 Complete an incident report (see section 5.8 Incident Reporting).

9.15.7 Unconscious

9.15.7.1.1 Call 911.

9.15.7.1.2 Notify Staff of the incident.

9.15.7.1.3 Complete an incident report (see section 5.8 Incident Reporting).

9.16 Mercury Spill

9.16.1 **If mercury is released in any form through breakage or explosion of a containment vessel,** evacuate the immediate area (bay or room).

9.16.2 During the evacuation, ensure others do NOT enter the area of the spill.

9.16.3 Notify Staff or EHS immediately.

9.16.4 Complete an incident report (see section 5.8 Incident Reporting).

9.17 Odors in the Lab

The environmental controls and use of proper procedures should prevent unusual odors in the facility. In general, if you smell something, there is either an equipment malfunction or a lab member has not followed appropriate material handling procedures. On occasion, the odor may originate from outside the lab or building. Regardless, the odor should be reported immediately.

9.17.1 Notify Staff of the odor.

9.17.1.1 Describe the location, type of odor, and any other information that may help find the source.

9.17.2 Clear the affected area.

9.17.3 Wait for further instructions from Staff.

9.18 Power Failure

If electrical power to the facility is lost, backup electrical systems will provide sufficient power to maintain life safety conditions. If full power has not been restored within 10 minutes, it is still necessary to leave the cleanroom. However, it is not necessary to exit the building unless warranted by other conditions.

9.18.1 Remain calm.

9.18.2 Quickly secure your process.

9.18.3 **If using any chemicals,** cap or cover them.

9.18.4 **If working at a fume hood**, close the sash.

9.18.5 **If working at a wet bench,** remove the PPE, clean it from any residues, and place it in the appropriate storage location.

9.18.6 **If possible,** proceed to the emergency exit near the gowning room at the south end of the main aisle.

9.18.6.1 If the path to the exit is obstructed or presents physical danger, identify a safe, secondary path to any exit door and proceed.

9.18.7 **Without placing yourself in danger,** assist others as necessary.

9.18.8 Open the emergency exit door.

9.18.9 Exit the cleanroom.

9.18.10 Proceed to the atrium.

9.18.11 Contact Lab Staff.

9.18.12 Remain near the atrium until otherwise instructed by Lab Staff or emergency responders.

9.18.12.1 This enables Staff and responders to account for all individuals in the cleanroom at the time of the evacuation.

9.18.13 While waiting for authorization to re-enter the cleanroom, remove all cleanroom clothing. It must be collected and laundered.

9.18.13.1 New, clean clothing must be obtained upon re-entry to the cleanroom.

9.19 Security

9.19.1 **If you observe any suspicious activity, theft, harassment, or physical threat,** call University Police immediately.

9.19.1.1 Do not attempt to intervene.

9.20 Severe Weather

Severe weather includes – but is not limited to – tornados, thunder storms, and high winds. The National Weather Service classifies severe weather conditions as *watch* or *warning*.

A Severe Weather Watch is when the risk of a hazardous weather or hydrologic event has increased significantly, but the occurrence, location, and/or timing is still uncertain. A *watch* is intended to provide time to prepare.

A Severe Weather Warning is when a hazardous weather or hydrologic event is occurring, imminent, or has a very high probability of occurring. A *warning* is used for conditions that pose a threat to life or property.

Should a weather watch or warning be issued, it may be necessary to suspend lab activities and/or evacuate. These instructions will be communicated by Lab Staff, as necessary.

9.21 Ventilation Failure

To maintain the desired air balance in the cleanroom, both the exhaust and supply air systems must be working properly. If either system exhibits failure, risks exist and appropriate actions are necessary. The HPM system will initiate an alarm and the lab must be evacuated.

9.21.1 Exhaust Failure

9.21.1.1 **If an individual tool has an exhaust failure,** use of the tool is to be suspended immediately.

9.21.1.1.1 **If it is a fume hood,** lower the sash.

9.21.1.1.2 Contact Lab Staff.

9.21.1.2 **If a facility exhaust failure alarm occurs**, the HPM alarm will activate.

9.21.1.2.1 Evacuate the building as per 9.2.2 Scheduled/Unscheduled Evacuation.

9.21.2 Supply Air Failure

9.21.2.1 **If a supply air system failure alarm occurs**, the HPM alarm will activate.

9.21.2.1.1 Evacuate the building as per 9.2.2 Scheduled/Unscheduled Evacuation.

10 Revision History

Rev	Date	Originator	Description of Changes
7	22-Jul-24	K Anderson	• Updated contacts and chemical categories. Cateogories now include electroplating chemicals, EPN and EPA. • Updated chemical disposal section to specify aspirator must be held in place until aspiration is complete. • Added GHS info in Appendix • Added Chemical ID Label form as Appendix • Changed Emergency Rally point for Cleanroom to be no longer directly over the underground dock.
6	07 Feb 2023	E. Fluckiger/T. Olsen	• Annual Review. Several minor corrections and updates. • Changed section (3.7) from CORAL to HSC and replaced all references to CORAL with HSC. • Update (4.15.2) to allow external members to request after-hours access. • Added waste containers (standard, vented, and sharps to section 5.13. • Updated 8.1.1 to never leave an aspirator unattended. • Update Appendix D, Nanofab Emergency Contact List.
5	08 Jul 2021	T. Olsen	• Annual Review. Several minor corrections and updates. • Updated description of CORAL and usage options (3.7) • Explanation of Equipment Interlocks (4.9.2) • Add instruction to keep fume hood sashes down when not being used (4.10 and 7.1.2) • Add 5.9 Ladders and 5.15 Step Stools • Add 5.13.5 Chemical Bottle Carrier • Update information for 5.14.2 Human Reproduction/Pregnancy • Add instruction that Pass-through Storage Cabinets are for unopened bottles only (7.1.5.2) • Rename Waste Containers to Unwanted Material Containers • Add instruction to remove any eye obstruction when using eye wash for chemical exposure (9.7.2.1.3 and 9.7.3.1.3) • Add notes to 9.15.2 and 9.15.3 that specific SDS's may override general instructions. • Update Appendix D, Nanofab Emergency Contact List

Rev	Date	Originator	Description of Changes
4	26 Aug 2016	T. Olsen	• Updated map in 2.5 with names for 2223 and 2227. • Change Dress Code to require long pants and tops with sleeves. • Clarified the reservation cancellation information in 4.9.3. • Redefine Acetone Rinse as Acetone Pre-Rinse and added explanation on Appendix E.
3	18 Feb 2016	T. Olsen	• Update 7.1.8 with comments for improper placement of hot plates. • More clearly indicate that all labware and bottle rinses are a minimum of 3 times. • Change name of rooms 2223 and 2227 to BM Lab and MP Lab, respectively. Update all references. • Update all maps for new room names and new placement of egress door from Bay G. • Update hyperlinks due to website changes.
2	17 Nov 2014	T. Olsen	• Changed MSDS to SDS throughout document. • Updated 3.5 Laboratory Rates to reflect new billing model (tool cost recovery). • Updated 4.9.3 Equipment Reservations to describe 15 minute blocks (not 30) and consequences of unused reservations and those not cancelled in a timely manner. • Update 4.15.1 Process for Obtaining General Lab Access to reflect on-line form and instructions, • Updated the image for Appendix H, Emergency Evacuation Map.
1	14 Jan 2014	T. Olsen	Initial Release

Appendix A, How to Read GHS Pictograms and Hazard Statements

U of U Campus EHS Requires that all campus labs follow a set of safety rules.

One of those rules is that every hazardous material must be labeled.

Also required is a visual image of that hazard.

GHS Pictograms meet that requirement as do NFPA diamonds.

GHS is a Globally Harmonized System of Hazards Communication used internationally. NFPA is USA only.

All new safety datasheets (SDSs) include GHS pictograms while not all SDSs include NFPA diamond values.

Most SDSs also include GHS hazard statements that describe the unique hazards associated with the associated chemical.

Each chemical in the Nanofab Cleanroom now has associated GHS pictograms posted on their bottles and at their storage locations.

Drawers under wetbenches where chemical source bottles are stored include not only histograms, but also individual hazard statements quantifying severity.

Posted on the South wall in Bay D is a table of hazards by chemical for acids and bases.The following is a snapshot of a portion of the table.

Hazards by Chemical
Acids and Bases

GHS Pictogram										
Chemical	**Nanofab Chemical Code**	**pH**	**TOXIC** Immediate, severe, even lethal effects	**HARMFUL** Skin, eyes, or respiratory irritant	**HEALTH** Causes cancer, reproductive harm, or targets organs	**FIRE** Flammable, pyrophoric, self reactive or water reactive	**OXIDIZING** Helps ignite substances that would not otherwise combust	**CORROSIVE** Skin corrosion or burns, eye damage, and corrosive to metals	**ENVIRON-MENTAL** Toxic to aquatic wildlife. Staff Assisted Disposal.	**Disposal**
Acetic Acid *CH_3COOH*	GA General Acid	2.4*				FIRE 		CORROSIVE 		AWN Aspirate In Wet Bench
Aluminum etch Type A *Phosphoric Acid 70% H_3PO_4*	OA	<2	TOXIC	HARMFUL 	HEALTH			CORROSIVE		AWN Aspirate In Wet Bench

Posted on the East wall in Bay C is a table of hazards by chemical for solvents.

Posted on the wall in the Prototyping Room is a table of hazards by chemical for electroplating materials.

Point of use hazard labels and tables are used as references when circling hazards while filling out chemical identification labels to prepare for transferring chemicals into previously unmarked containers.

Point of use hazard labels and tables are subject to updates by Nanofab Cleanroom Staff as materials use changes location or as new materials are introduced.

Appendix B, Chemical Identification Label

Chemical Identification Label

Lab Member _____

Contact # _____

Date Time

Completion _____ _____

Staff Approval _____

(required for overnight)

Chemicals in Use (check all that apply and circle hazard pictogram for each):

- ☐ Acetone
- ☐ Aluminum etch
- ☐ BOE/HF
- ☐ Chromium Etch
- ☐ Developer, AZ 1:1
- ☐ Developer, 300 MIF
- ☐ Developer, AZ 400K
- ☐ Developer, SU8
- ☐ DI Water
- ☐ Hydrochloric Acid (HCl)
- ☐ Hydrogen Peroxide (H_2O_2)
- ☐ IPA
- ☐ Kwik Strip
- ☐ Methanol
- ☐ Nitric Acid (HNO_3)
- ☐ Potassium Hydroxide (KOH)
- ☐ Sulfuric Acid (H_2SO_4)
- ☐ Xylenes

☐ Other acids, solvents, mixtures (specify below with ratios)

_____

_____

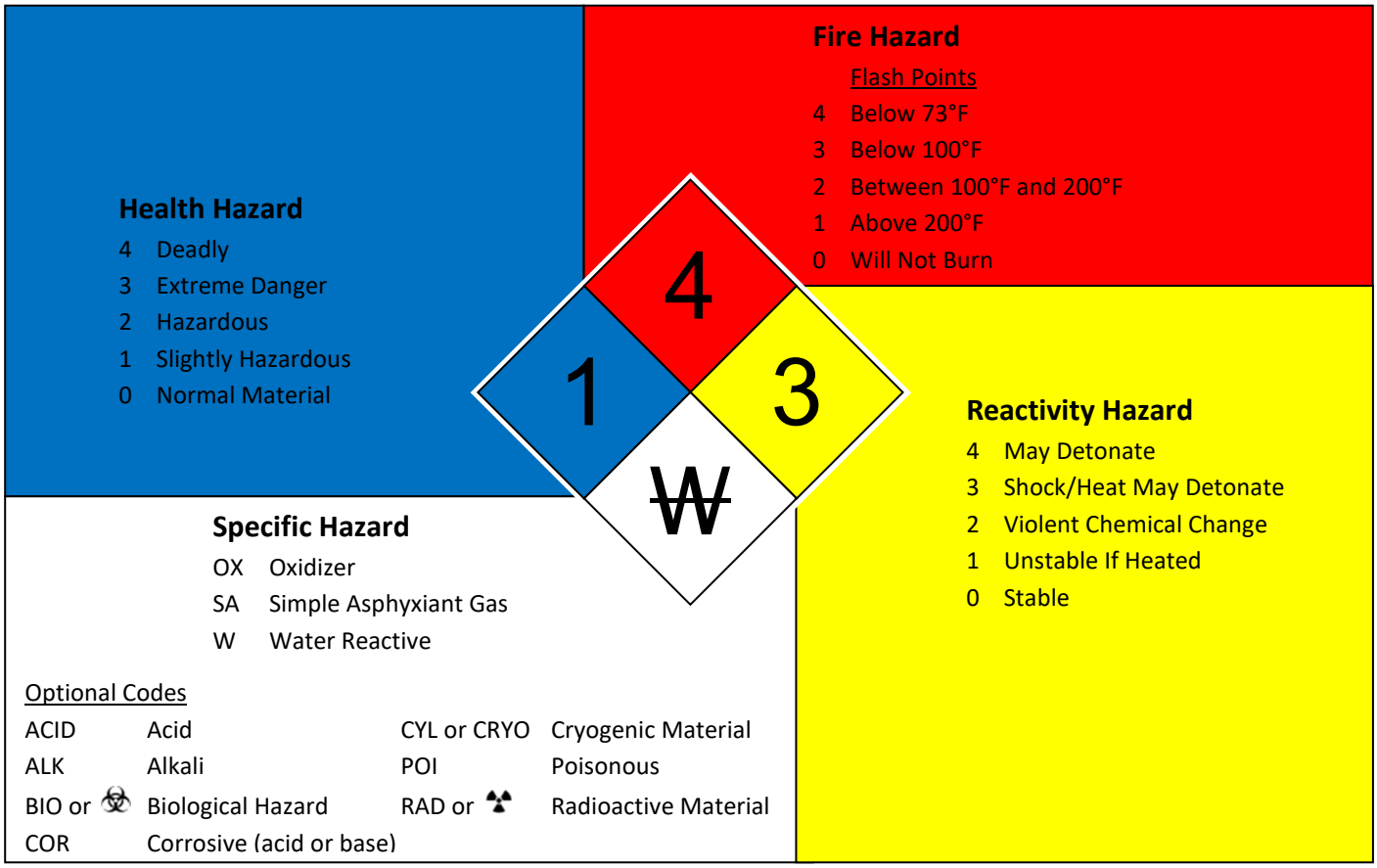
Proper Disposal is the responsibility of Lab Member

Clean, rinse and dry labware when finished.

Appendix C,How to Read the NFPA Hazard Communication Diamond

Each quadrant of the National Fire Protection Association (NFPA) diamond represents a different type of hazard. It was developed to help emergency personnel identify the hazards of a particular chemical during an emergency response incident. For visual reference each hazard category has been assigned a different color. For Health (blue), Fire (red), and Reactivity (yellow), the hazards are scaled from 0 to 4, where 0 is the least hazard and 4 is the highest. Specific Hazards (white) are represented by text or a symbol to identify other concerns for the material. This category may include multiple text or symbols. Although the standard only defines three (3) specific hazards, additional hazards are often used and are optional.

The upper portion of the following graphic provide a brief summary of the hazard definitions. The lower portion includes slightly more detail. For full criteria, refer to NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response.



General Rating Summary

	Health	Fire	Reactivity	
4	May be fatal on short exposure. Specialized protective equipment is required.	Flammable gas or extremely flammable liquid.	Explosive Material at room temperature.	4
3	Corrosive or Toxic. Avoid skin contact or inhalation.	Flammable liquid with a flash point below 100°F.	May be explosive if shocked, heated under confinement, or mixed with water.	3
2	May be harmful if inhaled or absorbed.	Combustible liquid with a flash point between 100°F and 200°F.	Unstable or may react violently if mixed with water.	2
1	May be irritating.	Combustible, if heated.	May react if heated or mixed with water, but not violently.	1
0	No unusual hazard.	Not combustible.	Not reactive when mixed with water.	0

Appendix D, How to Read an HMIS® Label

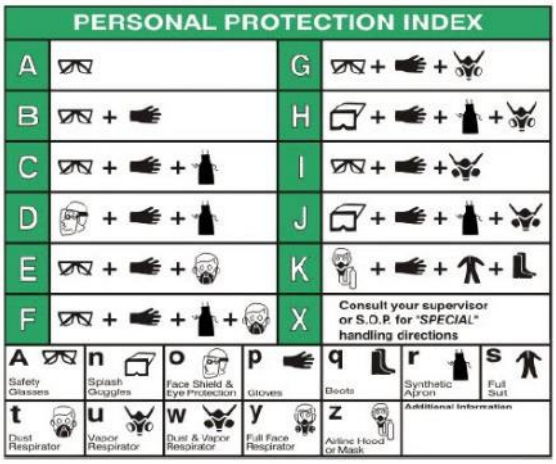
The Hazardous Materials Information System is designed to provide hazard warning information to those who USE or STORE chemicals. Where the NFPA diamond has been developed for emergency responders, the HMIS® system is targeted to the chemical user. Consequently, the label categories are different from the NFPA diamond. The HMIS® label has 4 color-coded categories: Health (blue), Flammability (red), Physical Hazard (orange), and Personal Protection (white). Within each category a numeric value is determined to indicate the hazard level for that category. Health hazards may also show an asterisk "*", indicating a chronic or long-term health effects may occur through repeated overexposure.

HMIS® Label Example

Chemical Name	
2*	Health
3	Flammability
0	Physical Hazard
B	Personal Protection

Hazard Rating

* Chronic Hazard
0 Minimal Hazard
1 Slight Hazard
2 Moderate Hazard
3 Serious Hazard
4 Severe Hazard



General Rating Summary

	Health	Flammability	Physical Hazard	
0	No significant risk to health.	Materials that will not burn.	Materials that are normally stable, even under fire conditions, and will NOT react with water, polymerize, decompose, condense, or sel-react. Non-Explosives.	**0**
1	Irritation or minor reversible injury possible.	Materials that must be preheated before igntion will occur. Includes liquids, solids, semi-solids having a flash point above 200°F (Class IIIB).	Materials that are normally stable, but can become unstable (self-react) at high temperatures and pressures. Materials may react non-violently with water or undergo hazardous polymerization in the absence of inhibitors.	**1**
2	Temporary or minor injury may occur.	Materials which must be moderately heated or exposed to high ambient temperaturs before ignition will occur. Includes liquids having a flash point at or above 100°F but below 200°F (Classes II & IIIA).	Materials that are unstable and may undergo violent chemical changes at normal temperature and pressure with low risk for explosion. Materials may react violently with water or form peroxides upon exposure to air.	**2**
3	Major injury likely unless prompt action is taken and medical treatment is given.	Materials capable of ignition under almost all normal temperature conditions. Includes flammable liquids wih flash points below 73°F and boiling points above 100°F, as well as liquids with flash points between 73°F and 100°F (Classes IB & IC).	Materials that may form explosive mixtures with water and are capable of detonation or explosive reaction in the presence of a strong initiating source. Materials may polymerize, decompose, self-react, or undergo other chemical change at normal temperature and pressure with moderate risk of explosion.	**3**
4	Life-threatening, major or permanent damage may result from single or repeated overexposures.	Flammable gases, or very volatile flammable liquids with flash points below 73°F and boiling points below 100°F. Materials may ignite spontaneously with air (Class IA).	Materials that are readily capable of explosive water reaction, detonation or explosive decomposition, polymerization, or self-reaction at normal temperature and pressure.	**4**

Appendix E, Staff Maintained Chemical Baths

Chemical	Description/Use	Location	Change Frequency
351 Developer	Develop photoresist	Bay C, Wetbench 1976	Weekly
Pirahna (Nanostrip)	Remove organics.	Bay E, Wetbench 1982	Bi-Weekly
Standard Clean 1 (SC1)	A 5:1:0.25 mixture of H_2O:H_2O_2:NH_4OH by volume. This mixture is used to remove small particles from wafer surfaces by quickly growing and etching a thin oxide. The effectiveness of this bath is enhanced by a Megasonic unit.	Bay E, Wetbench 1982	4 Days (users should spike with H_2O_2 prior to use)
Standard Clean 2 (SC2)	A 5:1:1 mixture of H_2O:H_2O_2:HCl by volume. This mixture is used to remove metal contamination.	Bay E, Wetbench 1982	Monthly
50:1 HF	A dilute mixture of H_2O and HF used to remove thin oxides.	Bay E, Wetbench 1982	Monthly
49% HF	Frequently called Straight HF, this is the strongest concentration of HF used in the facility. It is used to remove oxide, glass, and nitride films.	Bay E, Wetbench 1974	Monthly
10:1 BOE	A Buffered Oxide Etchant composed of 10:1 NH_4F and HF by weight. It maintains a constant etch rate for etching oxides.	Bay E, Wetbench 1974	Monthly
Potassium Hydroxide (KOH, PSE-200)	This heated bath is used for anisotropic etching of silicon.	Bay E, Wetbench 1974	Monthly

Appendix F, Nanofab Emergency Contact List

PHYSICAL LOCATION

UTAHNANOFAB
University of Utah
Sorenson Molecular Biotechnology Building (Building 0151)
36 South Wasatch Drive

Event	First Action	Next Actions
Medical Emergency, including chemical exposure	Cal 911	**1)** Follow instructions given **2)** Notify Staff
Fire, Smoke, or Explosion	Pull local fire alarm	**1)** Evacuate **2)** Notify Staff
Utility Failure (power outage, flood, ventilation failure, etc.)	Staff Hours: 801-581-7221 (Facilities) Non-Staff Hours: 801-585-2677 (University Police)	Notify Staff
Odd odor	Staff Hours: 801-581-6590 (EHS) Non-Staff Hours: 801-585-2677 (University Police)	Notify Staff
Major Chemical Spill	Staff Hours: 801-581-6590 (EHS) Non-Staff Hours: 801-585-2677 (University Police)	Notify Staff
Hazardous Gas Leak	Pull local HazMat alarm	1) Evacuate 2) Notify Staff
Security Concern (unauthorized person, harassment, violence, etc.)	801-585-2677 (University Police)	Notify Staff

If a tool malfunctions, call Staff in the following order:

Staff Member	Office Phone	Cell Phone
Brian Baker	801-587-1291	801-803-8212
Jim Pierce	801-587-1219	385-277-3294
Joe Jacob	801-587-0684	801-643-2273
Kathy Anderson	801-213-6555	801-440-1465

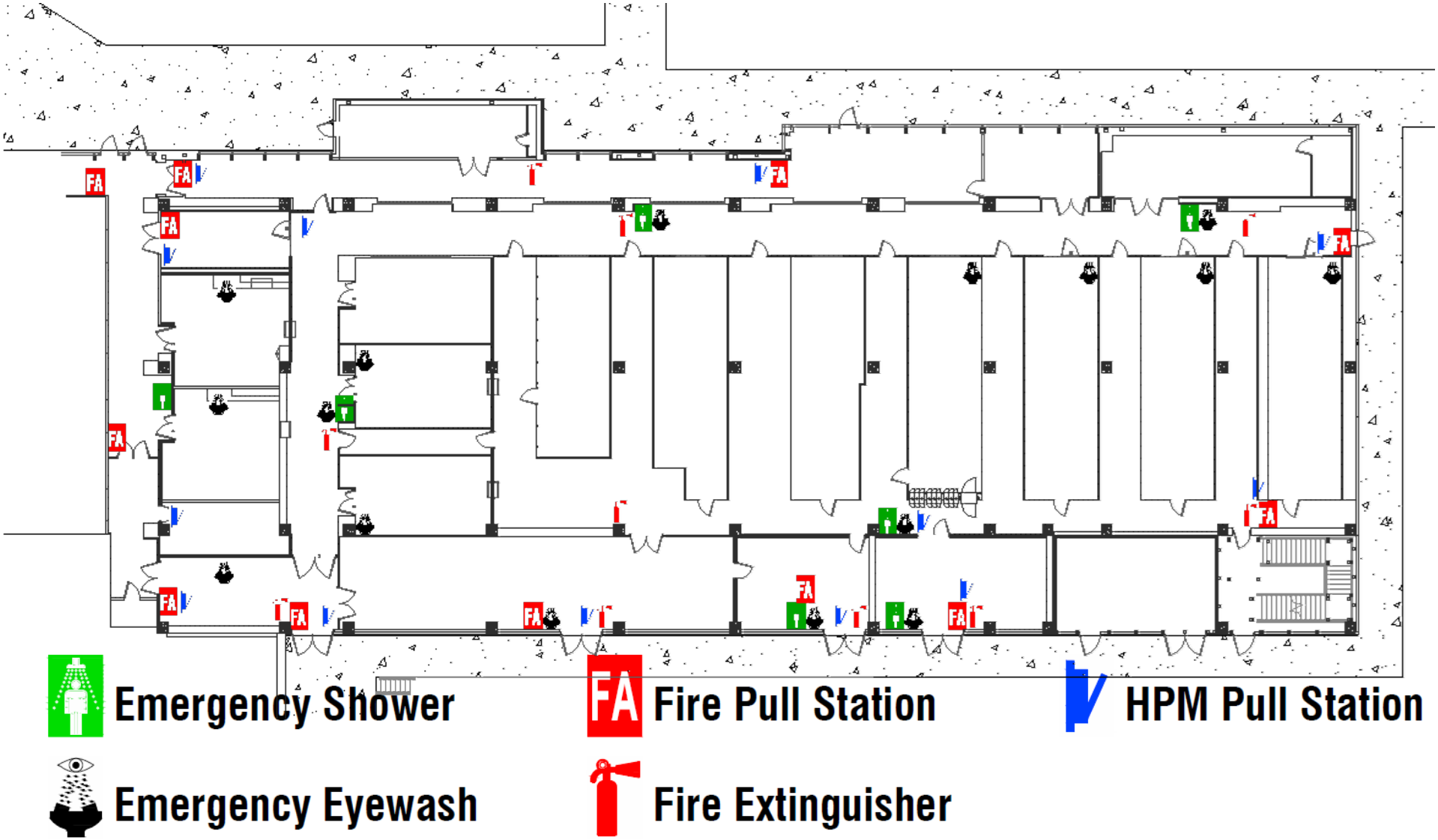
U of U Campus Emergency Dispatch	801-585-2677	
Nanofab Emergency Contact	801-440-1465	Kathy Anderson
SMBB Facility Manager	801-644-6447	Chris Zuech
SMBB Custodial Manager	801-587-1127	Nick Cramer

Appendix G, Chemical Category Information

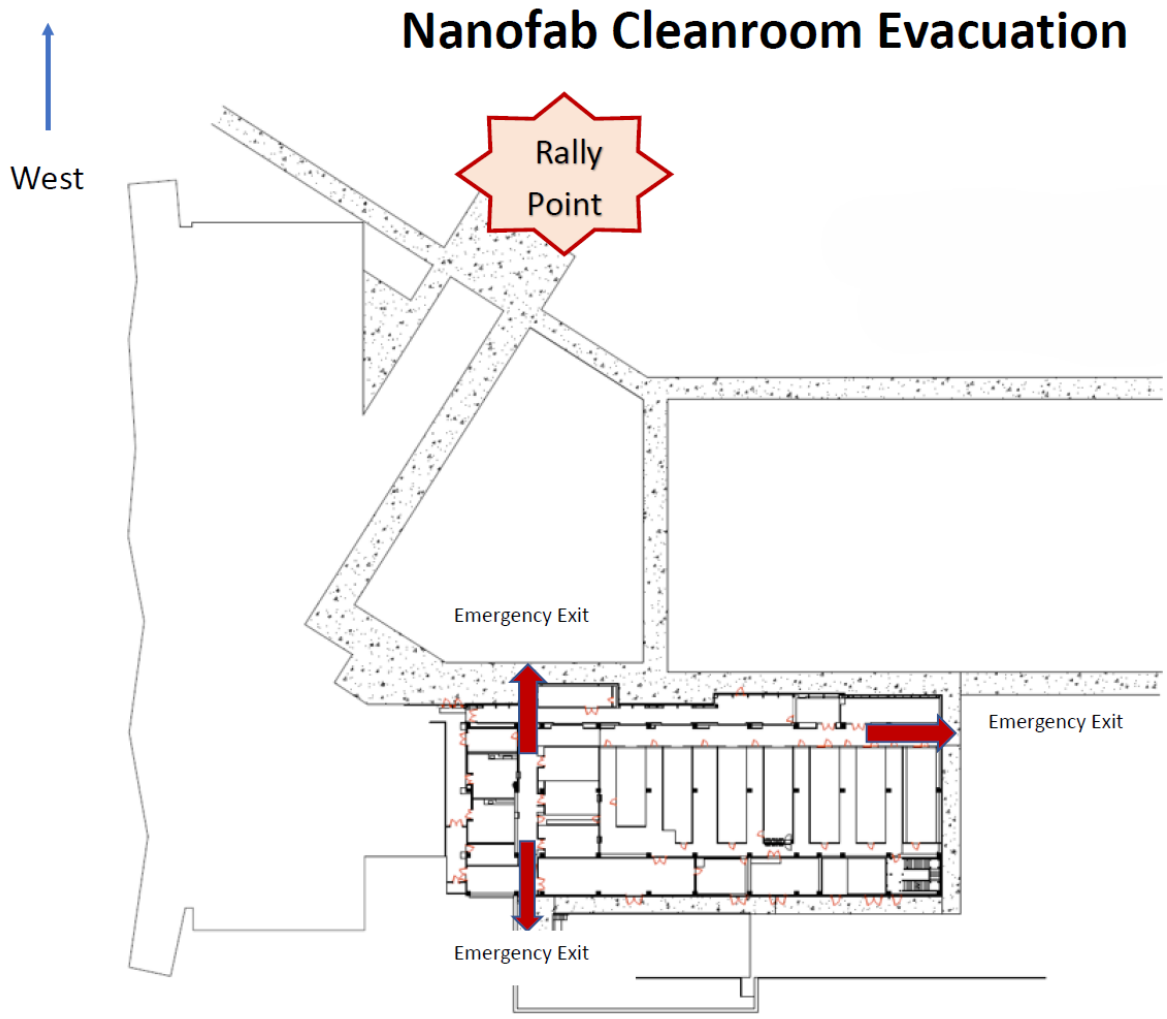
Label[1]	Description	Examples	Use Location	Chemical Disposal	Bottle Disposal[1]
CS	Chlorinated Solvent	Chlorobenzene Trichloroethylene	Fume Hood	CS Waste Container	Acetone Pre-Rinse
EP	Electroplating Solution	Elevate Cu 6340 Techni Nickel HT-2	Fume Hood, Rm 2223	EP Waste Container	Done by Staff only
GA	General Acid	Hydrochloric Acid Phosphoric Acid	Wet Bench	Aspirator	Bottle Wash
GB	General Base	351/352 Developer Potassium Hydroxide	Wet Bench	Aspirator	Bottle Wash
GE	Gold Etch	Gold Etch	Designated Wet Bench	GE Waste Container	Done by Staff only
HF	Hydrofluoric Acid	Ammonium Fluoride Hydrofluoric Acid	Wet Bench	Aspirator	Bottle Wash
MS	Water Miscible Solvent	Acetone Isopropyl Alcohol Methanol	Fume Hood	MS/NS Waste Container	Bottle Wash
NS	Non-water Miscible Solvent	PGMEA Xylene	Fume Hood	MS/NS Waste Container	Acetone Pre-Rinse
OA	Oxidizing Acid	Aluminum Etch Nitric Acid	Wet Bench	Aspirator	Bottle Wash
OX	Oxidizer	Hydrogen Peroxide	Wet Bench	Aspirator	Bottle Wash
PR	Photoresist	SU-8 Shipley 1813	Spinner (in Fume Hood)	MS/NS Waste Container	Acetone Pre-Rinse
SA	Sulfuric Acid	Nanostrip Sulfuric Acid	Wet Bench	Aspirator	Bottle Wash
SO	Spin-On Materials	HMDS PDMS Spin-on Glass	Spinner or Oven (in Fume Hood)	MS/NS Waste Container	Acetone Pre-Rinse
EPN	Electroplating Neutral	LPKF Cleaner 110, 210	Prototyping Lab	EPN Waste Container	Water Rinse
EPA	Electroplating Acid	LPKF Copper Plater 400 LPKF Shine 410	Prototyping Lab	EPA Waste Container	Water Rinse

[1]Labels printed with white text on a black background are used for all chemicals that require an Acetone Pre-Rinse, followed by a Bottle Wash.

Appendix H, Safety Equipment Map



Appendix I, Nanofab Assembly Location Map



Appendix J, Emergency Evacuation Map

Primary Egress Path

Secondary Egress Path