

# WASHINGTON NANOFABRICATION FACILITY

User Manual

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## INTRODUCTION

The Washington Nanofabrication Facility, located in Fluke Hall on the University of Washington Seattle Campus, is an open-access facility for micro and nano-scale research, development, prototyping, and fundamental science. The 15,000 square foot lab represents more than \$20 million in facilities and equipment, and is the largest public-access fabrication facility in the Pacific Northwest. As a member of the National Nanotechnology Infrastructure Network (NNIN), an integrated network of user facilities supported by the National Science Foundation (NSF), we strive to enable rapid advancements in science, engineering and technology.

The WNF offers a full range of semiconductor processing and packaging capabilities, including photo and electron-beam lithography, wet and dry etch, sputter deposition, evaporation, chemical vapor deposition, atomic layer deposition, annealing, dicing, wafer and flip-chip bonding, metrology, and inspection.

By bridging academia, local start-ups, established businesses, and professional organizations, the WNF promotes local economic and job growth by fostering innovation. Additionally, staff engineers provide foundry services through which fabrication and characterization can be performed for customers both in the US and internationally. University researchers and industry clients are active in a wide range of applications and research areas, including:

- Silicon Photonics
- Biosensors
- Micro and Nano-ElectroMechanical Systems (MEMS/NEMS)
- Microfluidics
- Electrochemical Sensors
- Genomic Sequencing
- Mono and Bilayer Semiconductor Devices (e.g. graphene)
- Basic Physics and Materials Investigations
- Advanced Packaging and De-packaging
- Flexible Electronics

The WNF's sister site, the Molecular Analysis Facility (MAF), located in the Molecular Engineering and Sciences Building on the UW campus, houses leading-edge instruments for nano-scale characterization. Equipment capabilities include scanning transmission electron and scanning electron microscopy, confocal, Raman, and fluorescence microscopy, ellipsometry, and atomic force microscopy. A complete list of tools and contact information for the MAF can be found at <http://www.washington.edu/research/maf/>.

## GENERAL INFORMATION

### WEBSITE AND CONTACTS

Up-to-date contacts, news, and information about the WNF can be found at our website, <https://www.wnf.washington.edu/>, which has links to start a project, to contact staff, and to download forms (User Agreement, Non-Disclosure Agreement, New Materials Request, Visitor Request, etc.).

### USING THE FACILITY

Users are classified as either UW (internal students, faculty, staff, or business unit with a UW budget number) or external (non-UW). External users are further categorized as academic (other academic institutions, US governments and agencies, and certified non-profit organizations) or industrial (all other for-profit organizations). As a user facility, the most common paradigm is for individuals to process their devices in person (onsite users). An alternative approach is contract facility staff to perform limited scope fabrication processes (remote users).

#### ONSITE USERS

While working at the WNF, you will learn a variety of processes and gain valuable skills. After a lab orientation and wet bench training, you will sign up for equipment training as needed. We advise finding a mentor or consulting with staff to ensure proper cleanroom technique, especially if you plan to repeat or expand upon an established process.

#### REMOTE USERS

WNF staff engineers are available to conduct limited-scope process work on a best effort, time and materials basis for remote users. Due to the experimental nature of most contract processes, we cannot provide product guarantees, but will work closely with clients to determine project feasibility, to provide cost estimates, and attempt to obtain mutually satisfactory results. Remote users will be assessed a fee for sample shipping.

#### BECOMING A USER

Before becoming a user, we suggest scheduling a meeting with staff to discuss your project and, optionally, to see the facility. Next, you will need to complete the registration process on the new user site at:

<https://www.coral.washington.edu/tomcat/CORAL/WNF.html?mode=register>

This website will direct you through the induction process. In short, the process involves determining your role (UW or external, remote, etc.), and then entering contact and billing information and a project proposal. After reading and understanding this User Manual, you must complete and return the appropriate Facility Use Agreement, either UW or Non-UW. Optionally, you can complete a Non-Disclosure Agreement (NDA). Lastly, you will also be required to complete a variety of online and in person training, explained in more detail on the website.

#### REPORTS AND ACKNOWLEDGEMENTS

As a provision of the National Nanotechnology Coordinated Infrastructure (NNCI) program, we are required to submit an annual report on active projects. Occasionally, WNF staff may request input in compiling publication lists and highlighting research in our labs. Additionally, you are required to acknowledge work conducted at the WNF in your publications and presentations. A suggested acknowledgment is: "Part of this

work was conducted at the Washington Nanofabrication Facility, a member of the NSF National Nanotechnology Coordinated Infrastructure.” Your cooperation in response to these requests is mandated by federal funding sources and greatly appreciated.

## BILLING

The WNF is a non-profit business unit within the University of Washington that charges time and materials on a cost reimbursement basis with monthly invoices. Academic pricing is achieved through UW, state, and federal grants and subsidies. Industrial rates are set for cost recovery. UW Management Accounting and Analysis (MAA) mandates an annual rate proposal to ensure cost recovery. Rates are a function of cost of operation (labor and materials) and utilization; if the user base grows and utilization increases, costs decrease.

Furthermore, the rate structure falls into four tiers: basic, low, mid, and high, consistent with the MAF. Users of the WNF are eligible to use MAF characterization capabilities under a single purchase order, but will receive a separate monthly invoice from each facility.

Due to the nature of work at the facility, it is not possible to issue binding quotations for projects. Many projects have unanticipated changes in scope and processes based on experimental results, so a “not to exceed” purchase order is recommended to account for possible changes with minimum logistical overhead.

## CONSULTING

Staff engineers are readily available for Design Reviews. These consulting sessions are a venue to discuss project concepts, process flows, or specific technical issues. Current or potential users are encouraged to hold discussions with staff on a regular basis to work through processes and to troubleshoot problems. Independent Design Reviews can be scheduled as needed by contacting the lab director or engineering staff.

## USER AND STAFF MEETINGS

User meetings are held every Monday afternoon. These are open forums for registered lab users to discuss issues pertaining to the laboratory, instrumentation, and processing. To ensure a timely response to issues and concerns, the WNF staff meets when the user meeting is adjourned. If you cannot attend the weekly meeting, please contact the lab director or engineering staff for alternative solutions.

## INTELLECTUAL PROPERTY AND SECURITY

While working in the WNF, you will not have intellectual property (IP) restrictions or entanglement with the University of Washington. Many clients execute an NDA in order to protect their IP (use of the UW pre-approved form will expedite the NDA process).

Occasionally staff will engage in collaborative development campaigns with users. In these cases, general processing techniques that are not IP-specific may be shared with the general user base, but applications and full process flows will not be shared unless given explicit permission.

## FACILITY INFORMATION

### SPACE DESIGNATIONS

#### OFFICES

Offices are located in Fluke Hall Room 135 and 136. Office provisions are made on a discretionary basis by the director, primarily for heavy onsite, full-time users, but are not guaranteed and are only available as space permits.

#### NON-CLEANROOM LABORATORIES

The WNF operates non-cleanroom space on the UW campus. The Soft Lithography Area (primarily for microfluidics and processing with polydimethylsiloxane, PDMS) is located in Ben Hall.

#### CLEANROOM LABORATORY

The cleanroom is located in Room 125. In addition to policies that apply to all laboratories, the cleanroom has specific rules for contamination control and safety. Most of the particulate-sensitive processes and equipment are located within the cleanroom, as well as most wet chemicals.

### EQUIPMENT CAPABILITIES

A complete and updated equipment list can be found on the website at <http://coral.engr.washington.edu/tools/?lab=WNF>. Equipment is separated into the following categories:

- Photolithography: laser direct write, spin coating, adhesion promotion, contact lithography, hotplates, and ovens.
- Nanolithography: electron-beam lithography and nanoimprint lithography.
- Chemical Vapor Deposition (CVD)/Furnaces: plasma enhanced chemical vapor deposition (PECVD), atmospheric furnaces for thermal oxidation, doping, and annealing, and rapid thermal annealing.
- Metallization: electron beam evaporation, sputtering, electroplating.
- Dry Etch: parallel plate reactive ion etching (RIE), inductively coupled plasma etching (ICP RIE, fluorine and chlorine chemistries), deep silicon etching (Bosch, DRIE), plasma ashing.
- Metrology: scanning electron microscopy, profilometry (stylus and optical), spectral reflectance, optical microscopy.
- Back-End-of-Line: dicing, wire bonding, flip chipping, screen-printing, laser cutting, wafer bonding.
- Wet Processing: wafer cleaning, anisotropic silicon etching, resist stripping, oxide etching.

## LABORATORY POLICIES AND PROCEDURES

### PRIORITIES

1. **Safety.**  
You are responsible for your safety and for those around you. Do not work in the facility when you are tired, sick, medicated, or intoxicated. Read and understand the safety information in this manual, in equipment protocols, and in safety data sheets.
2. **Facility and Equipment Integrity.**  
Never compromise the equipment or facilities for your research. Understand and abide by equipment restrictions. If you damage or contaminate equipment while straying from equipment protocols, you will be liable for property and equipment damages that may include staff time, spare parts, vendor services, or equipment replacement.
3. **Your Research.**

### CODE OF CONDUCT

Assume responsibility for the lab. Always follow safety, equipment, and cleanliness protocols, even if your work is not sensitive to contamination or particulates. Never leave a mess; if you find one, either clean it, ask the responsible parties to clean it, or notify staff. Report equipment problems, and notify staff and other users if you have made a mistake or may have caused contamination. Share space and respect equipment reservations. Ask questions if you are unsure. The lab operates effectively when everyone is cordial, follows instructions, and communicates.

### LABORATORY ITEM AND ACTIVITY RESTRICTIONS

The following table lists items and activities that are restricted in all laboratory spaces, cleanroom and non-cleanroom. This is not an exhaustive list; be sure to ask if you have questions.

<b>Partial List of Prohibited Items/Activities</b>	<b>Allowed Items/Activities</b>
Food or drink, gum, cough drops, mints, etc.	Cell phones, headsets
Smoking	Cameras (no flash in yellow rooms)
Offensive or obscene materials or media	Laptops, PDAs, e-readers, music players

### VISITORS

Visitors are not allowed in lab spaces without approval. If you want to bring visitors into lab spaces, you must submit an online Visitor Request Form (<https://www.wnf.washington.edu/lab-user-portal/visitor-request/>) prior to the visit. For each approved visitor you will be assessed a fee to cover cleanroom consumables. An active WNF user must escort each visitor during his or her entire time in laboratory spaces and is responsible for the visitor's actions and safety. Visitors are to abide by all safety measures expected of laboratory users and are not allowed to operate any laboratory equipment or perform any chemical operations. Visitors are not allowed in the facility after normal hours or as buddies to meet the buddy system requirement.

### DRESS CODE

The WNF dress code applies to all laboratory areas, cleanroom and non-cleanroom. It is based on industry-wide best practices for working in areas containing hazardous materials, and emphasizes



covering as much skin as possible to contain sloughed skin particles. You will be denied access to laboratory spaces if you are not dressed according to the following rules.

#### HYGIENE

You and your clothing should be clean (i.e. free of dust or dirt) before entering lab spaces. Avoid clothing that sheds fibers such as wool, fur, fake fur, mohair, etc. Dirty or shedding clothes contaminate everyone's work, even in non-cleanroom spaces. Make-up and cosmetics are not allowed in lab spaces.

#### SHOES

You must wear shoes that completely enclose the heel, toes, and top of your feet. Socks or stockings are required. Sandals, open-weave shoes, or shoes that expose the top of the foot are not allowed. High heels and deep-treaded shoes that hold mud or dirt are also not allowed. Despite the substantial wet weather in the Pacific Northwest, your shoes should be clean and dry before entering the labs. It is preferable that you bring a clean, dry change of dedicated lab shoes that you do not wear outside. It is imperative that you avoid tracking mud, dirt and leaves into the labs.

#### PANTS

You must wear long pants that run from your shirt to your ankles. Shorts, short pants, capris, skirts and dresses are not allowed. During warmer weather, you may bring with you a pair of lightweight hospital-scrub style pants to wear over your shorts. You can purchase inexpensive scrub pants from the WNF staff for this purpose. You can either purchase a pair of scrub pants from WNF staff or need to return home to change into acceptable attire.

#### SHIRTS

Your shirt must cover your shoulders and reach from the top of your arms to your pants. Tank tops, halter-tops, and spaghetti strap tops are not acceptable.

#### SAFETY GLASSES

Safety glasses must be worn at all times in all labs. The WNF provides safety glasses, or you may choose to purchase your own glasses, provided that they meet ANSI Z87.1-2003 standards. You are allowed to remove your safety glasses when using optical microscopes, but remember to put them back on when you step away from the microscope. Safety glasses are not acceptable for chemical protection; face shields must be worn during chemical use. Please refer to the Personal Protective Equipment (PPE) section for details in chemical protection protocols.

#### CONTACT LENSES

Consistent with recent recommendations from the American Chemical Society, contact lenses are allowed in WNF laboratories, provided that safety glasses are also worn at all times. In the case of an eye exposure emergency, rinse at the emergency eyewash station with contacts in place, and remove them while flushing.

#### CORAL

CORAL (Common Object Representation for Advanced Laboratories), originally built by Stanford and MIT, and extended here at the UW, is software used to measure and control the use of user facilities. The WNF uses UW CORAL Web Front End, an interface layer that allows users (and administrators) to use the UW CORAL installation without having to install any application on their computer (or mobile

device). The interface is usable for basic tasks on a mobile device, though some functionality requires a desktop or laptop computer. The key features of UW CORAL are listed below:

- User Registration
- Instrument Restrictions
- Instrument Scheduling
- Instrument Problem Reporting
- Use Monitoring
- Review and Corrections
- Billing and Reporting

You will be given a short introduction to CORAL in your lab orientation. Additional information is located at <http://coral.engr.washington.edu/doco/>.

## EQUIPMENT POLICIES

### RULES

- You must be trained and officially qualified before using any equipment.
- Do not use equipment for unapproved purposes.
- Tool owners must authorize all new processes.
- Your reservation will be void if you have not enabled the tool within 15 minutes of your start time.
- You must report equipment problems or damage in CORAL.
- Do not use equipment that has been enabled by other lab users.
- Disable equipment when you are finished.
- You must submit a Billing Adjustment Request, found under “User Portal” on the WNF website, every time you need staff to adjust your billing. If you require an adjustment because you forgot to disable an instrument, you will be charged a fee.

### EMERGENCY MANUAL OFF (EMO)

Most tools have EMO switches that will disable all power to the system, and should only be used in emergencies. Using an EMO can be detrimental to equipment, so you should carefully distinguish process instabilities and uncommon runs from emergency situations. If you notice electrical arcing, smell or see smoke, or determine your health is in immediate danger, do not hesitate to use the EMO switch. Flickering plasma, unusual etch rates, or a system that will not pump to the expected vacuum are not emergencies that warrant the use of an EMO.

## CLEANROOM POLICIES AND PROCEDURES

### PERSONAL EFFECTS STORAGE

While you are working in the labs or cleanroom, store all personal items, such as coats, knapsacks, bicycle helmets, books, etc., in the alcove just opposite the cleanroom entry door, near the central restrooms. Do not bring any of these items into the gowning room or cleanroom. This is a short-term storage; items left for prolonged periods may be disposed or reclaimed.

### CLEANROOM ITEM/ACTIVITY RESTRICTIONS

People and the items they bring into the cleanroom are primary sources of particulate contamination. In addition to the table above that applies to all WNF lab spaces, the table below lists items that can and cannot be brought into the cleanroom. Minimize contamination by only bringing items necessary for your research into the cleanroom.

<b>Partial List of Prohibited Items/Activities</b>	<b>Allowed Items/Activities</b>
Cardboard, fiberboard, wooden containers	Plastic items, plastic boxes, plastic containers
Paper, paper notebooks, books, magazines, etc.	Cleanroom paper, cleanroom notebooks
Pencils, erasers	Pens
Over-the-ear headphones	Ear bud headphones (keep at low volume)
Hats, coats, scarves, bags, backpacks, etc.	Over-the-ear if fully under hood (at low volume)
Makeup, cosmetics	Laptops, e-readers, cell phones
Running jogging	

### GOWNING PROCEDURES

Proper gowning is important to maintain garment and facility cleanliness. Gowning will be demonstrated for you during your cleanroom orientation.

To enter the cleanroom, swipe your keycard to unlock the gowning room door. Even if someone else opens the door for you, you must also swipe your keycard to indicate your entry into the cleanroom. CORAL tracks the real-time user list for emergency response accountability. It is imperative that you swipe out of the lab when you leave; otherwise, EMS personnel will assume you are in the lab in an emergency. If your keycard does not unlock the door, you may not enter the cleanroom. If you have completed all access requirements and your access card does not work, please see or email lab administration in Fluke Hall Room 215 to troubleshoot access issues. Entering the cleanroom without swiping your keycard or when your keycard is disabled is a violation of both lab and university policy.

- Before entering the cleanroom, make certain you meet the dress code requirements.
- Before stepping beyond the first bench, put on a pair of blue shoe covers, a bouffant hair net, enclosing as much of your hair as possible, and a first pair of nitrile cleanroom gloves.
- If you do not have a cleanroom suit already on a hanger, select a hood, cloth face veil, coverall, and pair of boots in your appropriate size from the shelves.
- Put on the cleanroom hood with the seams facing inward, and then snap the cloth face veil inside the hood. Some of the hoods are packaged inside out, so check that you are putting the hood on correctly.
- Verify placement of the face veil using the mirror on the wall. Some of the hoods have a pair of snaps under the chin. There are multiple snaps on the hoods and face veils so you can adjust and find positions that provide maximum cleanliness and comfort. The face veil needs to



completely cover your mouth and nose, resting on the bridge of your nose where your safety glasses rest.

- Place your safety glasses outside of your hood and on the bridge of your nose where the face veil rests.
- Put on the cleanroom coverall suit; do not to drag the suit on the floor in the process. Hold the sleeves in your hand while putting your feet into the suit to prevent the sleeves from touching the floor. Your first pair of gloves should be tucked under the cuffs of the suit.
- Tuck the bottom of the hood into the suit, zip up your suit, and snap the top snap on your suit. Use the mirror on the wall to verify that the hood is correctly positioned inside the cleanroom suit and that both your mouth and nose are covered.
- Sit on the second bench and put on your white cleanroom boots, tucking the legs of the suit into the boot. Connect the strap across the top of the foot and tighten it snugly. Snap the top of the boot to the back of the suit leg. Avoid putting your clean white cleanroom boot down on the gowning-room side of the bench, and avoid putting your blue bootie-covered foot down on the cleanroom side of the bench.
- Put another pair of gloves on over the top of the gloves you initially put on (double-glove). These should extend outside the sleeves of the coverall.
- Using an IPA squirt bottle, moisten a cleanroom wipe and wipe down all the items you bring into the cleanroom.
- Once inside the cleanroom, do not open or unzip your cleanroom suit. If you need to access something within your suit (e.g. cell phone), go into a gray area to do so.

## CLEANROOM PROTOCOL

All users must help maintain the integrity, usability, and effectiveness of the cleanroom. Even if your project is not sensitive to particulates or other contamination, you must follow all cleanroom protocols at all times.

- If your gloves are torn, soiled, or otherwise contaminated, immediately remove the outer pair and put on new gloves.
- Never touch doorknobs, telephones, equipment controls, microscopes or other common objects with contaminated gloves. Cross contamination can permanently damage equipment and expose other users to chemical hazards.
- Tacky mats are placed throughout the lab to reduce airborne particulates. Do not step over or bypass the tacky mats.
- Do not leave items strewn about the lab. Use your assigned dry box storage space. Items left in the lab will be moved to the lab lost-and-found, in the east gray space. After one week, unclaimed items will be discarded or reclaimed.
- If you need something from under your suit, do not unzip your suit in the cleanroom. Move to a gray area (gowning room or maintenance/storage chase) to open your suit. If you intend to use the retrieved item in the cleanroom space, it must be wiped with IPA.
- Do not sit or lean on equipment or tables.
- Do not shake hands in the cleanroom.
- Use all materials (e.g. wipes and chemicals) sparingly to keep costs down.

## WAFER HANDLING

### CASSETTES

Whenever possible use cassettes to carry and process your wafers, except in cases where using a cassette would result in excessive and unnecessary chemical usage. Although you can orient wafers in your cassette however you please, they are generally positioned starting from the H-bar (horizontal bar) with the polished surface facing away from the H-bar. Cassette-to-cassette transfers are the

easiest method to transfer a large number of wafers. First, set the filled cassette on a flat surface, then flip an empty receiving cassette upside down and mate the two cassettes using the dimples and holes. Grab both cassettes, compress them together, and then slowly tilt both until the wafers roll from the donor cassette to the receiving cassette.

## TWEEZERS

Only handle wafers with wafer tweezers. Only touch tweezer handles; do not touch the shovel or pincer (gripping end). Ensure your tweezers are compatible with the chemicals your processing requires. Use care to avoid gouging equipment (e.g. hotplates or RIE chucks). Pick up wafers from the major flat whenever possible. When carrying wafers, it is advisable to hold your other hand under the wafer in case you drop it. Clean your tweezers regularly.

## GLOVES

Do not touch the front or back surfaces of your wafers. Your gloves are always contaminated to some extent. Brand new gloves can have plasticizer residues, or you may have accidentally touched something dirty or dusty. Unless you have a very specific reason, you should never touch your wafers with your hands. However, for some processes, such as transferring wafers with freshly spun thick photoresist (e.g. SU-8 2100) to a hotplate, it may be appropriate to carefully transfer your wafer by lifting it gently from the edges with a doubled gloved hand (never pinch with your thumb and index finger). Another example would be to avoid transferring tweezer marks to a hard mask if you plan to do anisotropic silicon wet etching. Again, change your outer gloves immediately if they become contaminated for any reason.

## CLEANROOM DRY BOX STORAGE SPACE

Research groups and companies can request dry box storage for active wafers, photomasks, and necessary lab supplies. Additional dry box space is available for a monthly rental fee. Lab storage is intended for active materials, not archival storage. You are not permitted to store chemicals or other hazardous materials in your dry box (evaporation sources and crucibles are allowed). You cannot store any items that are incompatible with cleanroom protocols (e.g. cardboard or paper). If you need special chemical storage, please make a request to the WNF staff.

In addition to access from the cleanroom, you can access your storage dry box without gowning by going through the non-cleanroom office/work space in Room 135. Walk past the back-end process room, turn left, and follow that corridor to the end. To enter this maintenance and storage gray space, you must put blue shoe-covers over your shoes and step on the tacky mats. Before touching your dry-box or items inside, put on a pair of cleanroom gloves. You must clean any materials you bring into the cleanroom by wiping with IPA and cleanroom wipes located at the entrance to this gray space.

## EXITING THE CLEANROOM

- When you exit the cleanroom, sit on the inner bench and remove your outer gloves and your white cleanroom boots. Leave your blue shoe-covers in place while in the gowning room, and avoid putting your blue shoe-covered foot down in the cleanroom areas or your white boot down in the middle gowning area.
- In the middle gowning room area, remove your coverall first, and your hood second, leaving the hairnet, blue shoe-covers and inner gloves in place. While removing the coverall, do not allow the sleeves or upper part of the suit to touch the floor. Place your coverall on your hanger. Snap your hood to the collar snap of your cleanroom suit, with the outside facing



outward and on the outside of the suit. Snap your boots to the legs of your coverall. Clip your ID clip to the suit. If you do not have an ID clip, ask a WNF staff member for a labeled clip.

- Continue to reuse the same gown upon each entry. On Monday evening or Tuesday morning, all gowns are sent out for laundering. The first time you enter the cleanroom after a garment change, get a new cleanroom suit and locate your nametag.
- If your cleanroom garment becomes soiled, do not place it back on the coat rack where it can contaminate other garments. Instead, place the garment in the laundry bin and get a new suit on your next entry.
- You must swipe your keycard each time you exit the cleanroom. This is required so that there will be an accurate record of who must be accounted for in an emergency.

## WORKING WITH CHEMICALS

### UNIVERSITY OF WASHINGTON LABORATORY SAFETY MANUAL

The WNF is a laboratory space located on the University of Washington's Seattle Campus. As such, we must follow rules outlined in the University of Washington Laboratory Safety Manual put together by Environmental Health and Safety (EH&S). This manual can be found at:

<http://www.ehs.washington.edu/manuals/lsm/lsm.pdf>

You are responsible for understanding this laboratory safety manual and abiding by its rules. Additionally, there are several EH&S online safety courses you must complete to become a lab user.

### UNDERSTANDING HAZARDS

Do not use or handle any chemical until you read and understand its label and safety datasheet (SDS). Understand the hazards, handling, storage, disposal, and emergency procedures for every chemical you use. SDSs are located at or below the Right-to-Know Workstation at the southeast side of the gowning room, and are also available through CORAL. You also need to know evacuation routes and locations of eyewashes, and shower stations.

### GENERAL SAFE PRACTICES

- Do not taste, touch, or smell any chemicals.
- Do not mix, heat, dispose, or otherwise use chemicals in an unauthorized manner.
- Work with chemicals in an exhausted fume hood or wet bench.
- Use chemicals only in wet benches where they are approved.
- Never mix acids and solvents.
- Never dispose of solvents down water drains or water down solvent drains.
- Change your gloves if they might be contaminated.
- Label your chemicals.
- Do not place or store chemicals above the level of the wet bench surface.
- Never remove chemicals from the lab without permission.
- Use chemicals and cleanroom wipes sparingly.
- Do not interrupt users working with chemicals.
- If you are unsure of handling or safety procedures, ask questions.

### BUDDY SYSTEM

Most chemicals used for cleaning and etching wafers are very dangerous, so it is required that another authorized cleanroom user accompany you while you are working at the wet benches. A buddy is required for all wet processing performed in wet benches on the north side of the photolithography room. All dry processes are permitted without a buddy; however, it is recommended that you coordinate lab activities to ensure that at least one other person is in the vicinity. You may not assume that someone is your buddy if they happen to be in the lab. You must explicitly notify them that you need a buddy, and they must accept that responsibility. Your buddy may not leave until chemical operations are completed and you have cleaned up.

## CHEMICAL CLASSES AND STORAGE

### ACIDS

Acids are substances that donate protons when dissolved in water. Acids are used for etching metal and cleaning wafers, are generally corrosive, and can be toxic or water reactive (e.g. sulfuric acid). Acids are stored in the blue corrosives cabinets on the northeast side of the photolithography room, and in BATH1-Piranha, BATH2-RCA, BATH3-HF-BOE. Metal etchants are also stored in the HOOD1-HFok and HOOD2-noHF.

### BASES

Bases accept protons, and can increase the hydroxide ion concentration when dissolved in water. Many photoresist developers are dilute bases, and some concentrated bases can be used to etch silicon. Bases are stored in the upper gray cabinets on the northeast end of the photolithography room, and in BATH4-KOH-TMAH.

### OXIDIZERS

Oxidizers are agents that are easily reduced, and generally supply oxygen to chemical reactions. Examples in the lab include hydrogen peroxide and nitric acid. Oxidizers can react violently with organic chemicals.

### SOLVENTS

Although the term “solvent” refers to any liquid used to dissolve another material, in a cleanroom setting “solvents” are typically organic liquids that are flammable or combustible. We use acetone, isopropyl alcohol, methanol, n-methyl pyrrolidone, dimethyl sulfoxide, and a variety of others. Photoresists are usually photoactive polymers suspended in organic solvents such as propylene glycol monomethyl ether acetate (PGMEA) or cyclohexanone. Solvents and photoresists are stored in the yellow flammables cabinets on the east wall of the photolithography room. Photoresist strippers and solvent waste containers are kept in the blue cabinet next to the southeast emergency exit of the photolithography room.

## NEW MATERIALS REQUESTS

Before bringing a new chemical into the cleanroom, you must submit a New Materials Request Form, an SDS, and a Standard Operating Procedure to the WNF website, which will be sent to the lab manager and the lab safety manager for approval. We do not permit long-term storage of any personal chemicals in the facility or wet benches without explicit permission.

## WET BENCH TYPES

The photolithography room has metal (stainless steel) and plastic (chlorinated polyvinylchloride) wet benches. Organic solvents such as acetone, isopropanol, and SU-8 developer are not allowed on the plastic benches because they will dissolve the working surfaces. Acids and bases are not allowed on metal benches. More detailed restrictions are available in the documentation for individual benches that can be found in CORAL. You are responsible for understanding the specific requirements and chemical restrictions for each bench.



## AVOIDING FUMES

Fume hoods are designed to limit your exposure to chemical fumes and are equipped with pressure gauges and sash height sensors to ensure safety and proper operation. Although the benches are designed to turn off during exhaust outages, check the pressure sensors to make sure the pressure is within the acceptable limit. Many fumes in the lab are toxic, corrosive, or carcinogenic, so it is important to only work under the sash for very brief periods of time and only when absolutely necessary.

## PERSONAL PROTECTIVE EQUIPMENT

You are required to use additional personal protective equipment (PPE) when working in the wet benches on the north side of the photolithography room and when transferring chemicals to and from the corrosives cabinet.

### DONNING PPE

PPE consists of three items that should be donned in the following order: a chemical apron, a face shield, and chemical gloves. Check all items for damage before use. Look for cracks or pinholes in gloves, tears or holes in aprons, and scratches or cracks in face shields. If any gear is damaged (e.g. ripped apron or gloves), discard it and use another item. Rinse damaged items with DI and dry before disposing. Use care when putting on aprons to avoid ripping the seams, and make sure the apron sleeves are fully tucked under the chemical gloves.

### WEARING PPE

Do not touch anything unnecessarily with the chemical gloves and treat them as though they were contaminated. For example, do not touch face shields, sashes, controllers, or any other equipment with the chemical gloves, and do not leave the photolithography room while wearing chemical gloves. It is acceptable to leave your chemical gloves on the edge of a wet bench while you work elsewhere. The apron must fully cover your shoulders at all times (i.e. make sure it is tied around the neck and do not let it slip off while you work).

Wearing PPE is not an excuse to act in an unsafe manner. Do not ever put your hands or fingers into a chemical bath, and always avoid splashing or spilling chemicals. Also, PPE provided by the WNF is only for temporary protection. It will not protect you from a spill, splash, or mist for a prolonged period of time.

### DOFFING PPE

Rinse and dry the chemical gloves, remove them and hang them up. Hang face shields and avoid scratching the plastic. Lastly, remove the apron and be careful to avoid ripping it. If condensation has accumulated in the apron, use a wipe to dry the inside. Do not leave the apron inside out.

## LABELING

Prior to filling, all chemical containers must be properly labeled even if you do not intend to walk away. You must include your name, the chemical name, and the date. If you plan to leave chemicals out after leaving the room, a phone number or email and an expected time of disposal must also be provided. Water must be labeled. If the chemical is not regularly used in the cleanroom (e.g. it was brought in after approval from the lab staff), list all hazards.

## POURING CHEMICALS

Assume that all chemical bottles are contaminated. Use a bottle carrier when transferring chemicals to and from storage locations. Immediately before pouring, always recheck the chemical label and make sure the chemical container you intend to use is set flat on the wet bench surface. Do not try to pour small volumes from gallon jugs; instead, transfer chemicals from gallon jugs to graduated cylinders or beakers, and then pour again from this secondary container. Use good judgment and do not overfill containers (i.e. do not fill them so close to the top that moving the container or disposing the chemical is unsafe). Never return poured chemicals to their original container.

Use containers that are compatible with your chemicals. For example, some chemicals or solutions, such as piranha (a mixture of sulfuric acid and hydrogen peroxide), cannot be stored in closed containers even for brief periods of time because it outgases and could cause an explosion. Also, hydrofluoric acid cannot be used with glassware because it will dissolve the container.

## CHEMICAL BOTTLE CLEAN-UP

Use chemicals in partially used bottles before opening new bottles. Properly clean empty chemical bottles before disposal. Leave empty solvent bottles open in the hood behind the cascade bath at the back of BATH6-Strip to evaporate. After the solvent residue has evaporated, fill the bottle half full with DI water and dump down a water drain. Repeat this process three times. Acid and base bottles must also be rinsed by filling the bottle half full with DI water, emptying the bottle into a water drain, and repeating at least three times. After rinsing, dry the outside of the bottle with wipes, use a black marker to cross out the label, and then write "Rinsed 3x" in at least two different locations on the bottle. Set the empty, rinsed, dry, and labeled bottle in the bottom shelf of the blue photoresist stripper cabinet.

## DISPOSING SOLVENTS

To dispose of used solvent, empty it into a solvent drain or into an appropriate waste container. A list of solvents allowed into the solvent drains is posted on the hood. Clean the chemical container with an acetone soaked wipe, and then wipe thoroughly with isopropanol (IPA). Remove the label with acetone or IPA (do not bring a solvent squirt bottle into a plastic bench), rinse with DI at any of the plastic benches, and return the container to the drying rack.

## DISPOSING ACIDS AND BASES

Almost all acids and bases can be disposed into sinks in the plastic benches that drain to the neutralization system. Run the faucet so the solution will be diluted at least ten to one with DI water while carefully dumping the acid or base into the sink. Avoid splashing. Take the chemical container to the south side of the room and remove the label with acetone or IPA on a wipe and then return it to the drying rack.

## HANDLING SMALL SPILLS

Attempt only to clean small spills for which your training and experience are appropriate, provided you can do so safely without taking unnecessary risks. Large spills or spills outside of wet benches should be treated as emergencies. Refer to the Chemical Emergencies section of this manual.

Clean small solvent spills with lint-free wipes and dispose them in the red solvent waste can. Then use acetone and IPA with wipes to clean the metal surface.

Clean acid or base spills in plastic benches by thoroughly rinsing the working surface with DI from a spray gun. Use care to avoid getting water in staff-maintained baths. Do not wipe up chemicals directly with cleanroom wipes without first rinsing and diluting the spill thoroughly. This is of particular concern with highly oxidizing agents (e.g. hydrogen peroxide or nitric acid), because of the potential fire hazard. After rinsing the surface, use a plastic scraper to move the water into the cracks between bench panels or into the sink (not into baths). Once you are sure that there is only water left on the surface, dry the remaining drops of water with a wipe to leave a clean, dry surface. Wipes are expensive; use sparingly.

## HOTPLATE SAFETY

Hotplates are used extensively for baking photoresist and occasionally for heating solutions. Do not touch hotplate surfaces. Use extreme care when hotplates are used in proximity to flammable solvents or other liquids. Do not spill on hotplates or spray water on hotplates, and do not heat high vapor pressure solvents. For example, do not heat up acetone or isopropanol. It is acceptable to remove hotplates from a wet bench if you need more room or if you feel more comfortable working without one in the hood. If you need to heat an organic solvent or material in a bottle (e.g. SU-8), heat the container in a water bath, not directly on a hotplate.

## LEAVING WORKSPACES

After using a bench or other workspace, clean up all chemicals, chemical containers, wipes, and other materials (samples, tape, markers, notes, personal effects, etc.). Always leave wet bench surfaces clean and dry within comfortable arms reach, and as organized as possible. It is not necessary to clean out the cascade rinse tanks or the very back of the bench tops.

## EMERGENCY PROCEDURES

You are strongly encouraged to read the WNF Emergency Evacuation Operations Plan. This document has detailed information for most emergencies, some of which are not covered here (e.g. bomb threats, anthrax threats, civil demonstrations, etc.), as well as evacuation options for persons with disabilities. You are also encouraged to be familiar with the information found at websites like:

[www.washington.edu/emergency/](http://www.washington.edu/emergency/)

[www.washington.edu/safety](http://www.washington.edu/safety)

[www.ready.gov](http://www.ready.gov)

If you find yourself involved in a major emergency, do not be shy or embarrassed about calling for help or pulling the fire alarm. If possible, when emergency personnel arrive, approach them, tell them that you were involved with the incident, and be ready to explain what happened.

## EMERGENCY COMMUNICATIONS

### TELEPHONES

Use a cell phone or the campus telephone system to report emergencies. In case of a system failure or a power failure, campus phones will not function. However, the emergency single line phone, located outside Fluke Hall on the northeast side of the building designated with a blue light, may still function. Similar emergency phones, part of the UW's Emergency Communications System (ECS), are strategically located in nearly 200 locations throughout campus.

To dial campus numbers from campus phones, simply dial the last five digits of the number. To dial other local (206 area code) numbers, dial 9, followed by the seven-digit number.

<b>Emergency Resource</b>	<b>Contact Information</b>	<b>Purpose and Responsibilities</b>
UW Police Department (UWPD) Bryant Building 1117 NE Boat Street	Emergency Assistance: Dial 9-1-1. Non-Emergency Assistance: Dial 206-685-8973.	UWPD maintains an Emergency Communications Center 24 hours a day, 7 days a week. Call 9-1-1 for emergencies of any kind.
Environmental Health and Safety (EH&S) 201 Hall Health Center	Dial 206-543-0462. After normal business hours, EH&S may be reached through the UWPD using the EH&S Duty Officer system.	EH&S maintains guidelines and provides training, consultation and support for building emergencies. EH&S is also available to provide consultation and support for hazardous material spills and releases, temporary controls, and other general information to the Seattle Fire Department (SFD), UWPD, and UW departments.
Facilities Services (FOMS & ATC-20)	Dial 206-685-1411. Routine and emergency services (essential services are covered 24 hours a day).	Facilities Services maintains a 24-hour a day, 7 days a week response unit called "FOMS" or "Unit 2." The FOMS respond automatically to all fire alarms and other emergencies to provide support for the UWPD and SFD. This support includes, but is not limited to, the operating/resetting of the fire alarm system; operating the heating, ventilation, and air-conditioning systems (HVAC); and the shutdown of steam, water, electrical, and other utilities.

<p>UW Emergency Operations Center (EOC)</p>	<p>The primary EOC is located in UW Tower, 4333 Brooklyn Ave NE, Room C-140. The secondary EOC location is Lander Hall, Room L-135.</p>	<p>For a major local or regional emergency, the UW President may request activation of the University’s Emergency Operations Center (EOC). Information on missing persons, building emergencies, first aid, and other needs during a large-scale emergency must be provided to the EOC by using campus telephone systems, computer, (See Emergency Communications in Section 1) or by runner if the telephone systems fail.</p>
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**FIRE ALARM SYSTEM**

The building fire alarm system is continuously monitored by a contracted service and, in a backup capacity, by the UWPD Communication Center. All alarms result in an automatic response by Seattle Fire Department, UWPD, and Facilities Services’ FOMS unit. Manual fire alarm pull stations are located on each floor and are shown on the Fluke Hall floor maps below.

**SIMPLEX DIALER / HAZARDOUS MATERIALS ALARM SYSTEM**

As an H5 occupancy zone, we have a toxic and pyrophoric gas monitoring system that is continuously monitored by a contracted service (Simplex Grinnell). In an alarm event, the monitoring service calls staff members prioritized by residential proximity to Fluke Hall to ensure as timely a response as possible during non-business hours.

There are several different cases in which a HAZMAT alarm can trigger. If there is a low-level gas detection event, or if a HAZMAT pull-station has been used, the yellow strobes in the cleanroom will activate and you are required to exit the cleanroom. Low-level alarms and manual pull stations will not immediately call the Seattle Fire Department.

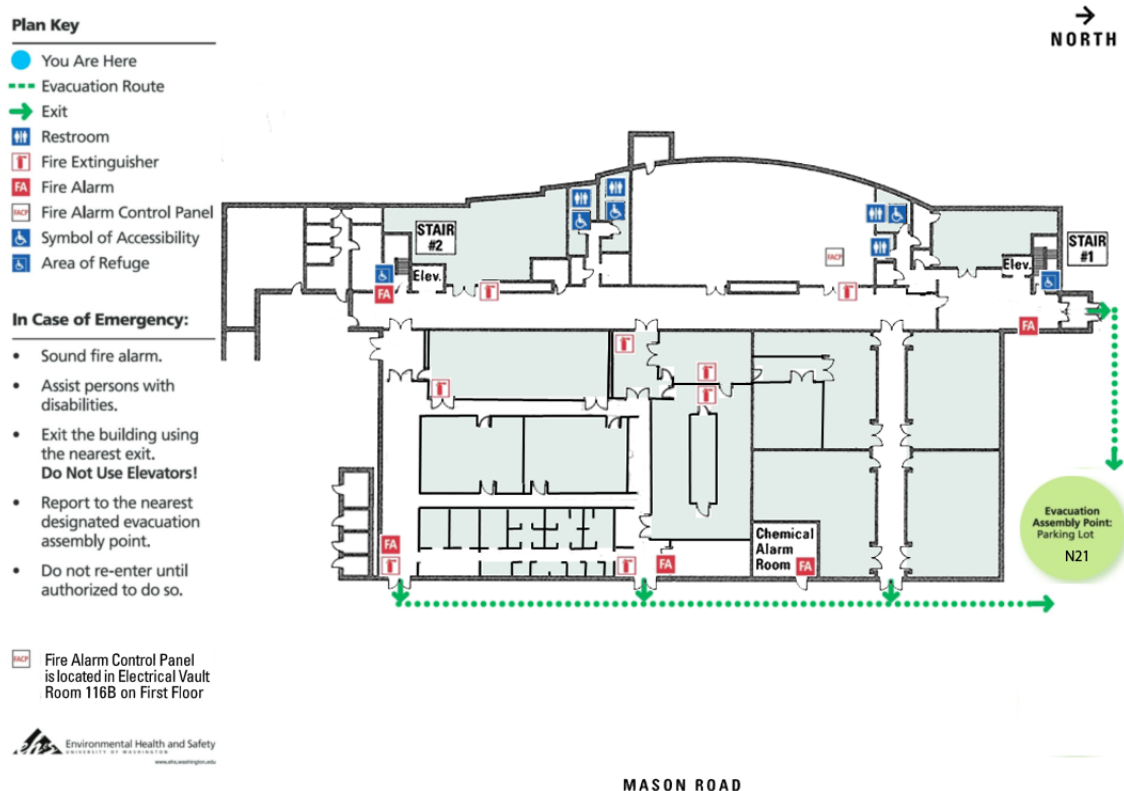
If there is a building fire, the manual fire pull stations have been used, or the HAZMAT system detects a high-level leak, the Seattle Fire Department will immediately be notified. Someone with knowledge of the lab will likely be required to advise them of (a) how to understand the alarm panels, (b) where the readout locations correspond to, and possibly (c) what response is necessary.

Other events, such as pressure or flow variations in the gas cabinets, can trigger problems with the detection system that do not require evacuation but can render equipment unusable. If there is trouble with the detection system, hazardous process gases will automatically be shut down. In this case, staff will be notified and will work to correct the problem and get the detection system and impacted tools operational in a timely manner.

## EVACUATION PLAN

The floor plans below identify exits and exit routes for the building. Occupants should go to the nearest exit during and evacuation. If access to the nearest exit is obstructed, an alternate exit should be taken.

### FLUKE HALL 1<sup>ST</sup> FLOOR



Note: Avoid the chemical storage room and gas bunkers! Evacuate to the east and north, not to the south.

## EVACUATION ASSEMBLY POINTS

Assemble after an evacuation so the evacuation warden (yellow hat) can account for you and so you can lend assistance as needed. The primary evacuation assembly point (EAP) for Fluke Hall and the WNF is the N21 parking lot located to the north of Fluke Hall. The secondary evacuation points are the E1 parking lot Husky Union Building yard. If the Evacuation Director finds the primary EAP unsuitable, then evacuees will be moved to the secondary EAP. The Area of Safe Refuge is located in the north lobby of the first floor.

## CHEMICAL EMERGENCIES

### SPILL RESPONSE

In order to become an onsite user, you are required to complete the UW EH&S Managing Laboratory Chemicals online training course. This training outlines chemical handling and emergency procedures. If you cause or encounter a chemical spill, respond accordingly based on the following scenarios.

- Risk of fire or spills that could spread out of the room: Pull the nearest fire alarm. This alerts the local fire and police departments that there is an emergency at your location and sounds the alarm in the building for everyone to evacuate. Leave the building, helping others as necessary. Then, if possible, call 9-1-1. Tell them what happened. Stay on the scene to help personnel respond to the emergency. Do not fight any fires yourself.
- No risk of fire, spill and vapor contained in the room, but someone is injured or exposed: Call 9-1-1 only. If someone has been exposed to a chemical, begin decontamination and/or first aid as soon as possible. Evacuate the room and wait for emergency personnel to arrive.
- Everyone is safe, but there is a large chemical spill: Contact the lab staff or call the EH&S Spill Advice Line during normal hours at 206-543-0467. Call 9-1-1 after normal business hours and ask for EH&S chemical spill advice. EH&S will advise you on how to clean up your spill or will call the UW's spill cleanup contractor to clean up the spill for you at the lab's expense.

Only attempt to clean small spills for which your training and experience are appropriate. If you feel comfortable and are properly trained, there is a spill cart located in the tool gray area for any chemical spill that is not considered a HAZMAT emergency. Spill carts contain acid and base neutralizers, HF spill kits, mercury spill kits, caution tape for clearing an area, and personal protective equipment. Personal protective equipment includes nitrile and neoprene gloves, aprons, and face shields. Additionally HAZMAT Level B suits are available on the spill cart for staff use only. Contact staff for large spills (>100 mL) or spills outside of a wet bench. Do not clean spills that occur outside of the fume hood that may require specialized respiratory protection (e.g. large acid or solvent spills, including any HF spills)..

Regardless of the size of spill, contact the staff and report the spill details and if/how it was cleaned. Once the spill is handled properly and everyone is okay, the events need to be reported and discussed to improve spill prevention and evaluate the response as a laboratory group.

Also, if you are involved in a spill, you must fill out an Online Accident Reporting System (OARS) accident report on the EH&S website. State and federal law requires that all accidents and near-misses be reported. The University of Washington also has committees that track accidents on campus in order to assess and improve campus safety.

## CHEMICAL EXPOSURES

Working with chemicals is dangerous. Even common mistakes like dropping a container or leaving a reaction unattended for "just a minute" can have serious consequences when chemicals are involved. Work carefully and deliberately; keep in mind what to do if things go wrong. Read the MSDS for all chemicals you plan to use to ensure you are aware of hazards and emergency procedures. Avoid exposures by following the rules below:

- Don't work with chemicals when you're too tired to think clearly.
- Keep your workspaces clean and organized.
- Wear personal protective equipment

If you are exposed to a chemical (other than hydrofluoric acid, discussed in the next section), do the following:

- Stay calm. Move out of the contaminated area.
- Get the chemical off. Fast dilution is key. If the chemical is on skin or soaking through your clothing, go to the safety shower. Pull the handle on the safety shower, and do not worry about

getting the floor wet. Stay in the shower for a minimum of 15 minutes, taking off all clothing necessary to minimize exposure to the chemical. Do not be modest, as your life may depend on removing soiled garments! Get coworkers to help shield you or cover you up. If the chemical is in your eyes, use the eyewash, holding your eyes open in the water for 15 minutes.

- Get a coworker to call 9-1-1 as soon as possible. Have them explain the situation to emergency personnel.
- If possible, obtain an MSDS/SDS to give to emergency personnel.

You must inform WNF staff if you have had an exposure to a dangerous chemical. If a hospital visit is needed, it is always valuable to take the material safety data sheet (MSDS) for the chemical to the hospital because the proper medical care can be better determined with the MSDS.

### HYDROFLUORIC ACID EXPOSURE

Hydrofluoric Acid (HF) is among the most dangerous chemicals in the WNF, and the medical treatment for exposure is specialized and differs from that of most other chemicals. HF exposure is very serious, as it can cause severe burns, metabolic imbalances, pulmonary edema, and cardiac arrhythmias. As little as 100 mL is potentially lethal if untreated. HF and Buffered Oxide Etch (BOE) will not necessarily cause an immediate burning sensation, so respond quickly if you have had an exposure even if you do not feel any immediate pain.

- In the event of skin contact: remove clothing and flush the affected area for a maximum of 5 minutes. While rinsing, have someone call 9-1-1. Put on double nitrile gloves and then apply calcium gluconate gel, located on the HF wet benches, to the contaminated skin. This will help to neutralize fluorine ions.
- In the event of eye contact: use the eyewash for 15 minutes. Do not use calcium gluconate in your eyes! Call 9-1-1. Emergency personnel will treat eyes with a solution of calcium gluconate mixed with saline.
- In the event of inhalation: Call 9-1-1. Move to fresh air and wait for medical assistance.

If you are aiding someone experiencing HF exposure, wear black, neoprene gloves that offer the highest protection from HF, or double nitrile gloves if those are not available. The University of Washington EH&S provides details on HF hazards, exposures, spill cleanup, storage, etc. in a document that can be found at:

<http://www.ehs.washington.edu/manuals/focus/hf.pdf>

A much more thorough examination of HF and of first aid and medical procedures can be found at:

[http://www51.honeywell.com/sm/hfacid/common/documents/HF\\_medical\\_book.pdf](http://www51.honeywell.com/sm/hfacid/common/documents/HF_medical_book.pdf)

### HAZMAT EMERGENCIES

Pull one of the yellow HAZMAT alarm boxes if you believe there is an immediate danger to anyone in the lab. If you feel unsure about the danger, find another user to immediately contact staff for an assessment, while keeping other users out of the area.

- In the event of a HAZMAT alarm, all building occupants are required to rally to the building lobby on the north side of Fluke Hall on the first floor.
- If the chemical spill endangers other people outside your workspace or might cause a fire, pull the nearest fire alarm to initiate evacuation and call the local fire department.



- Call 9-1-1 as soon as you are safe to let emergency personnel know what happened. Stay available to help emergency personnel.
- If the spill caused serious injury or exposure, call 9-1-1.
- Move away from the accident scene and help keep others away.
- Do not walk into or touch any of the spilled substance. Try not to inhale gases, fumes and smoke. If possible, cover mouth with a cloth while leaving the area.
- Stay away from accident victims until the hazardous material has been identified.
- Try to stay upstream, uphill and upwind of the accident.
- Authorities may decide to evacuate an area for your protection. Again, it is important to stay calm, listen carefully and follow all instructions.
- If you are told to evacuate, make sure the evacuation order applies to you and to understand if you are to evacuate immediately or if you have time to pack some essentials. Do not use your telephone.
- If you are told to evacuate immediately, quickly and calmly take your personal belongings and medications, close and lock your windows, shut off all vents, lock the door.
- Return to building only when authorities say it is safe.

## FIRES

In the event of a fire, lab users should activate the nearest pull station and evacuate the building.

- When an alarm sounds on your floor or area, begin immediate evacuation following your floor plan. Close doors behind you.
- If you discover a fire, activate the nearest pull station, close the door and evacuate, and call 9-1-1.
- If the fire alarm does not work, call 9-1-1 and notify occupants verbally of the emergency and the need to evacuate. Evacuation Wardens or another responsible party needs to confirm that all occupants are notified.
- If you are on fire, STOP – DROP – ROLL. If another person is on fire, yell “STOP – DROP – ROLL.”
- Evacuate via the nearest stairwell or grade level exit. Do not block exit doors or wedge them in an open position. The doors must remain closed to keep smoke out and maintain safety for evacuation and fire personnel. Leaving doors open makes the stairwells dangerous and unusable. Persons with physical disabilities have several options (see Appendix D).
- Go to your pre-determined Evacuation Assembly Point (EAP). You may have two or more EAP's depending on the size of the building. Immediately report to an Evacuation Warden so that he or she can accurately track which occupants were able to evacuate. Evacuation Wardens will report to the Evacuation Director.
- If you are trapped by smoke, stay low, cover your mouth with a wet cloth, stay near a window, open it but do not break it, hang something out the window to let fire personnel know you are there and put something in the cracks around the door, phone 9-1-1 if possible.

## OTHER MEDICAL EMERGENCIES

There is a First Aid and CPR guide located in all first aid kits. These guides give detailed steps in the event of a heart attack, CPR, choking, bleeding, poisoning, and burns, as well as other injuries. EH&S recommends First Aid/CPR training for a handful of building volunteers to assist with medical emergencies associated with building evacuation and emergencies.

- Stay calm. Assess the situation. Look for a Medic Alert bracelet or necklace on the person requiring help.
- Have someone call 9-1-1. If you are alone, yell as loudly as possible for help. If you are unable to summon help, you have to call 9-1-1 first, and then return and assist the person to the best of your ability.
- When calling 9-1-1, give the operator as much information as possible, i.e. type of emergency, what help is needed, exact address, building name, room number, telephone number, information from Medic bracelet or necklace, and victim information. Don't hang up until you are told to do so by the 9-1-1 operator.
- Do not move the victim.

For additional information visit [www.ehs.washington.edu/ohshsplans/firstaidplan.pdf](http://www.ehs.washington.edu/ohshsplans/firstaidplan.pdf)

## UTILITIES OVERVIEW

Our primary utilities are a deionized (DI) water plant, an acid waste neutralization (AWN) system, a fume scrubber and burn box for lab exhaust, and a hazardous material (HAZMAT) emergency system. The deionized water plant supplies ~18.3 MΩ-cm water to spray guns, cascade rinse tanks, and spin-rinse-driers. The AWN neutralizes aqueous waste that has been disposed in the drains in the wet processing area, and the HAZMAT system monitors three pyrophoric gases: silane, dichlorosilane, and anhydrous ammonia. Compressed nitrogen and compressed air are also fed to lab spaces for various uses. Compressed dry air (CDA) is supplied via a house compressor and is used primarily for pneumatic controls on a variety of equipment. To maintain cleanliness, the WNF has high-efficiency particulate attenuation (HEPA) filters in the ceiling throughout the cleanroom. Lab air is a mix of external air from the supply fans and air from recirculation units.

## ACKNOWLEDGEMENTS

This document was created using information from the Washington Technology Center User Manual, the Microfabrication Facility User Manual, and user manuals from the Cornell Nanofabrication Facility, the Lurie Nanofabrication Facility, the Stanford Nanofabrication Facility, and the Center for Nanoscale Systems at Harvard. The UW EH&S website and training documentation were also used extensively, sometimes word for word.