

WASHINGTON NANOFABRICATION FACILITY
UNIVERSITY *of* WASHINGTON

Laboratory User Manual

Version: 2020.2



TABLE OF CONTENTS

Introduction	3
General Information	5
Becoming a User	5
Consulting and Contract Services	6
Billing.....	7
User and Staff Meetings	7
Intellectual Property and Security	7
Facility Information	8
Site Security.....	8
Space Designations	8
Cleanroom Laboratory	9
Equipment Capabilities.....	10
Non-cleanroom Laboratories.....	10
Public Spaces, and Meeting Areas.....	10
User Storage	11
User Offices	11
Laboratory Policies and Procedures	11
Annual Training Requirement.....	11
Code of Conduct.....	11
Dress code	12
Work Priorities	13
Visitors	13
CORAL.....	14
Equipment Policies	15
User Material and Chemical Abandonment	16
Cleanroom Policies and Procedures	16
Cleanroom Entry/Exit.....	17
Gowning Procedures	18
Cleanroom Protocol.....	19
Working with Chemicals	21
Understanding Chemical Hazards	22
Chemical Handling and Storage.....	22
New Materials and Mixture Requests.....	23
Guidelines for Chemical Use.....	24
Personal Protective Equipment.....	25
Buddy System	26
Labeling of Process Containers.....	27
Chemical Processing.....	28



Chemical Bottle and Waste Clean-up 31

Other Chemical Processing Risks 32

Emergency Procedures 33

 Chemical Response Safety Measures 34

 Chemical Exposures (non-HF) 35

 Hydrofluoric Acid Exposure 36

 Chemical Spill Response 37

 Fires 38

 Seismic Events/Earthquakes 38

 Power Failure 39

 Other Medical Emergencies 39

Alarm Operation: 40

 Audible Alarms and Emergency Indicators: 41

Emergency Evacuation: 43

 Evacuation Map 43

Emergency Communications 44

 Telephones 44

 Fire Alarm System 45

 Simplex Dialer / Hazardous Production Materials Alarm System 45

Utilities Overview 45

Acknowledgements 45



INTRODUCTION

The Washington Nanofabrication Facility (WNF) is administered by the Institute for Nano-Engineered Systems (NanoES) and is located in Fluke Hall on the University of Washington Seattle Campus. WNF is an open-access facility for micro- and nanoscale research, development, prototyping, and fundamental science. The 15,000 square foot lab represents more than \$100 million in facilities and equipment and is the largest public-access fabrication facility in the Pacific Northwest. As a member of the National Nanotechnology Coordinated Infrastructure (NNCI), an integrated network of user facilities supported by the National Science Foundation (NSF), we strive to enable rapid advancements in science, engineering, and technology. By bridging academia, local start-ups, established businesses, and professional organizations, the WNF promotes local economic and job growth by fostering innovation.

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, inspection, and a myriad of other capabilities including nanoscale 3D printing. A basic list of available equipment and current rates can be found online.

- Rates: <https://www.wnf.washington.edu/docs/WNF-Rates.pdf>
- Detailed equipment descriptions: <http://www.CORAL.washington.edu/tools/?lab=WNF>.

Self-directed users represent most of the equipment use in the facility. After being properly trained on the desired equipment, most users work hands-on, directly in the lab, to execute their own projects. Staff engineers are available to consult with users on best practices, review process flows, and provide input on use of standard/best processes.

Additionally, staff engineers can be engaged to provide contract services in support of device fabrication, process execution, characterization, etc.

University researchers and industry clients are active in a wide range of applications and research areas, including:

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



RELATED FACILITIES

As a part of the UW Institute for Nano-Engineered Systems (NanoES) and the National Nanotechnology Coordinated Infrastructure (NNCI), users have access to a broad network of local and national labs and facilities.

The Molecular Analysis Facility (MAF), located in the Molecular Engineering and Sciences Building on the UW campus, houses leading-edge instruments for nanoscale characterization. Equipment capabilities include a variety of cutting edge optical and electron microscopy, spectroscopy and surface analysis tools. A complete list of tools and contact information for the MAF can be found online at the link below.

Located nearby in the Bowman Building is the Clean Energy Institute's Washington Clean Energy Testbeds (WCET), which houses roll-to-roll (R2R) and nanoimprint prototyping, solar and battery testing, and other materials synthesis and testing capabilities.

Both MAF and WCET require individual registration but are easily accessible by WNF users through the CORAL management system.

Through NNCI, WNF users also have access to the broader network of facilities, equipment, and expertise represented by member sites. All NNCI facilities (many sites have partners and multiple locations) are accessible by students and professionals from around the country and globally. The facilities within NNCI support both academic research as well as product and process development. NNCI sites have experience supporting technological innovation and commercialization for start-ups as well as larger and more established companies.

Research undertaken within NNCI facilities is very broad with applications in electronics, materials, biomedicine, energy, geosciences, environmental sciences, consumer products, and many more. The toolsets of sites are designed to accommodate explorations that span the continuum from materials and processes through devices and systems. Micro-/nanofabrication as well as extensive characterization capabilities will provide resources for both top-down and bottom-up approaches to nanoscale science and engineering. For more information, visit the regional and national websites.

See links for more details:

- NanoES: <https://www.nano.uw.edu/>
- NNI: <https://www.nano.uw.edu/nni/>
- MAF: <https://www-moles.nano.washington.edu/maf/>
- WCET: <https://www.wcet.washington.edu/facilities/>
- NNCI: <https://www.nano.uw.edu/nnci/> & <https://www.nnci.net/>



GENERAL INFORMATION

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

As a user facility, the most common paradigm is for individuals to process their devices in person (**on-site users**). This is generally the most cost-effective and efficient manner to complete work in the facility. An alternative approach is to contract facility staff to perform limited scope fabrication processes (**remote users**).

Users are classified as either UW (internal students, faculty, staff, or business units with a UW budget number) or external (non-UW). External users are further categorized as academic (other academic institutions, US government and agencies, and certified non-profit organizations) or industrial (all other for-profit organizations).

BECOMING A USER

The process to become a new user is described on the WNF website at: <https://www.wnf.washington.edu/join-get-started/>.

In summary:

1. Contact WNF at wnfinfo@uw.edu to discuss your project and technology requirements and to set up an initial meeting as needed.
2. Initiate a new user registration: <https://www.wnf.uw.edu/register/>.
3. Complete and return the appropriate Facility Use Agreement.
4. All on-site users must go through WNF site orientation, cleanroom protocol, and wet bench training as well as several online chemical and general safety trainings as outlined in the WNF and UW safety manuals:

Course Title	Type
EHS Compressed Gas Safety	Online
EHS Hazardous Communications Training	Online
EHS Asbestos Awareness	Online
EHS Lead Awareness	Online
EHS Chemicals	Online
EHS Fume Hood Training	Online
EHS Hydrofluoric Acid Safety Training	Online
WNF Site Orientation	WNF Onsite
WNF Wet Bench Training	WNF Onsite

Table 1: Required Training



ON-SITE USERS

While working at WNF, you will learn a variety of processes and gain valuable skills as needed to execute your project. Once certified as a lab user, you will sign up for individual equipment training on an as-needed basis. WNF maintains standard operating procedures (SOPs) for all equipment and has standard process recipes defined for each tool that meet most typical user needs. We advise finding a mentor or consulting with staff to ensure proper cleanroom process flow and designs that align with the WNF's capabilities, especially if you plan to repeat or expand upon an established process. For more complex inquiries, engineering staff is available for consulting at posted rates for more in-depth project review and support of process development or troubleshooting.

REMOTE USERS

For remote users that do not plan to work directly in the lab, WNF staff engineers are available to conduct limited-scope process work on a "best effort" basis. Jobs will be accepted and scheduled based on time, material, and tool availability. Due to the experimental nature of most contract processes, we cannot provide product guarantees, but will work closely with clients to determine project feasibility, provide cost estimates, and attempt to obtain mutually satisfactory results. The activities and terms of remote/foundry activities will be detailed through an initial design review and executed under the appropriate use agreement:

<https://www.wnf.washington.edu/docs/RemoteWNF-MAFuserAgreement.pdf>.

Budgetary estimates can be provided on a project-by-project basis upon request, but no binding quotes or fixed-price work can be offered.

CONSULTING AND CONTRACT SERVICES

Staff engineers are readily available for limited complimentary Critical Design Reviews (CDRs) in support of user activities and projects. 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. When more extensive engagements or active development support are requested, staff rates may apply. Additionally, similar to remote users, staff services may be contracted by on-site users in support of ongoing projects.

REPORTING REQUIREMENTS

As a provision of the NNCI program, WNF is required to submit an annual report on active projects. Occasionally, staff will request input from users for compiling publication lists and highlighting research that has been performed in our labs. Additionally, users are required to acknowledge work conducted at the WNF in your publications and presentations. Your cooperation in response to these requests is mandated by federal funding sources and greatly appreciated. A suggested acknowledgment is:

"Part of this work was conducted at the Washington Nanofabrication Facility, a member of the NSF National Nanotechnology Coordinated Infrastructure."



BILLING

The WNF is a non-profit business unit within the University of Washington, and charges time and materials on a cost reimbursement basis with monthly invoices. 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.

- Academic pricing is supported through UW, state, and federal grants and subsidies.
- Industrial rates are set for cost recovery.

Users working in the facility will be billed on a monthly basis for time and materials according to their actual use of the lab. To track time, users are required to log on to individual equipment and for all active work areas (such as wet benches). Material charges are either calculated as part of the general equipment use fee or for special materials (such as gold) on a case-by-case basis. Staff time for training or additional consultation is billed at the standard posted rate. More details and current rates are available in CORAL or online at: <https://www.wnf.washington.edu/docs/WNF-Rates.pdf>.

As detailed in the facility use agreement, remote or foundry service users will be provided a good faith estimate at the start of the program. It is not possible to issue binding quotations for processes or projects. Monthly billing will be based on actual equipment use and staff labor rates. Because many projects have unanticipated changes in scope and processes based on experimental results, WNF will make reasonable efforts to inform the remote user when expenses are expected to exceed a 10% variance. A “not to exceed” purchase order may be used to account for possible changes with minimum logistical overhead.

Users of the WNF are also eligible to use MAF characterization capabilities under a single purchase order but will receive a separate monthly invoice from each facility. WCET billing activities will need to be managed directly with that facility.

USER AND STAFF MEETINGS

General user meetings are held weekly. These are open forums for registered lab users to discuss issues pertaining to the laboratory, instrumentation, and processing. Minutes for these meetings are posted upon approval to the main WNF website. If you cannot attend the weekly meeting, please contact the lab director or engineering staff for alternative solutions.

WNF staff meets weekly and as needed to address open equipment issues and provide timely feedback on user reported issues and requests.

INTELLECTUAL PROPERTY AND SECURITY

While working in the WNF, you will not have intellectual property (IP) restrictions or entanglement with the University of Washington unless engaged with other UW entities through the Office of Sponsored Programs or CoMotion. Many clients execute an NDA in order to protect their IP when engaged with staff engineers (use of the UW pre-approved form will expedite the NDA process).

Occasionally, staff will engage in collaborative development campaigns with individual users that may give staff information and insight into proprietary information or process techniques unique to that user. In these cases, general processing techniques or insights that are not IP-specific may be shared with the general user base to improve common practices in the lab, but in no circumstance will applications, full process flows, or other confidential material be shared unless given explicit permission by the user, irrespective of an NDA being in place.



FACILITY INFORMATION

SITE SECURITY

WNF is a controlled-entry facility and all users are required to do their part to maintain and protect the security of the lab. All users must individually use their keycard to enter the facility for security and safety purposes. Users should maintain awareness when accessing secured areas and prohibit unknown individuals from following through access doors. It is also important to secure perimeter doors and windows. As a positive pressure cleanroom, high internal pressure can force doors to remain ajar. Please ensure that doors to secured areas close and latch behind you. This not only provides security but promotes cleanliness in clean spaces.

All authorized users will have key card access to the facility. Unknown individuals, visitors, or users with lost key cards should be directed to staff. If the front reception desk is not occupied by WNF staff, do not allow an unknown individual to enter the facility unless you are willing to accompany them to find an appropriate staff member. It is ok to ask someone to wait in the lobby while you look for staff to help them. Even if it is after hours or staff is unavailable, it is not your responsibility to resolve their entry issue, but it is your responsibility to maintain the security of the facility. Please be courteous and do your best to be helpful, but do not put yourself at personal risk if you are uncomfortable with the situation. Please report any concerns to staff and contact UW police department to report suspicious persons or activities.

SPACE DESIGNATIONS

The WNF occupies the first floor of Fluke Hall. Its main corridor is accessed via the north lobby, south dock, or south stairwell. Client offices are in the southeast corner of the main facility. South of the main corridor is the loading dock and access to storage for hazardous production materials including wet chemical and hazardous gas bunkers. The cleanroom, administrative, and staff offices are accessed via the northern door into Fluke 115, adjacent to the reception desk.

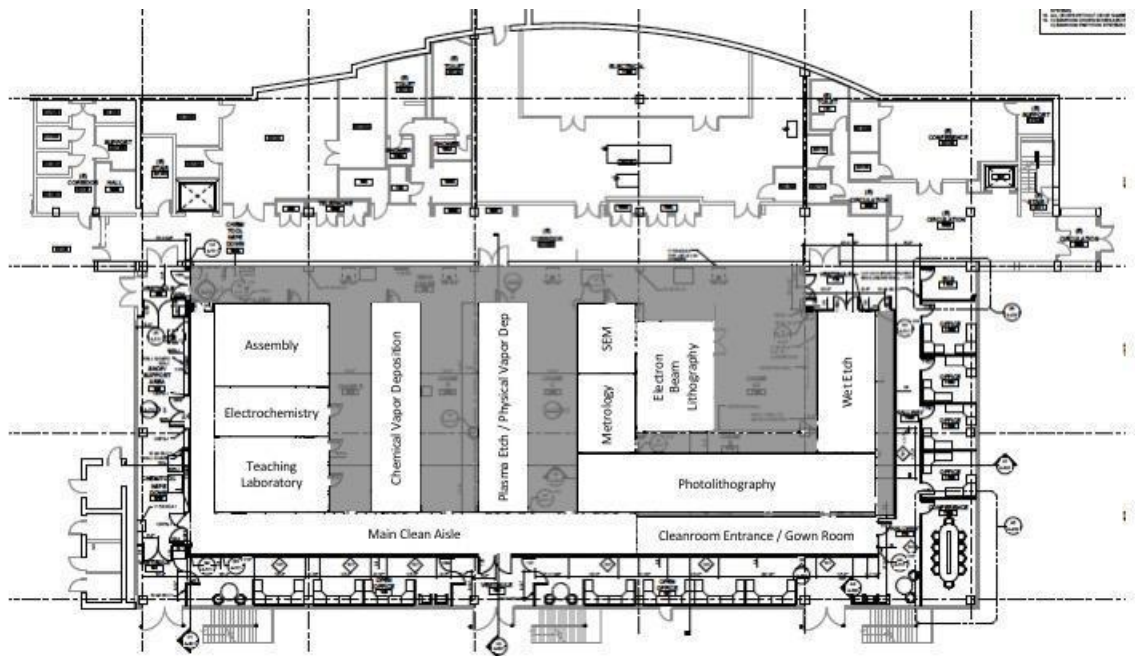


Figure 1: Fluke first floor layout



CLEANROOM LABORATORY

The primary lab area covers ~15,000 sq. ft including the cleanroom space. Entrance to the gowning room is in Fluke 115 near the staff offices. All users must swipe into and out of the cleanroom to ensure there is an accurate list of people who are in the lab at a given time. Users will only be granted access when all required training is complete. Visitors must be pre-approved by WNF staff and accompanied at all times by a qualified user.

The cleanroom is organized in a bay-and-chase style architecture and segmented by operation types. Users access all bays via the Main Clean Aisle from the Gowning Room. Unauthorized users should not access chases, or “gray areas”, which house all the support facilities for process equipment. Cleanroom perimeter doors are to be used exclusively for emergency evacuation and staff functions.

Bays are defined as follows:

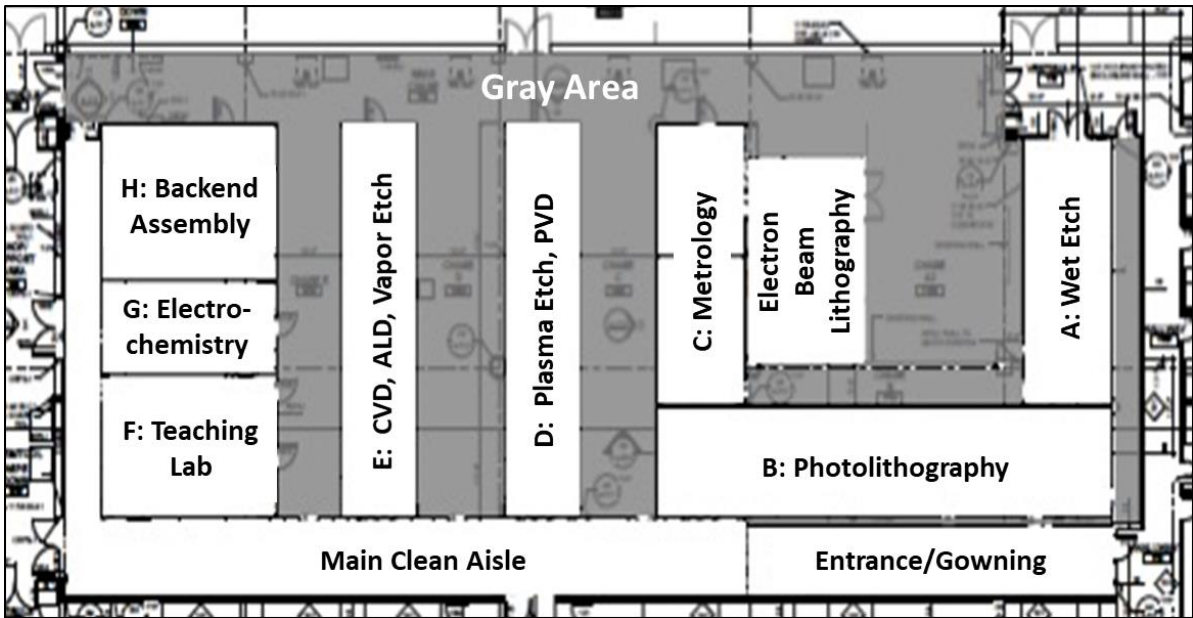


Figure 2: Process Bay Layout

Process Bay : CORAL Designation	Description	Iso Class (STD Class)
A - Wet Etch	All aqueous chemistry, acid and base processing	5 (100)
B - Photolithography	Resist spinners, solvent processing, contact and stepper Lithography, UV exposure, direct write UV processing, Nanoscribe, Rite track	5 (100)
C - Metrology	Microscopes, surface profilers, SEM, EBL	5 (100)
D - Plasma Etch PVD	RIE, ICP etch, DRIE, Evaporation and Sputter deposition	6 (1000)
E - CVD	Atomic Layer Deposition, Furnaces, Ion Mill, PECVD, Rapid Thermal Anneal (RTA), Vapor Etch (HF, Xe)	6 (1000)
F - Teaching Lab	Cross section of equipment for contact lithography and simple wet processing. Available for general use if not being used for teaching purposes.	7(10k)
G - Electrochemistry	Variable chemistry industrial plater, gold bath, analyzer	7(10k)
H - Assembly	Dicing, flip chip bonder, screen print, wafer grind/polish, wire bond	7(10k)

Table 2: Process Bay Definition



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 roughly separated into the following categories:

- **Photolithography:** laser direct write, spin coating, automated track coating and developing, adhesion promotion, contact and stepper/projection lithography, resist strip, hotplates, and ovens
- **Nanolithography:** electron beam lithography (EBL) and two-photon polymerization 3D lithography (Nanoscribe)
- **Chemical Vapor Deposition (CVD)/Furnaces:** plasma enhanced chemical vapor deposition (PECVD), atmospheric furnaces for thermal oxidation, doping, annealing, rapid thermal annealing (RTA), and Atomic Layer Deposition (ALD)
- **Metallization:** electron beam evaporation, sputtering, ALD, and electrochemical deposition
- **Etch:** wet etching, silicon micromachining, non-plasma dry (vapor) etching, parallel plate reactive ion etching (RIE), inductively coupled plasma etching (ICP RIE, fluorine and chlorine chemistries), deep silicon etching (Bosch, DRIE), and plasma ashing
- **Metrology:** scanning electron microscopy (SEM), profilometry (stylus and optical), spectral reflectance, probe station with electrical characterization, ellipsometry, optical and laser confocal microscopy
- **Mechanical wafer processing:** wafer bonding, wafer grinding, chemical mechanical planarization (CMP)
- **Assembly:** dicing, wire and flip chip bonding, screen printing, manual probe station

NON-CLEANROOM LABORATORIES

The WNF operates a limited area of non-cleanroom space in the facility, primarily for soft lithography, microfluidics, and processing with polydimethylsiloxane (PDMS) as well as parylene coating. Additional equipment includes an automatic laser cutter for plastics and grit blasting. Please coordinate directly with staff if you need access to this space.

PUBLIC SPACES, AND MEETING AREAS

There are several public areas open to users within the facility. Please be respectful of others and maintain a professional environment by controlling noise and doing your part to keep things clean and uncluttered.

Work and meeting spaces are available to users on a first-come basis throughout the facility. There are meeting tables in the first floor main hall, as well as general seating and a number of temporary use individual workstations/desks in the areas outside of the cleanroom in Fluke 115.

The WNF Conference Room (Fluke 119A) is available for reservation through CORAL. The Bowen Conference Room (Fluke 104) can be reserved pending availability. If interested, check with WNF staff for assistance.

There is a small kitchen area off the main hallway near the restrooms available for your convenience. This area must be kept clean and other users' food items must be respected. Please clean up after yourself and wash any dishes or items that you use. The refrigerator will be emptied periodically. Items, including containers, will be thrown out unless clearly labeled with a name and an expiration date.



USER STORAGE

User storage is available within WNF at published rates on an as-available basis. General purpose lockers are available in the main corridor. These are for general storage and may not be used to store chemicals or other hazardous materials. Contact staff to be assigned an available locker. WNF is not responsible for lost, damaged, or stolen items.

Cleanroom dry box storage is available at published rates for ongoing projects. Please see the “Cleanroom Policies and Procedures” section for details on usage and restrictions.

USER OFFICES

Limited space for user offices exists in Fluke Hall Room 132. Office provisions are made available at the posted monthly rate on a discretionary basis by the director, primarily for heavy on-site, full-time users. Availability is only as space permits and is not guaranteed. Office assignments may be revoked at the director’s discretion. Reasonable notice will be given when possible.

LABORATORY POLICIES AND PROCEDURES

ANNUAL TRAINING REQUIREMENT

As part of lab certification and Environmental Health and Safety (EH&S) requirements, all lab users are required to complete annual training. Regular training helps to improve user vigilance, lab safety, and compliance with the latest policies and protocols to ensure optimal lab performance.

Annual training may include review of the lab manual and safety documentation, viewing of the lab safety video, and/or supplemental compliance reviews.

CODE OF CONDUCT

- All users shall assume responsibility for the lab. The lab operates most effectively when everyone is cordial, follows instructions, and communicates openly.
- Always follow safety, equipment, and cleanliness protocols, even if your work is not sensitive to contamination or particulates.
- No smoking/vaping is allowed anywhere in the WNF facility and access to the cleanroom is prohibited within 30 minutes after smoking.
- Offensive or obscene language, materials, or media are not allowed.
- Food or drink, gum, cough drops, mints, etc. are not allowed in any laboratory workspaces but are allowed in office and common areas.
- Never leave a mess; if you find one, either clean it, ask the responsible parties to clean it, or notify staff.
- Report equipment problems or other lab issues or concerns. Use CORAL to track equipment issues or irregularities. Do not assume the behavior you observe is a known issue. Having a formal log of issues helps to prioritize work in an expeditious manner.
- If you suspect you have contaminated a tool or work area, notify staff as well as other users of the tool so that the issue can be resolved and subsequent work isn’t impacted.
- Share workspace and respect equipment reservations and equipment use policies.
- Ask questions if you are unsure about anything.



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 the cleanroom. Cosmetics contain powders, fillers and other materials that readily shed particles into the clean areas from the exposed skin of the face.

- **Shoes**

You must wear shoes that completely enclose the heel, toes, and top of your feet. High heels, sandals, open-weave shoes, or shoes that expose the top of the foot are not allowed.

Despite the substantial wet weather in the Pacific Northwest, your shoes should be clean and dry before entering the cleanroom. It is imperative that you avoid tracking mud, dirt and leaves into the labs. A good alternative is to keep a clean, dry change of dedicated lab shoes that you do not wear outside.

- **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 pants to wear over your shorts. If you arrive in insufficient pants without an alternative, inexpensive scrub pants may be available for purchase from the WNF staff. You will not be allowed in the lab without proper clothing.

- **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 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 recommendations from the American Chemical Society, contact lenses are allowed in WNF laboratories, provided 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 for 5 minutes, then remove contacts and continue flushing your eyes for a total of 15 minutes minimum.



WORK PRIORITIES

Your priorities while working in the WNF and making decisions should always consider these points in the following order:

1. **Safety**

You are responsible for your safety as well as 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, equipment protocols, and Safety Data Sheets (SDS). Do not experiment with equipment or chemicals without prior safety and protocol review. If you have ANY doubts, stop what you are doing and ask for help.

Any safety violation, incident or concern should be reported to staff and the director to ensure proper handling according to WNF and UW safety policies.

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 by straying from equipment protocols, including operating outside of approved parameters, use of unapproved materials, or unauthorized physical changes to the facility or equipment, you will be liable for property and equipment damages. Damages may include, but are not limited to, staff time, spare parts, vendor services, or total equipment replacement. WNF recognizes the research value of allowing flexibility in processes and materials into the lab. However, any non-standard activities need to be reviewed and formally approved by staff to minimize risk of impact to equipment and other users.

We want to hear from you. Active users have the best insight to current equipment status as well as any variance or issues in performance. Please use CORAL to report any unexpected or unusual performance issues; do not assume the issue you observed is already known.

3. **Your Project**

Your research is obviously what brought you to the WNF. However, your success must not impact safety, equipment integrity or otherwise cause undue risk to other users' success.

The WNF staff has a vested interest in helping you reach your research goals. Your success is our shared success. Please do not hesitate to ask for assistance at any time and make your issues and processing challenges known in a timely manner.

VISITORS

Visitors are not allowed in lab spaces without approval. Visit the WNF website user portal to make a visitor request: (<https://www.wnf.washington.edu/lab-user-portal/request-forms/>).

- For each approved visitor you will be assessed a fee to cover cleanroom consumables.
- A current WNF user must escort visitors during their entire time in laboratory spaces and is responsible for the visitor's actions, cleanliness, and safety.
- Visitors do not serve as buddies to meet the buddy system requirement.
- Visitors are observers only and are not allowed to operate any laboratory equipment or perform any chemical operations.
- Visitors are to abide by all safety measures expected of laboratory users.



CORAL

Within the WNF, facility access and key documentation is managed using a highly customized software management system. CORAL (Common Object Representation for Advanced Laboratories), was originally built by Stanford and MIT to manage the utilization of shared user facilities. The UW CORAL Web Front End interface is a dramatically expanded and customized software which allows users and administrators to access CORAL without having to install any application on their computer or mobile device. The interface is also 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 and maintenance of user training records
- Instrument scheduling for training and reservations
- Instrument qualification and tool performance logs
- Instrument problem reporting including comments, shutdowns, and remediation
- Instrument restrictions, standard operating procedures (SOPs), and user qualifications
- Safety Data Sheets (SDSs) chemical SOPs
- Equipment use monitoring and utilization tracking
- Billing, billing adjustments, invoicing, 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

In a shared use facility, there are a large variety of user processes, materials and operator skill levels in play both on individual tools and across equipment in the lab. To ensure reliable equipment performance and avoid conflict with access to tools it is important for all users to operate under a consistent set of guidelines while working in the lab.

Rules for equipment operation:

- You must be trained and officially qualified by staff for each piece of equipment before use.
- All tools have Standard Operating Procedures (SOP) that describe approved use of the equipment. You must follow the SOP explicitly every time you use a tool.
- Many tools are restricted to staff defined or staff approved process recipes to ensure best performance.
 - Do not use equipment for unapproved purposes or with materials not specifically approved for that equipment.
 - WNF staff tool owners must authorize all new processes, materials, and process recipes.
- Do not use equipment that has been enabled by other lab users without their permission.
 - Limit login sharing to “hand off” of processes only as needed.
 - Make every effort to change users as soon as is feasible.
- Reservation owners have precedence for tool use. Make best effort to finish before the next reservation starts.
 - Your reservation will be void if you have not enabled the tool within 15 minutes of your reserved starting time.
 - It is best practice to add a tool reservation at the same time you log into an unreserved tool to avoid a potential conflict with a new reservation
- Disable equipment when you are finished. This terminates the time for which you are billed.
 - To enable other users, please remove your reservation if you no longer plan to use it or end up finishing early.
- Equipment must be enabled in CORAL for the entire time that your actions, occupancy, or cleaning process on a tool prevent another user from accessing and using that tool. This includes long pump downs, heating or cooling cycles, etc.
- You must report equipment problems, unexpected behavior, or damage in CORAL in a timely manner.
- If you feel there are errors in equipment charges or billing, you may submit a Billing Adjustment Request, found under “User Portal” on the WNF website. If you require an adjustment because you forgot to disable an instrument, you will be charged a fee for repeated requests.

Introduction of new equipment processes, process changes, or new materials:

Because microfabrication equipment and processes are sensitive and highly dependent on baseline conditions and process interactions, it is important that process limits and materials are always well understood and controlled. New Process or Material requests will be addressed through an approval process to assess risks to safety, equipment impact, and process interactions. Process or material change recommendations will be the responsibility of the WNF staff tool owner with final approval at the discretion of the director. Inputs of key stake holders including staff and affected tool users will be considered as part of the approval process.



USER MATERIAL AND CHEMICAL ABANDONMENT

In some cases, users have gained approval for the use of new, custom or dedicated materials or chemicals to be brought into the lab in support of their work. These user-owned materials might take the form of (but are not limited to) deposition targets or material sources, chemical precursors, process chemicals, raw materials and wafers, or process fixtures and labware.

In order to be correctly managed for safety or proper cleanroom lab use, these items may need to be stored by WNF or in WNF directed locations which are not under direct user control and therefore have the opportunity to become orphaned or forgotten when users leave or move on to other projects. Such materials will periodically be reviewed for consideration to determine whether they should be classified as abandoned materials.

Approval for user-supplied and non-standard chemicals must be renewed annually. Materials with expired approval and/or improper labeling are subject to removal without further notice. Other user-owned materials, such as fixtures or deposition targets, may be considered abandoned if not associated with an active user account within the last 12 months. Abandoned materials will be dispositioned at WNF discretion as appropriate. Such actions might include (but are not limited to) disposal, destruction, transfer into general use, or repurposing. Original users may be held responsible for costs associated with disposal of hazardous materials

CLEANROOM POLICIES AND PROCEDURES

CLEANROOM STORAGE

Personal Effects Storage

While you are working in the labs or cleanroom, store all personal items, such as coats, knapsacks, bicycle helmets, books, etc., either at a rented desk or locker. Do not bring any of these items into the gowning room or cleanroom. Coats and backpacks can be hung up in the alcove next to the main corridor restrooms or on the racks near the gowning room. This is short-term storage; items left for prolonged periods may be disposed of or reclaimed. **WNF is not liable for theft or damage to personal items in the facility.**

Cleanroom Dry Box Storage Space

Users, research groups, and companies can request dry box storage for active wafers, photomasks, and necessary lab supplies. A monthly fee is charged for storage boxes. Companies and PIs with multiple users in the lab may request up to 1 box per user, space permitting. Boxes are not guaranteed to be adjacent. Storage of user materials elsewhere in the lab is not allowed unless otherwise posted and any such materials are subject to disposal during lab cleaning checks.

Lab storage is intended for active materials, not archival storage. You are not permitted to store chemicals, liquids, or hazardous materials in your dry box. All items inside the lab must be cleanroom compatible. Users are not permitted to modify the boxes in any way, including attaching additional labels. The doors to the dry boxes are to be left closed and latched when not in use.

Users with lab storage must comply with all policies. Materials in violation of this policy are subject to removal without notice. WNF staff reserve the right to modify this policy, including revoking previously authorized storage, as the needs of the lab change. Cleanroom storage is reserved for ACTIVE users of the WNF. Inactive users will be charged monthly membership and rental fees, even for a partial month, until the dry box storage is fully vacated, or the contents of the storage are declared abandoned.

Storage for user-owned chemicals will be addressed as part of the chemical approval process.



CLEANROOM ITEM/ACTIVITY RESTRICTIONS

People and the items they bring into the cleanroom are primary sources of particulate contamination. Minimize contamination by only bringing items necessary for your research into the cleanroom. All items brought into the cleanroom must be wiped down in the gowning room with IPA before entering. Use common sense when transferring materials from a non-clean to a clean environment.

Partial List of Cleanroom Prohibited Items/Activities	Cleanroom Allowed Items/Activities
Cardboard, fiberboard, wooden containers	Plastic items, plastic boxes, plastic containers
Paper, paper notebooks, books, magazines, etc.	Cleanroom paper, cleanroom notebooks
Pencils, erasers	Pens
Hats, coats, scarves, bags, backpacks, etc.	Headphones inside your hood are acceptable as long as they do not interfere with situational awareness (alarms, etc)
Makeup, cosmetics, smoking*	Laptops, e-readers, cell phones, cameras (no flash in yellow rooms)

Table 3: Prohibited Items

*Smoking and vaping generate a large quantity of particles that tend to contaminate all clothing and items exposed during smoking. Transferring these particles into the cleanroom is detrimental to other users and the lab’s filter lifetime. Prior to entering the cleanroom, users who have been smoking or vaping must wait 30 minutes after they have finished and then wash their hands and rinse their mouth with water or mouthwash.

CLEANROOM ENTRY/EXIT

To ensure site safety it is critical to maintain an accurate list of users and staff that are in the cleanroom. CORAL tracks the real-time user list based on user keycard access. All users must swipe in and out of the cleanroom. Even if someone else opens the door for you, you **must also swipe your keycard** to indicate your entry into the cleanroom.

If your keycard does not unlock the door or you do not appear on the monitor, 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 115 to troubleshoot access issues. Other than authorized and accompanied visitors, entering the cleanroom without swiping your keycard or when your keycard is disabled is a violation of both lab and university policy.

To enter and exit the cleanroom:

- Swipe or tap your card on the exterior card reader to enter.
- ENSURE THAT YOUR NAME APPEARS ON THE ROSTER SCREEN.
- Visitor names will be automatically posted for the duration of their approval period.
- Other than in an emergency evacuation, it is imperative that you swipe or tap out of the lab using the interior card reader when you leave; otherwise, EMS personnel will assume you are in the lab in an emergency.
- VERIFY YOUR NAME IS REMOVED FROM THE ROSTER SCREEN WHEN DEPARTING.



GOWNING PROCEDURES

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

- Before entering the cleanroom, make certain you meet the dress code requirements.
- Using sticky mats as directed and don blue shoe covers to minimize bringing dirt into the lab.
- Immediately after entering the changing room, put on a bouffant hair net, enclosing as much of your hair as possible, and a pair of nitrile cleanroom gloves. Do not move past the first table before these steps are complete.
- If you do not have a cleanroom suit already on a hanger, select a hood, cloth face veil, coverall, and boots in your appropriate size from the shelves.
- Don your cleanroom garments in the correct order:
 - Put on the cleanroom hood with the seams facing inward, and then snap the cloth face veil inside the hood, ensuring that the veil snugly covers the bridge of your nose.
 - The face veil needs to completely cover your mouth and nose AT ALL TIMES, crossing the bridge of your nose where your safety glasses rest.
 - Fasten the pair of snaps on the neck of the hood under the chin.
 - **Note:** There are multiple snaps on the hoods and face veils so you can adjust and find positions that provide maximum cleanliness and comfort.
 - Put on the cleanroom coverall suit
 - do not 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 hood into the neck of the suit, zip up your suit, and snap the top snap on your suit collar.
 - 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.
 - 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.
- Place safety glasses outside of your hood and over where the face veil rests on your nose. If you do not have a pair of approved safety glasses you may borrow an available pair from the glasses bin.
- Using an IPA squirt bottle, moisten a cleanroom wipe and wipe down all the items you plan to bring into the cleanroom. Items that are not compatible with IPA wipe-down are likely not acceptable to bring into the lab.
- 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.

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), return to the gowning room to retrieve it, wipe it down completely with IPA, and put on fresh outer gloves before returning into the cleanroom.



DE-GOWNING AND EXITING THE CLEANROOM

- When you exit the cleanroom, de-gown in reverse order to entry.
- Remove and dispose of your outer pair of nitrile gloves.
- Remove your white cleanroom boots. Leave your blue shoe-covers in place while in the gowning room.
 - Either place your boots in an appropriately marked slot in the available bench or store with your gown as noted below.
- 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 the hanger marked with your name.
 - Snap your hood to the collar snap of your cleanroom suit, with the outside facing outward and on the outside of the suit.
 - If desired, snap your boots to the legs of your coverall.
 - 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.
- If your cleanroom garment becomes soiled, do not place it back on the rack where it can contaminate other garments. Instead, place the garment in the laundry bin and get a new suit on your next entry.

Approximately, once per week, 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.

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 used in the lab to reduce airborne particulates. DO NOT step over or bypass the tacky mats.
- Do not leave items strewn about the lab on lab benches or tables when not in active use. If you require cleanroom storage, request dry box storage space. Items left in the lab will be moved to the lab lost-and-found. After one month, unclaimed items will be discarded.
- Do not sit or lean on equipment or tables.
- Do not shake hands in the cleanroom.
- Do not touch your exposed skin with your gloves.
- Be conscientious about your use of lab supplies and chemicals.
- No running or jogging. Walk at all times, **even during an emergency.**



CLEANROOM SOLID WASTE MANAGEMENT

Please manage trash in the lab and sort into the appropriate waste bins:

- Clear plastic film (e.g. the packaging for gowning pieces) is to be recycled in the blue bins found in the gowning area.
- Gowning pieces to be laundered must be placed completely in the fabric hampers or designated carts found in the gowning area.
- Resist and solvent-contaminated materials must be disposed in vented trash receptacles. Primary disposal is the red metal trash can in Bay B.
 - The only exception is for IPA-dampened wipes used to wipe down items in the gowning area. These may be disposed of in the gowning room trash can. Wipes should not be excessively wet.
 - IPA-dampened wipes may never be disposed of in Bay A.
- Blades and syringes must be disposed of in the small red sharps container found in Bay B.
- Broken wafers and glass should be placed in the plastic bin in the chase behind Bay A.
- Any lead-contaminated process must be pre-approved through special means and all waste generated must be properly contained in the specific purpose lead waste container for that process. Contact staff if you have questions.
- General chemical waste disposal is discussed in the “Working with Chemicals” section below.
- Items that do not fit these categories may be disposed of in the metallic general purpose trash cans found throughout the lab.



WORKING WITH CHEMICALS

The WNF is a laboratory space located on the University of Washington’s Seattle Campus. As such, the facility and users must follow all rules established by UW Environmental Health and Safety (EH&S) as outlined in the University of Washington Laboratory Safety Manual. This manual can be found at:

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

Users are responsible for understanding the UW 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.

The UW Laboratory manual and safety trainings are set up as general information for all university labs and related facilities. WNF is required to be compliant with UW safety policies, but, due to the highly specialized nature of the WNF lab and the availability of fully trained support staff within the facility, in some cases WNF may have specialized procedures or policies to compliment and sometimes supersede the standard UW training and procedures.

Table 4: UW EH&S Online Training courses:

Training Course	Comment for WNF Users
EHS Compressed Gas Safety	Training is applicable. Users should not handle compressed gas cylinders in the lab without additional training by WNF staff.
EHS Asbestos Awareness	Training is required but not generally applicable to the cleanroom environment.
EHS Lead Awareness	Typical lead risk sources described are not generally applicable for WNF users. Lead risk in the lab is specific to certain defined processes and shall be described in process SOPs.
EHS Chemicals	Training is applicable. WNF specific lab practices are required as described below and during WNF wet bench training.
EHS Fume Hood Training	Training is applicable. WNF benches are custom for cleanroom use. Additional training specific to WNF lab practices is required.
EHS Hydrofluoric Acid Safety Training	Training is applicable. HF processing is common in WNF. Safety and HF awareness are of high importance. Additional safety training is provided by WNF.



UNDERSTANDING CHEMICAL HAZARDS

The WNF cleanroom contains many chemicals (gasses and liquids) for use in normal processing. These chemicals include several which are considered extremely hazardous due to risk of fire, explosion, severe burns, and death. Risks are minimized during regular operation of the lab when users are properly trained and follow proper procedures. However, all users should remain situationally aware and know the nearest evacuation routes and locations of nearby eyewashes and shower stations.

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. Printed SDSs are located within the Emergency Control Station room in Fluke 115A and in the gowning room. They are also available digitally in CORAL.

CHEMICAL HANDLING AND STORAGE

Acids, bases and oxidizers can react strongly when mixed with one another or handled improperly. Such reactions can quickly lead to process contamination or an emergency situation. To mitigate these risks, these materials are stored and used only in wet benches that are authorized for that particular chemical.

Solvents are typically organic liquids that are flammable or combustible and stored with photoresists in the yellow flammables cabinets or under refrigeration as appropriate.

Bay B - Photolithography has metal (stainless steel) benches while Bays A - Wet Etch, G - Electrochemistry, and H- Assembly have plastic (chlorinated polyvinyl chloride (C-PVC) flame retardant) benches. The Teaching Lab in Bay F contains a mixture of both C-PVC and stainless steel benches.

You are responsible for understanding the specific requirements and chemical restrictions for each bench as well as proper disposal protocols for each chemical or formulation you are using.

- Organic solvents such as acetone, isopropanol, and SU-8 developer are not allowed on the plastic benches because they will dissolve the working surfaces. When operating in the plastic benches, take particular care with the transparent chemical sashes as these are easily damaged and clouded by solvent cross-contamination and are very difficult to clean.
- Acids and bases are not allowed on metal benches because they may corrode the working surfaces. Additional specific chemical restrictions are documented in the SOPs for individual benches.

Common process chemicals are provided by WNF for general use. If a chemical is not available in the normal location, users may retrieve chemicals from secondary storage in the chase behind Bay A.

- Proper PPE is required when transporting wet chemicals (non-solvents).
- Bottle carriers should be used when transferring 1 gallon chemical bottles between wet benches or from storage cabinets.
 - Non-corrosive solvents such as Acetone and IPA do not need bottle carriers when being transferred for use from storage cabinets within Bays B or G.
- Use two hands any time when not using a bottle carrier.
- If the chemical you need is not available in any storage cabinet, contact staff for restock.

We do not permit storage of any personal chemicals in the facility or wet benches without explicit permission. All storage of user-poured chemicals must follow all appropriate guidelines.



NEW MATERIALS AND MIXTURE REQUESTS

When bringing a new chemical into the lab or trying a new mixture of approved chemicals for a process, you must complete and submit a New Materials Request Form, appropriate SDS forms, and a Standard Operating Procedure through the WNF website. These will be sent to the lab safety manager for approval. When warranted, a meeting may be scheduled in accordance with the new material approval process to discuss the chemical safety, storage, and intended use to help mitigate concerns with safety and cross-contamination of equipment and ensure that best practices are being followed.

Upon approval, a label will be generated including an approval expiration date. This label must be on your chemical bottle before it is stored or used in the cleanroom. Custom chemicals can only be used in the designated process bench and must be stored in an approved location.

User chemical approval expires annually and must be renewed. Management of expired chemicals is the responsibility of the users. Users may be assessed a fee for disposal of abandoned and/or expired chemicals.

WET BENCHES / WET PROCESS STATIONS

WNF uses wet process stations or benches vs. traditional fume hoods that are described in the University of Washington Laboratory Safety Manual. The benches are designed to limit your exposure to chemical fumes by maintaining a negative pressure airflow from the lab into the benches.

- The benches are designed for operation with sashes lowered to approximately 18 inches and are equipped with pressure gauges and sash height sensors to ensure safe and effective operation.
- Users should check the pressure sensors to make sure the pressure is within the acceptable limit.
- Warning alarms will trip on the benches during exhaust outages or if sashes are left above target height for more than a few minutes. Alarms will silence when the issue is corrected.
- While preparing the bench for operation, working in the back of the bench, or cleaning up after processing, it is sometimes necessary to open the sashes fully and work inside of the bench space. It is important to only work with your head under/inside the sash for very brief periods of time and only when absolutely necessary.

Most of the WNF's benches are designed for moderate volume, cassette-compatible processing in the rear third of the bench surface and smaller volume and custom processing in the front third.



GUIDELINES FOR CHEMICAL USE

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 SDS for all chemicals you plan to use to ensure you are aware of hazards and emergency procedures.

- Don't work with chemicals when you are too tired to think clearly.
- Keep your workspace clean and organized.
- Work with chemicals in an exhausted fume hood or wet bench.
- Never dispose of solvents down water drains or water-based chemicals down solvent drains.
- Change your gloves if they might be contaminated.
- Never remove chemicals from the lab without permission.
- Do not interrupt or distract users working with chemicals.
- Never wear PPE outside their designated areas.
- If you are unsure of handling or safety procedures, ask questions.

CARDINAL SAFETY RULES FOR CHEMICAL USE

Failure to comply with the following cardinal safety rules may result in immediate expulsion from the cleanroom for a minimum of one week. Expulsion is at the discretion of staff, the lab manager, or director, and no warnings need be issued. Failure to comply with repeated requests regarding general guidelines and best practices may also result in expulsion from the lab.

Re-entry into the cleanroom will require, at a minimum, Wet Bench retraining at the next scheduled training session.

Cardinal safety rules:

- Full Personal Protective Equipment (PPE) is required at all wet benches labeled as such in the WNF. This includes benches in Bay A - Wet Processing, Bay F - Teaching Lab, and Bay G - Electrochemistry. Full PPE includes: apron, face shield, and both chemical gloves when working inside the sash of a wet bench.
- Never work in a wet bench requiring PPE without meeting buddy protocol.
- All process containers must be properly labeled.
- Never stack chemical containers.
- Never set any chemical container higher than a hot plate surface or the bench working surface.
- Never place hands or fingers (even when gloved) in any chemical bath or solution. PPE chemical gloves are intended as a precaution and do not provide protection for prolonged or direct contact with chemicals.
- Do not taste, touch or smell any chemicals.
- Never use chemicals in a bench for which they are not authorized.
- Do not mix, heat, dispose or otherwise use chemicals in an unauthorized manner.
 - Any new chemical, formulation, or mix of existing chemicals must be approved prior to use in the lab.
 - Seek help from staff or another qualified user if there is any uncertainty regarding appropriate use or disposal for a particular chemical.
- Read and abide by any posted signage, including CORAL problem reports. Current events may necessitate temporary changes to normal procedures.



PERSONAL PROTECTIVE EQUIPMENT

In addition to the double nitrile gloves and safety glasses required for cleanroom entry, you are required to use additional personal protective equipment (PPE) when working in wet benches with all acids, bases, or oxidizers. Additionally, anyone authorized to transport these chemicals from the chemical cabinets or the chemical bunkers must be donned in full PPE.

DONNING PPE

- PPE consists of three items that should be donned in the following order:
 - Chemical apron
 - Face shield
 - Chemical gloves
- Check all items for damage before use.
 - Look for tears or holes in aprons; scratches or cracks in face shields; and cracks, pinholes, or excessive discoloration in gloves.
 - If any gear is damaged (e.g. ripped apron or gloves), dispose of it in the trash and use another.
 - Likewise, if chemical gloves are wet inside (more than humid from use), they should be discarded.
 - Please wipe off damaged items with DI water dampened wipes and dry off with wipes before disposing.
- Use care when putting on aprons to avoid ripping the seams (a small tear at the collar line is acceptable) and make sure the apron sleeves are fully tucked under the chemical gloves.
- The apron must fully cover your shoulders at all times (i.e. make sure it is secured around the neck and do not let it slip off while you work).
- Either safety glasses or chemical goggles are required under the face shield.

GUIDELINES WHILE WEARING PPE

- Do not touch anything unnecessarily with the chemical gloves. Treat them as though they are contaminated. Do not touch face shields, sashes, controllers, or any other equipment outside of the wet bench working surface with the chemical gloves.
- Do not leave the designated area or room while wearing PPE.
- It is acceptable to leave your chemical gloves on the edge of a wet bench while you work elsewhere within the bay keeping the “hands” laying inside the bench.
- Wearing PPE is not an excuse to act in an unsafe manner. **DO NOT EVER** put your hands or fingers into any chemical bath or container.
- 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 chemical gloves with DI water and completely dry using cleanroom wipes.
- Remove chemical gloves and hang them up.
 - If gloves are wet inside, more than humidity from use, they should be disposed of.
- Hang face shields carefully to avoid scratching the plastic.
- Lastly, remove the chemical apron while being careful to avoid ripping it.
- Hang aprons front-to-front/back-to-back to avoid transferring potential contamination to the inside of the aprons.



BUDDY SYSTEM

To ensure the safety of all lab users, WNF requires that another authorized cleanroom user be present nearby while you are working in any bench that requires Personal Protective Equipment (PPE).

In the unlikely event of a spill or accident during chemical processing, a buddy's role is to respond appropriately to help you or to get help as needed to contain the issue, avoid further exposure to users and evacuate the lab when appropriate.

To maintain adequate situational awareness, buddies must maintain sufficient proximity to the processing activity to be able to recognize a situation and respond accordingly. This requires buddies to have both awareness and direct access. For processing in Bay A, no more than one unlocked door may be between you and your buddy. Your buddy must remain with you or no farther than Bay B – Photolithography or the chase behind Bay A. If wet processing in Bay F: Teaching Lab, your buddy must also be present within one door of the bay or directly in line of sight the main clean hallway. Likewise, if wet processing in Bay G: Electrochemistry, your buddy must be in the Electrochemistry Room or visible through the window into the Assembly Room. **Buddies must be inside the cleanroom**; in no situation does line-of-sight from outside of the cleanroom meet the buddy requirement of direct access.

During lab hours when many users are present, strict buddy requests are not needed. However, this requires that all users be mindful of those working with wet chemistry, aware of buddy requirements, and responsive in the case of an emergency. Additionally, all users should notify one another when leaving the area if doing so impacts safe coverage. All users working in or around bay A or B should keep this in mind when exiting the lab.

If there is any question or it is approaching late afternoon or lunchtime when many users leave the lab, 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.

- Users are not required to agree to be your buddy or stay around only to support your work.
- However, once responsibility is accepted, your buddy may not leave until chemical operations are completed and you have cleaned up.
- If your buddy must leave, you must clean up and stop your processing.
- This works because users are willing to help one another. Keep up the good work!

All dry processes are permitted without a buddy; however, it is strongly recommended that you coordinate lab activities to ensure that at least one other person is in the vicinity when you are using the facility.



LABELING OF PROCESS CONTAINERS

In order to minimize risks and maximize safe lab operations, it is critical that all chemicals in the lab are clearly identified. All benchtop chemical containers must be properly labeled even if you do not intend to walk away. Water must also be labeled.

Prior to filling, any process container must be labeled to include:

- your name (or user ID)
- the date
- the chemical name and mix ratio/percentage
 - Please match the placard on the bench or common chemical formulation (eg H₂O).
 - If there is any uncertainty, use the chemical name as listed on the SDS.
- If you plan to leave chemicals out for overnight processing or to use at a future date, an expected date of disposal must also be provided.
 - If a single date is provided, this date is presumed to be the planned disposal date.
 - Users are expected to manage chemical disposal and maintain responsibility during the dates listed. It is ok to update the end date if you continue to need the chemical and are happy with the results.
 - If you are not using your UW NetID, please provide an email or contact phone number.
- **Shared Use:** In order to minimize chemical waste, it is good for users to share chemicals when it does not impact process quality. If you are pouring a large, cassette-capable, processing tank and do not need to restrict access, feel free to add the label “**Shared Use**” to the process tank.
 - Please use an end date that is reasonable to maintain the chemical performance.
 - Users are still expected to retain responsibility for disposal of the chemicals.
 - Do not use “**shared use**” as a way to avoid having to clean up after yourself.

If you have poured a mixture, such as a resist or developer dilution, you must list the components and their ratios (e.g. 4:1 DI Water:AZ400K, or 10% HCl). All materials in any new mixture **and the specific formulation** must be WNF-approved through the New Materials and Mixture Request process detailed above.

If the chemical is not in regular, general use in the cleanroom (e.g. it was brought in after approval from the lab staff), please provide information about the primary hazards for that material. Use a signal word “Danger/Warning” followed by the hazard type(s) from the SDS: flammable, corrosive, irritant, etc.

Improperly labeled or expired chemicals will be disposed of by Staff at user expense. Staff charges will be accrued at a minimum of 30 minutes.



CHEMICAL PROCESSING

It is your responsibility to understand the proper use, compatibilities, risks, and common chemical reactions for the process chemicals that you are using. Improper use or mixing of chemicals can result in fire, explosions, toxic gas release, chemical burns, or worse. Refer to SDS and SOP as needed. If you are uncertain, ask questions of lab staff or other users.

CHEMICAL PROCESSING GUIDELINES:

- Be sure to 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, because they outgas and can explode. Hydrofluoric acid and buffered oxide etch (BOE) cannot be used with glassware because they will dissolve the container.
- When handling process chemicals, take care to minimize risks of spillage and accidental contamination of the work area.
 - Do not try to pour small volumes from gallon jugs; instead, transfer chemicals from gallon jugs to graduated cylinders or beakers, then pour from this secondary container.
 - Do not overfill containers such that they are difficult to handle or transport.
 - **NEVER** return poured chemicals to their original container.
- Use best practices when pouring mixtures. For example, it is usually best to pour acid into water (or strong chemical into weak) to maximize dilution and reduce the rate of chemical reactions.
- When handling chemicals, assume that the outside of chemical bottles is contaminated and take appropriate care to avoid contaminating other surfaces.

DISPOSING OF PROCESS CHEMICALS

Acids, bases and oxidizers:

Most wet chemicals can be disposed of into the sinks in the plastic benches, which drain to the neutralization system. Note that in Bay A – Wet Processing, the benches are segregated into an acid side and a base side.

- Be sure to work in and dispose of chemicals ONLY in the benches where they are approved for use. Failure to follow these directions can cause fumes to be released into the cleanroom.
- Before dumping chemicals, turn on the faucet in the sink to ensure dilution of at least ten to one with DI water.
 - Typically run the faucet for 30s before and for 2-3 minutes after dumping chemicals to push the waste through the system.
 - In certain cases, it may be important to pay attention to the order which chemicals are/were disposed of into the sink, or to record the volume and/or dilution of the chemicals used. This is specific to certain materials and will be defined as part of the chemical SOP and training for those chemicals.
- **Exceptions:** Some chemicals may require special handling for disposal and cannot be allowed down the sinks. Storage and disposal requirements are defined as part of the chemical SOP for each material.
 - Used chemicals may be stored in carboys or other approved containers pending disposal.
 - Use only approved containers. DO NOT reuse old chemical bottles.
 - Storage of carboys must be coordinated with WNF staff.

Solvents:

To dispose of used solvent, empty it from your process container into a solvent drain or into an appropriate waste container.

- Common solvents go into one of the solvent drains or designated carboys.
- Custom or specialty solvents should be captured as directed in the SOP for that material.



WET BENCH CLEAN UP

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 that are within reach clean, dry and as organized as possible.

Users should clean up small spills and drips within the wet bench work surface, provided you can do so safely without taking unnecessary risks. Only attempt to clean spills for which your training and experience are appropriate.

Spills >100 mL or spills outside of wet benches need to be addressed appropriately. Small drips on the front of the bench can be wiped up as appropriate. Be sure to clean thoroughly. In the event of a larger spill, take steps to keep users away from any contaminated areas and send someone immediately to contact staff to address the issue. Refer to the Chemical Emergencies section of the lab user manual.

In the event that something falls into the installed chemical baths, users should not try to retrieve the item. Contact staff to resolve the issue.

Acid, Base, or Oxidizers:

- Clean small spills in plastic benches by thoroughly rinsing the working surface with DI water from a spray gun.
 - Spray chemicals in the direction of the drains and seams in the bench surface but use special care to avoid getting contaminated water in staff-maintained baths and cascade rinse tanks.
- **NEVER** 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) due to the fire hazard when introduced to the organic wipes.
- After rinsing the surface, use a plastic scraper to move the water into the seams between bench panels or into the sink (not into baths or cascade rinse).
- Once you are sure that there is only water left on the surface, use a wipe to leave a clean, dry surface.
- It is not necessary to clean out the cascade rinse tanks or the very back of the bench tops.

Solvent Spills:

- Clean up solvent spills with cleanroom wipes and dispose of them in the solvent waste can.
- Use wipes with acetone followed by IPA to thoroughly clean the metal surface until all residual solvent is removed.
- Do not attempt to clean bench sashes with anything other than water. Solvents will dissolve them.

Users may be charged staff time at posted rates if work areas are not properly cleaned up after use. Likewise, users may be charged staff time for chemical disposal if materials are left out past the expiration date posted on the label. Staff time will be charged at a minimum of 30 minutes.

**PREPARING CHEMICALS FOR PROCESSING:**

- Collect appropriate beakers or graduated cylinders as needed to safely measure target volumes for transfer to the process container.
- Properly label the process container and place on the wet bench surface.
- Don PPE. **PPE is required for all non-solvent processing.**
- Retrieve the chemical(s) to be used from storage below the bench (or designated cabinet). **Immediately before pouring, always recheck the label to ensure you have the correct chemical.**
- Carefully transfer chemicals to the process container or beaker. Take care to avoid dripping and be sure to properly clean up any drips on the chemical bottle.
- Before processing:
 - Properly clean/rinse all secondary process beakers and ensure work surface and chemical bottles are clean and free of contamination.
 - Make sure chemical bottles are securely closed and return to storage below the bench.
- Process your work.
- After processing, dispose of chemicals and clean up area as appropriate:
 - **For Wet Processing (Acids, Bases, Oxidizers):**
 - When moving a chemical container, keep close to the bench surface to avoid spills.
 - Slowly and carefully pour process chemicals into the sink to avoid splashing.
 - Rinse the container(s) thoroughly, typically 3 times, with DI water and dry with cleanroom wipes.
 - Remove clean process containers from the wet bench.
 - Rinse and clean up bench as directed.
 - Remove PPE.
 - **For Solvent processing:**
 - Empty solvent into a solvent drain or approved waste container.
 - Be sure to filter out any particles such as metal from liftoff operations to avoid clogging the solvent drains and valves.
 - Clean the chemical container with an acetone-soaked wipe, and then wipe thoroughly with isopropanol (IPA).
 - Ensure bench is clean and dry.
- Use an IPA-soaked wipe to remove the label from the container
- Dispose of solvent soaked wipes in the red solvent waste can in Bay B or other vented trash.
 - Do not dispose of solvents in Bay A – Wet Processing area under ANY circumstances.
- Return the cleaned containers to the drying rack.



CHEMICAL BOTTLE AND WASTE CLEAN-UP

There is limited user accessible chemical storage in the working areas. To avoid running out of chemicals during normal operations, it is critical to use up partially filled chemical bottles COMPLETELY before opening new bottles. If the quantity of chemical after your use is below typical use levels for the next user, dump the remaining chemical from the bottle using appropriate disposal methods.

Properly clean empty chemical bottles before disposal using the following methods:

Acid, Base, and Oxidizer Bottles:

- Fill the bottle half full of DI water, and empty completely into a water drain. **Repeat 3x.**
- After rinsing, dry the outside of the bottle with wipes.
- Use a marker to cross out the label.
- Write the **date** and then write "**Rinsed**" in 3 places on the bottle.
- Set bottle in the back of a wet bench to be collected by staff for disposal.

Solvent and Resist Bottles:

- Use a marker to cross out the label.
- Write the **date** and then write "**evap**" in 3 places on the bottle.
 - 1 location is ok for small bottles.
- Leave the uncapped bottle in the back of a metal bench to evaporate for at least 24 hours.
 - There is no need to try to clean out or rinse resist bottles.
- Staff will dispose of these bottles appropriately.

Other Solvent Waste:

- All other solvent coated waste should be disposed in the red, vented solvent waste cans.
- Syringes should be pulled apart to allow the solvents to evaporate in the trash.
- Other contaminated items such as resist soaked wipes used for spinner clean up, should be disposed of in the solvent waste can.
- In all cases, please use enough wipes to avoid dripping on the bench or floor when moving waste to the trash.



OTHER CHEMICAL PROCESSING RISKS

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. Do not heat high vapor pressure solvents such as acetone or isopropanol.

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.

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. HOWEVER, assume the hotplate is contaminated and fully wipe down the hotplate and dry before removing it.

Compressed Gas and Cryogenic Safety

Many of the materials used in the facility are compressed and hazardous gasses. Improper handling of cylinders can be extremely dangerous resulting in toxic gas releases, explosions, or creation of high-speed projectiles. Only lab staff are trained and permitted to connect, disconnect and transport compressed gas cylinders.

The lab also makes use of liquid nitrogen as a cryogenic cooling agent on several tools. Liquid nitrogen can create severe cold burns and can become an asphyxiant in poorly ventilated areas. Only properly trained personnel should connect, disconnect, or transport liquid nitrogen tanks.



EMERGENCY PROCEDURES

The document sections below cover emergency related information such as alarms and warning indicators, evacuation and assembly instructions, and response plans for a number of specific hazards and emergencies most relevant to operations in the WNF Lab:

- Chemical Response Safety Measures
- General Chemical Exposure
- Hydrofluoric Acid (HF) Exposure
- Chemical Spill Response
- HAZMAT Emergencies
- Fires
- Seismic Events/Earthquakes
- Power Failure
- Other Medical Emergencies

You are strongly encouraged to read the Fluke Hall/WNF Fire Safety and Evacuation Plan (FSEP) (https://www.wnf.washington.edu/docs/Fluke_FSEP.pdf). The FSEP 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/

www.washington.edu/safety

www.ready.gov



CHEMICAL RESPONSE SAFETY MEASURES

Chemical response spill kits and carts

- Available for staff and trained users
 - **Only attempt to clean small spills for which your training and experience are appropriate.**
- Spill carts are located in the chase next to Bay A – Wet Processing and in the chase near the Teaching and Electrochemical Deposition labs.
- 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.

HAZMAT Level B suits and Self-Contained Breathing Apparatus (SCBAs) are available for trained STAFF USE ONLY.

Safety shower and eyewash stations are located in every Bay and conveniently throughout the lab:

- Pull right side lever for shower
- Pull left side handle to fold out eyewash and start water flow
- Note that there are no floor drains and water will pool and spread on the lab floor. This is OK. Focus on getting yourself cleaned off. Safety is first priority.





CHEMICAL EXPOSURES (NON-HF)

If you are exposed to a chemical other than hydrofluoric acid (HF/BOE) 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!
 - If the chemical is in your eyes, use the eyewash station.
 - Hold your eyes open in the water stream for 15 minutes.
 - Contacts: rinse at the emergency eyewash station with contacts in place for 5 minutes, then remove contacts and continue flushing your eyes for 15 minutes total. Take care when removing contacts not to add contamination to your eyes from your fingers.
- Call for help and get your buddy to contact staff and call 9-1-1 as soon as possible. Have them explain the situation to emergency personnel.
- If possible, obtain or print out an SDS from CORAL to give to emergency personnel.
- If a hospital visit is needed, it is always valuable to take the safety data sheet (SDS) for the chemical to the hospital so the proper medical care can be determined in a timely manner. For chemical burns, even seconds count.
- The buddy should assess the situation and take steps to avoid additional exposures.

You must inform WNF staff if you have had an exposure to a dangerous chemical.



HYDROFLUORIC ACID EXPOSURE

Hydrofluoric Acid (HF) is among the most dangerous chemicals in the WNF lab. The medical treatment for HF 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, cardiac arrhythmias, or death. As little as 100 mL or skin exposure in excess of 25 in² (160 cm²) is potentially lethal if untreated.

HF and Buffered Oxide Etch (BOE) are unlikely to cause an immediate burning sensation at time of contact, so respond quickly if you have had an exposure even if you do not feel any immediate pain. Skin contact with acid concentrations in the 20% to 50% range may not produce clinical signs or symptoms for 1 to 8 hours. With concentrations less than 20%, the latent period may be up to 24 hours. HF concentrations as low as 2% may cause symptoms and must be treated seriously.

- Stay calm. Move out of the contaminated area.
- Get the chemical off. Fast dilution is key.
- In the event of skin contact:
 - remove clothing and flush the affected area for 5 minutes. No longer!
 - While rinsing, have your buddy call 9-1-1.
 - Using gloves to avoid secondary HF contamination to your fingers, apply calcium gluconate gel to the contaminated skin. This is critical to neutralize fluorine ions, draw out already subcutaneous fluorine ions, and avoid additional exposure. Tubes of calcium gluconate gel are located in all benches approved for HF
- 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, the black, neoprene gloves (found among the wet bench PPE) offer the highest protection from HF. If unavailable, double nitrile gloves will suffice. In either case be sure to rinse your hands after doffing potentially HF-exposed gloves.

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://www.honeywell-hfacid.com/?document=hf-medical-book&download=1>



CHEMICAL SPILL RESPONSE

Any spill outside of the wet bench or larger than 100 ml inside a wet bench requires appropriate chemical spill response.

If you cause or encounter a chemical spill:

- Manage safety/exposure first. Appropriately treat chemical exposures as first priority.
- **In the event of imminent threats to human safety, such as major, uncontained chemical spills, vapors or gas clouds, uncontrolled or significant electrical hazard, etc., EMERGENCY/HAZMAT or fire alarms should be activated to evacuate the Lab and/or building as appropriate.**
 - Activate a manual Emergency/HAZMAT station by lifting the cover and hitting the “PUSH” button.
 - The HAZMAT alarm requires all occupants of Fluke first floor to evacuate.
 - If the chemical spill poses a fire hazard or endangers people outside of Fluke first floor, pull the nearest fire alarm to initiate building evacuation and call the local fire department.
 - Do not walk into or touch any of the spilled substance. Try not to inhale gases, fumes, or smoke. If possible, cover mouth with a cloth while leaving the area.
 - Try to stay upstream, uphill, and upwind of the accident.
 - Take steps where possible to keep others from moving into the affected area.
- **Spills that do not require evacuation should be immediately reported to WNF staff who are trained in spill response.**
 - Avoid exposure: Do not walk into or touch any of the spilled substance.
 - Keep other users out of the affected area while having another user immediately contact staff for an assessment.
 - Please report the name of the material and approximate quantity that was spilled so that appropriate clean up procedures can be applied.
- Due to the extensive use of process cooling water for equipment and processes in the lab, water leaks and puddles may occur. This is not a “normal” condition and should be reported to staff immediately. Leaks or puddles should be considered to be chemical spills and treated with appropriate caution until evaluated by staff.

If Staff is unavailable or it is after hours: See the contact list posted near the phones throughout the lab for the after-hours staff contact number.

- **In the event that staff cannot be contacted to address a spill or there are further questions:**
 - Contact 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.
 - In most cases, WNF staff will have a plan to address a specific spill, but EH&S can advise on how to clean a spill and can call the UW's spill cleanup contractor as needed.
- **Regardless of the size of spill, contact 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. WNF staff are required to file an Online Accident Reporting System (OARS) accident report on the EH&S website. Your input will be required to ensure that all applicable information is available.



FIRES

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

- When an alarm sounds and strobes flash, begin immediate evacuation following your floor plan. Close doors behind you.
- If you discover a fire, activate the nearest pull station, close the door, evacuate, and then 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 other responsible parties need 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 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 needing assistance to evacuate should assemble in the areas of refuge identified in the FSEP.
- The WNF Evacuation Assembly Point (EAP) is the N21 parking lot. Immediately report to the Evacuation Warden or WNF Staff so that they can accurately track which occupants were able to evacuate. Evacuation Wardens will report to the Evacuation Coordinator.

SEISMIC EVENTS/EARTHQUAKES

The WNF HPM system includes a seismic activity monitor. In a major event, this should automatically halt hazardous material flows and sound alarms to evacuate the lab.

If an earthquake or other seismic event should occur:

- Move away from hazardous chemicals, particularly benchtop containers and baths.
- Move away from cables, tall equipment, and gas lines.
- Drop, Cover, and Hold under a sturdy table or work surface, or near structurally stable corners or pillars.
- **Do not immediately run outside**

Once things have stabilized:

- Check your surroundings carefully for danger and move to safer locations as warranted.
- Be situationally aware while checking for others in trouble or requiring first aid.
 - Be careful not to move injured parties unless the area is unsafe.
 - Notify 911 of any injuries, and provide any first aid you are trained and comfortable with providing.
- Lab users should carefully proceed to the evacuation point, activating the manual EMERGENCY station or fire alarm on the way if the facility alarm is not already active.
- If you have concerns about the building’s structural integrity, proceed to the outdoors evacuation assembly point keeping clear of overhead structures. Notify 911 of your observations.
- **Do not re-enter the facility until cleared by staff.**



POWER FAILURE

While uncommon on campus, power failures and brownouts can occur and cause potentially dangerous situations with equipment and/or chemicals in the lab.

Many critical systems in WNF, including all life and safety systems, have emergency backups in the event of a power failure so that brief interruption or voltage fluctuations may have only minor symptoms or go completely unnoticed. However, even if systems seem to remain operational, do not assume any alarms that may sound can be ignored. Follow normal emergency response procedures in alignment with the type of alarms that occur. In a full blackout, not all sensors or safety equipment may be functional.

- **Do not remain in the lab in a power outage.** Leave the facility and ensure you are safe.
- On your way, if safe to do so, cap open containers and close fume hood and wet bench sashes to minimize chemical fume collection in the lab bays.
- Notify WNF staff of any observed issues.
- **Do not reenter the facility until cleared by staff.**

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. In addition, WNF maintains two registered and certified Automatic External Defibrillators (AEDs). EH&S recommends First Aid/CPR training for a handful of building volunteers to assist with medical emergencies associated with building evacuation and emergencies. Many of WNF Staff have CPR training, including AED operation and use.

In the event of a medical emergency:

- Stay calm.
- Assess the situation. Look for a Medic Alert bracelet or necklace on the person requiring help.
- **Have someone call 9-1-1** and place them on speaker.
 - If you are alone, yell as loudly as possible for help.
 - If you are unable to summon help, call 9-1-1 first, and then return and assist the person to the best of your ability, following any instructions given by 9-1-1.
 - WNF is a secure facility, meaning doors are locked. Inform the 9-1-1 operator of this and that you may need to leave the injured person to admit emergency personnel.
- If others are available, give them tasks or instructions as a tool to manage the situation. Have someone locate WNF staff or find and return with a first aid kit and/or an AED in case they are needed. Have someone else monitor the crowd, ask for recording devices to be put away, count compressions and breaths for you if performing CPR, etc.
- When calling 9-1-1, give the operator as much information as possible. For example:
 - 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.
 - Keep track of the time any medications or treatments are given.
 - Don't hang up until you are told to do so by the 9-1-1 operator.
- **Do not move the victim unless it is otherwise unsafe not to do so.**

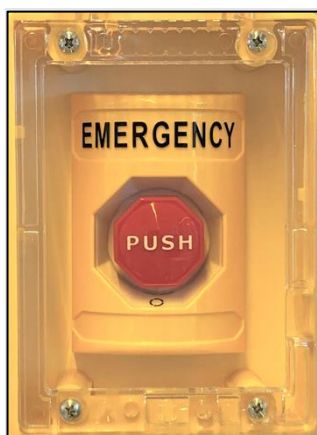


ALARM OPERATION:

If you find yourself involved in a major emergency, do not be shy or embarrassed about calling for help or activating the EMERGENCY/HAZMAT or FIRE alarms. If a hazard is uncontained, uncontrolled, spreading, or accelerating in any way, it is better to pull an alarm than to put lab users at risk.

It is important to note that only the fire alarm will turn on alarms throughout Fluke hall to evacuate the whole building and alert emergency first responders. The Emergency/Hazmat alarm will evacuate the lab but not all of Fluke Hall and it will not call first responders.

After activating an alarm, communicate with staff as soon as possible, and, if emergency personnel arrive, tell them that you were involved with the incident and be ready to explain what happened.



When to pull an alarm:

- **Fire:** Smoke or open flame are present. Or other major event where building evacuation is warranted.
- **Emergency/Hazmat:** Major uncontained chemical spill, vapors or gas cloud in the lab, uncontrolled or significant electrical hazard, any major event where lab evacuation is warranted but likely contained to the lab facility and unlikely to spread to the rest of the building. Emergency responders **will not be called**.
- **If someone is hurt, but other users are not in danger, call 911.**

Equipment Emergency Manual Off (EMO) buttons on equipment should be pressed in EMERGENCIES ONLY. Most tools have EMO switches that will disable all power to the system and releases all potential (stored) energy including shutting down vacuum, cryo, and turbomolecular pumps. Use of the equipment EMO can cause damage to process or user materials and result in significant equipment down-time to reset and requalify equipment to a working state. Using an EMO can be extremely detrimental to equipment and its ancillary equipment. In some cases, other tools might also be impacted. For these reasons you should carefully distinguish process instabilities and uncommon runs from emergency situations. Equipment EMO should not be used to halt unwanted processes or retrieve wafers or process material out of the normal cycle. 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. Please see the tool-specific SOP for additional information. Smoke, sparks, fire, or an imminent threat to someone's life always warrants the use of the EMO - Do not hesitate in this situation.

If you notice electrical arcing, smell or see smoke, or determine anyone's health is in immediate danger, do not hesitate to use an EMO switch.



AUDIBLE ALARMS AND EMERGENCY INDICATORS:

WNF has two primary alarm systems including a building fire alarm and a Hazardous Process Materials (HPM) alarm. There are both audio alarms and visual light indicators that communicate status of emergency events. Users should be familiar with these indicators and understand how to respond.

Fire Alarm



A Fire Alarm is indicated by a strobing flash and audio alarm. **Evacuate the building immediately when the Fire Alarm is active.**

The Red indicator on the HPM light tower is a Hazardous Evacuation alarm which is triggered by the fire alarm, automatic hazardous gas detection sensors, activation of the seismic/earthquake sensors, or by someone pressing the red button on a yellow EMERGENCY station within the lab (not to be confused with tool emergency stop controls). **Evacuate the lab immediately when the red indicator light is active.**

The Yellow indicator on the HPM light tower is triggered by tool, lab, or process monitors to indicate that a process fault has occurred and/or maintenance is needed. **Lab evacuation is not needed for a yellow light.** 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 restore operability of the detection system and impacted tools in a timely manner. To minimize response time, tool users or users in the lab after hours should inform staff or log a CORAL comment when a yellow light comes on.

Either a fire or red alarm on the HPM light towers prompts users and staff to immediately evacuate the cleanroom facility; however, **ONLY the fire alarm will clear the entire building and call Emergency Responders.** If you think emergency response by the Fire department is needed, pull the fire alarm.



OTHER AUDIBLE ALARMS

Several other audible alarms may occur in the lab:

- Sump Pit Alarm will sound if sumps overflow. This is a very loud buzzing alarm. Users should halt use of chemical sinks and flowing water sources such as cascade rinses. Evacuation is not required.
- Wet Process Station alarms will sound if air flow sashes are raised for too long. This is a reminder to return sash to target height. Alarms will also sound if exhaust pressure is lost or too low.
- Machine alarms may occur due to equipment faults. Some tools also have dedicated light tower indicators. Machine alarms should be communicated to Staff and logged in CORAL as appropriate. Critical or Hazardous issues would also automatically trigger appropriate evacuation alarms.
- Simplex panel alarms may be audible in the office hallway area. These act as audible reminders of ongoing faults.
 - Critical or Hazardous issues will automatically trigger appropriate evacuation alarms.
- Several items have audible alarms that will also turn on the yellow HPM light:
- Gas bottle controls will alarm when switching from the primary to secondary bottle.
 - Gas panel alarms trigger for high or low gas flows.
 - Burn box alarms will sound if temperature or flow rates are out of range.



EMERGENCY EVACUATION:

Emergency evacuations for WNF are dependent on the alarm type: **Fire or HPM tower alert.**

Fire: In the event of building evacuation due to a fire alarm, 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 OR Husky Union Building yard.

HPM: The HPM tower red alert requires evacuation of the cleanroom and offices east of the main Fluke hallway. Move to the primary EAP in the Fluke north lobby.

Always proceed to the primary evacuation point first if it appears safe. The Evacuation Coordinator or emergency responders will make the decision to change assembly points if needed. Please follow the instructions of staff or emergency response personnel.

In the event of either alarm:

- **Immediately exit the lab** through the nearest exit
 - Move preferentially to the north and east (towards parking lots)
 - **DO NOT exit to the loading dock past the chemical or gas bunkers**
- **DO NOT** stop and take off your cleanroom garments.
- **DO NOT** traverse the building to attempt to get your personal belongings.
- **Assemble in the designated evacuation assembly point (EAP).** This is especially important if you have exited the cleanroom because emergency personnel or staff will need to account for everyone who was logged into CORAL as being inside the lab.
 - Persons with physical disabilities needing assistance to evacuate should assemble in the **Areas of Refuge** identified in the FSEP.

EVACUATION MAP

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

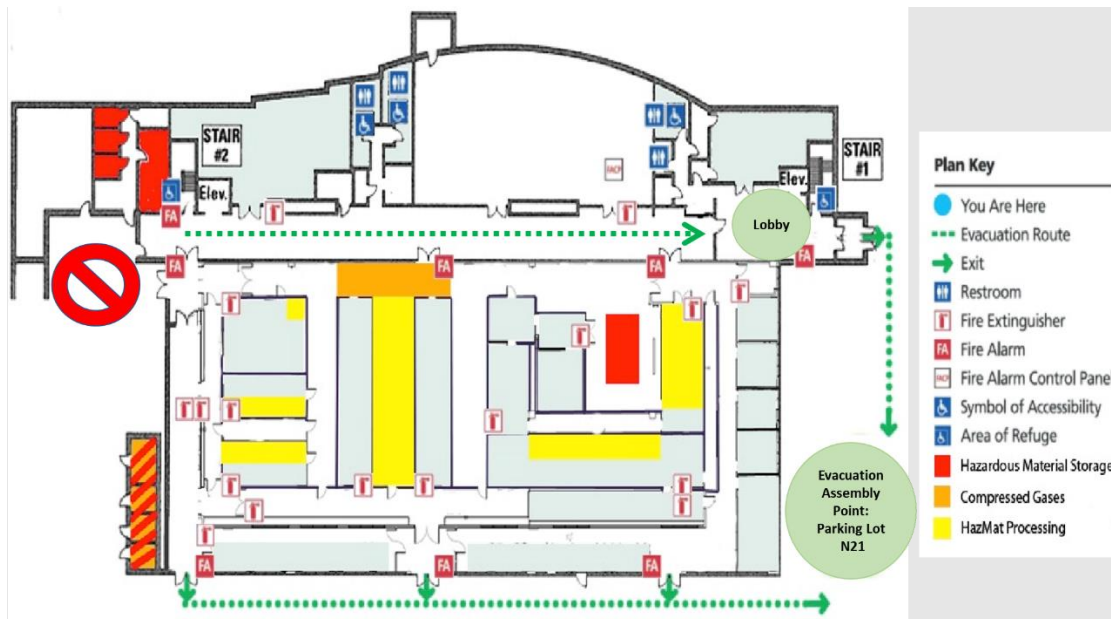


Figure 3: Fluke Hall First Floor Evacuation

Note: During an evacuation, avoid the chemical storage and gas bunkers located near the loading dock on the South end of the facility. Evacuate to the east and north, not to the south.



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.

Emergency Resource	Contact Information	Purpose and Responsibilities
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-hours a day, 7 days a week response unit called “FOMS” or “Unit 2.” FOMS responds 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.
UW Emergency Operations Center (EOC)	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.	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.



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 fire alarms result in an automatic response by Seattle Fire Department, UWPD, and Facilities Services' FOMS unit.

SIMPLEX DIALER / HAZARDOUS PRODUCTION MATERIALS ALARM SYSTEM

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

UTILITIES OVERVIEW

Our primary utilities are a deionized (DI) water plant, a process chilled water circulation system, an acid waste neutralization (AWN) system, Exhaust Gas Pyrolyzer for lab exhaust, a hazardous material (HAZMAT) emergency system, a compressed air dryer, and several levels of air handling and filtration. The DI water plant supplies water to spray guns, cascade rinse tanks, and spin-rinse-driers. The process chilled water circulation system provides quality-controlled cooling water to sensitive lab equipment. The AWN neutralizes aqueous waste that has been disposed of in the drains in the wet processing areas. The HAZMAT system monitors for several different hazardous gases along with ambient oxygen levels. Compressed nitrogen and compressed air are also fed to lab spaces for various uses. Compressed air is provided by UW campus facilities and dried on delivery to Fluke Hall. It is used primarily for pneumatic controls on a variety of equipment. To maintain cleanliness, the WNF has minimum efficiency reporting value (MERV) pre-filters at the HVAC level and ultra-low particulate air (ULPA) filters in the ceiling throughout the cleanroom. Lab air is a mix of external air from the supply fans and air recirculated via the support chases.

ACKNOWLEDGEMENTS

This document was created using information from the Washington Technology Center User Manual, the Microfabrication Facility User Manual, the WNF Overview Video, 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 verbatim.