

Quantum Structures Facility (QSF)

Policy, Guidelines, and Chemical Hygiene Plan

While working in the QSF, you are surrounded by dangerous and deadly chemicals, gases, high voltages, radiation, and mechanical systems. It is the responsibility of all users and staff to act in a professional, courteous, and safe manner at all times while in the facility. Users violating the operating and safety rules of the facility or endangering the safety of themselves or other users will be denied further access to the facility.

This document attempts to define acceptable actions and behavior for the users of the Quantum Structures Facility. However, it is impossible to define a policy for every conceivable situation. QSF users are expected to employ common sense and a high degree of prudence while working in this facility.

1. Visual and Audible Alarms in the QSF

1.1. Fire Alarm: White strobe with high volume pulsing audible alarm, located throughout the QSF and service bays. If this alarm activates, immediately leave the QSF and exit the building through the nearest exit. Do not remove your cleanroom apparel until outside.

1.2. Toxic Gas Alarm: Blue and Orange strobe with high volume continuous audible alarm, located at the end of each service bay and at the end of the clean corridor. In the event of a low level alarm, the orange strobe will flash. If you notice the orange strobe flashing, contact QSF staff or EH&S at x3194. In the event of a high level alarm, the blue strobe will illuminate and a buzzer will sound, and you should evacuate immediately. Do not remove your cleanroom apparel until outside.



Note locations of Toxic Gas Alarms



1.3. Wet Bench Alarms in the Cleanroom: Small illuminated visual alarms with buzzers. Each wet bench may have multiple alarms, with a placard beside the alarms indicating meaning of alarm and proper response. You must follow proper response if you see or hear a wet bench alarm.

1.4. Equipment Alarms: Please notify QSF staff if equipment alarm is activated.

2. Chemicals in the QSF, and the MSDS

All chemicals, compounds, gases, and materials, must be approved by the QSF manager before introduction into the facility. In order to introduce a new material into the QSF, a MSDS (material safety data sheet) for the material in .pdf format must be submitted to the QSF manager. The MSDS contains safety information regarding exposure, first aid, handling, storage, fire hazard, etc., for all chemicals, gases, and materials present in the facility. Before using an unfamiliar material, consult the MSDS to determine any potential hazards. Consult the MSDS to determine the proper course of action if someone has been exposed to a gas or chemical, or a spill has occurred. A book containing the MSDS for any material used in the QSF is located just inside the cleanroom gowning room. Additionally, an electronic version of the MSDS in .pdf format for all chemicals in our inventory is located on the desktops of all the computers connected to microscopes in the QSF.

3. Lone Worker Policy

After-hours work is permitted in the QSF. As such, the lone worker pendant will be required to be worn by any worker who is in the lab alone after hours. After hours is defined as the hours outside of Monday through Friday, 9:30am – 5:00pm, in addition to university holidays. Upon entering the lab, lone workers are to attach the pendant to their person using the lanyard or clip provided. In case of an emergency, workers will hold down the blue button on the pendant for approximately 2 seconds until the pendant beeps and dials the 911 operator. Distressed workers will communicate with the operator through the speakerphone on the pendant to arrange for emergency response. For workers entering the cleanroom after hours who find the pendant is not on its designated hook, the worker should assume that another worker is in the cleanroom and in possession of the pendant. In this case, the second worker is required to alert the first worker of his or her presence upon entering the lab. If the first worker exits the lab and leaves the second worker alone, the pendant must be passed off from the first worker to the second worker. When exiting the cleanroom, workers will return the pendant to its hook in the gowning room so it is available for the next lone worker. The pendant battery will be tested and logged by QSF staff during the work week, and changed as needed. In addition a weekly system test is performed along with a quarterly communication test to ensure reliability.

4. Visitors in the QSF

Any visitors in the QSF should be cleared with the QSF Manager either by email or verbally prior to bringing them into the lab. **Visitors are only allowed to observe processes and must follow all safety guidelines that apply.** If users are caught violating the visitor policy and operating/handling anything in the lab while being a visitor, both the user and visitor will be suspended from the lab with no exceptions.

5. Pregnancy and the QSF

The effects on a fetus of many of the chemicals utilized in the QSF are unknown. The QSF is designed to prevent exposure to the fumes and vapors from these chemicals, but absolute 100% containment is impossible, and it is possible to be exposed to extremely small concentrations of these materials. Consequently, we strongly recommend that you do not work in the QSF if you know or suspect that you are pregnant. **Small amounts of radiation are also present when the PCT irradiator is running. The affected region is outlined with caution tape and should be avoided whenever the equipment is running.**

6. Emergencies and First Aid

If you believe you may have been exposed to a toxic substance or gas, if appropriate rinse in the emergency shower. In all cases, quickly go to the emergency room at Goleta Valley Cottage Hospital. Emergency showers and eye wash stations are located near the exits of service bays. A first aid kit is located in the gowning room. Chemical spill clean-up kits for small spills are located on the wire shelving in each bay containing a wet bench. Clean-up kits for larger spills are located at the end of the hall in the West Corridor. After using a spill cleanup kit, please inform the QSF manager. Fire extinguishers are located in the clean corridor near the plastic strip door leading into the cleanroom area.



Note locations of
Emergency Showers
Fire Extinguishers,
First Aid Kits,
Spill Kits

7. Goggles, Aprons, and Gloves

Always wear gloves when in the QSF. Eye protection must be worn at all times, except when using optical microscopes. Lightweight, comfortable clear plastic goggles are stocked, but you are welcome to use an appropriate alternative eye protective goggle if you would like. Always wear full-face shields and aprons when handling highly corrosive or toxic chemicals.



Three types of gloves are available in the QSF:

7.1. Latex - 8 mil thick, another inexpensive general-purpose glove used primarily to prevent contamination of substrates or equipment from hand oils. These gloves are more resistant to nitric and sulfuric acid than vinyl gloves, and have better resistance to solvents than nitrile. They offer a limited degree of protection.



7.2. Trionic - 19 mil thick, this glove is the standard wet processing glove. A blend of latex, neoprene, and carboxylated nitrile, which offers excellent protection from corrosives and solvents such as HF and acetone. Highly resistant to cuts, tears, and snags. Always use this glove when working with acids.



7.3. Nitrile - 5 mil thick by 11 inches long, and this general purpose glove offers much improved dexterity over vinyl, along with fair protection from corrosives, poor protection from solvents. A very good all-round glove if optimum dexterity is required.

8. QSF Apparel

The QSF is split into three processing areas within the cleanroom; they are: the main cleanroom, which houses the diamond growth and etch tools, the material synthesis core, and the low temperature optical core. The three areas are separated by strip doors and have separate gowning requirements. They are as follows:

8.1. Main Cleanroom

Required Apparel:

- Closed toe shoes
- Long pants
- Launderable coverall
- Launderable shoe covers
- Bouffant Cap
- **Safety glasses**
- Gloves

Optional Apparel:

- Launderable hood
- Face Mask
- Beard Cover

8.2. Material Synthesis Core (aka Furnace Lab) and Cold Bay

Required Apparel:

- Closed-toe shoes
- Long pants
- Disposable Tyvek frock
- Disposable shoe covers
- Bouffant Cap
- **Safety glasses**
- Gloves

Optional Apparel:

- Face Mask
- Beard Cover

QSF Cleanroom



MSC/Cold Bay



Facemasks and beard covers are optional but strongly recommended for users with facial hair. Gloves and should be changed on every use and disposed of in the ***glove recycling receptacle***. Any contaminated gloves should be properly disposed of in hazardous waste containers. Store coveralls and hoods or smocks on hangers in the gowning room. Reserve a hanger by claiming a number and informing the QSF manager to print off a nametag. Store booties and safety glasses in the corresponding slot in the bootie storage rack. Change launderable items weekly if used frequently, or as needed based on limited use. These items should be placed in the laundry basket in the change room. Disposable frocks and booties should be changed out when they are showing significant signs of wear; these items go in the trash.

8.3. Never allowed in QSF

- Sandals or any other open-toed shoes
- Shorts
- Contact Lenses (**VERY DANGEROUS**)
- Loose makeup (generates particles)

9. Maintenance Ways

You may enter maintenance ways without wearing a cleanroom apparel from outside the QSF, or while wearing cleanroom apparel from inside the QSF.

10. Paper and Notebooks

The only paper allowed in the QSF is cleanroom type paper. We stock typical cleanroom paper and cleanroom paper notebooks. If you require a special type of cleanroom paper, ask and we will try to obtain it. You can laminate regular paper for use in the lab. Use pens, never pencils, for writing in the lab.

11. Cleanroom Wipes

We stock two types of wipes in the lab:

11.1. VWR Spec-Wipe 3 Wipers are a cellulose/polyester blend with high absorption, but medium particle and fiber generation.

11.2. Berkshire Valuseal 1500 is a 100% knit polyester wipe with a sealed edge and with low particulate generation, but also with relatively low absorption.

12. Preparing Equipment for Entry into the QSF

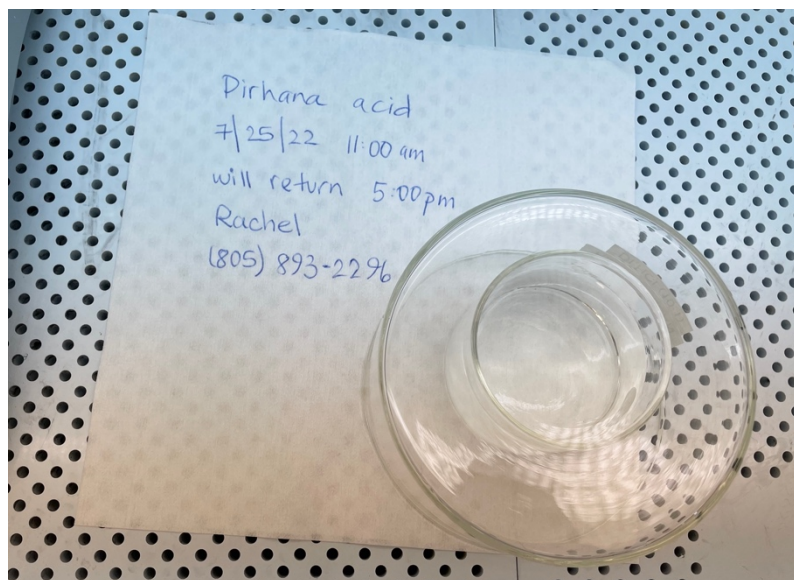
All equipment entering the lab must be clean. The procedure for cleaning equipment for entry is:

12.1. Wipe down all accessible surfaces with isopropanol or Nova Clean using cleanroom wipes while the equipment is outside the lab.

12.2. Move equipment into the lab.

13. Glassware

You may not leave unattended glassware in lab. Contents, date, and ownership information must be displayed on all glassware in use. Store glassware in your personal box; only common glassware may be stored on the glassware storage racks inside benches. We provide standardized storage boxes for this purpose.



14. Bosch Access Card System

The Bosch access card system provides security to the QSF. **ALWAYS** scan your access card when entering the lab and **SCAN OUT** when exiting the lab. Violating this policy will result in a warning for the first incidence, a two-week suspension for the second incidence, and possible permanent suspension for recurring incidences.

15. Equipment Sign-up Web Site

The majority of the processing tools in the QSF are scheduled through a web-based equipment scheduling system called FBS. Anyone with QSF access can view the schedule, but only users who have completed training on a tool will be able to access the calendar and schedule use of that tool. The site address is:

<https://ucsb.fbs.io/Anon/Logon.aspx>

Once you have been trained on a tool, you will be able to reserve time on the tool through FBS. Always make sure you have a reservation for a piece of equipment while you are inside the cleanroom. Tools that require multiple hours to run must be booked for the entire time it is being used, not just loading/unloading time. If you are only entering the cleanroom to pick up an item and will be in there for less than 15 minutes, no reservation is necessary. It is not necessary to book multiple tools unless you want to ensure it is open for your experiments. Door logs will be compared to reservations to verify compliance.

16. Wet Bench Housekeeping

If you are performing a procedure that requires you to leave a container or beaker unattended, your name, date, and contents of the container **MUST** be indicated on the container, or alternately, on a lab wipe placed under the container. A group name is not sufficient for labeling a container – an actual person's name must be indicated. Always leave wet benches clean, dry, and organized. This includes cleaning up all spills, storing glassware and chemicals, etc. If a bench is not clean when you start a task, you still have the responsibility to leave it clean. Do not cover the exhaust holes on the bench tops, as this will impede the laminar flow of air through the bench and possibly expose you or other QSF users to toxic fumes. **ONLY SHARED GLASSWARE IS ALLOWED TO REMAIN IN THE WET BENCHES.** Be sure to place your personal glassware in a storage container which can be kept on the racks just to the right of the cleanroom entrance corridor.

17. Chemical Storage

17.1. Acid Storage

The primary acid storage area is the acid cabinet located in the chemical storage room at the North end of the cleanroom (room 3406). The secondary acid storage area is the acid cabinet located near the entrance to the Diamond Suite (room 3416). Always use a bottle carrier when carrying glass bottles to their benches.



Note locations of ALL
Chemicals and
Storage



17.2. Base Storage

The primary base storage area is the base cabinet located in the chemical storage room at the North end of the cleanroom (room 3406). The secondary base storage area is located within the acid cabinet, near the entrance to Diamond Suite, on the bottom shelf and in secondary containment bins. Developers are located on the rack located in Photolithography Bay (room 3424) and labeled as Developer Storage. Always use a bottle carrier (located in the Acid Cabinet) when carrying glass bottles to their benches.



17.3. Solvent Storage

The primary solvent storage area is the stainless steel flammables cabinet in the chemical storage room at the North end of the cleanroom (room 3406). The secondary solvent storage area is stainless steel flammables cabinet located near the entrance to the Photolithography Bay (room 3424). Always use a bottle carrier when carrying glass bottles to their benches.



17.4 Photoresist Storage

The primary photoresist storage area is the spark-proof refrigerator located in Chase #2 (room 3420). The secondary photoresist storage area is the small stainless steel flammables cabinet located in Photolithography Bay (room 3424). Always use a bottle carrier when carrying glass bottles to their benches.



18. Solvent Processing

Solvents with flashpoints below 55°C cannot be heated in the QSF. This includes acetone, methanol, isopropanol, ethanol, and toluene. All solvent processing is limited to the stainless steel solvent processing benches.



Heated Chemical Warning

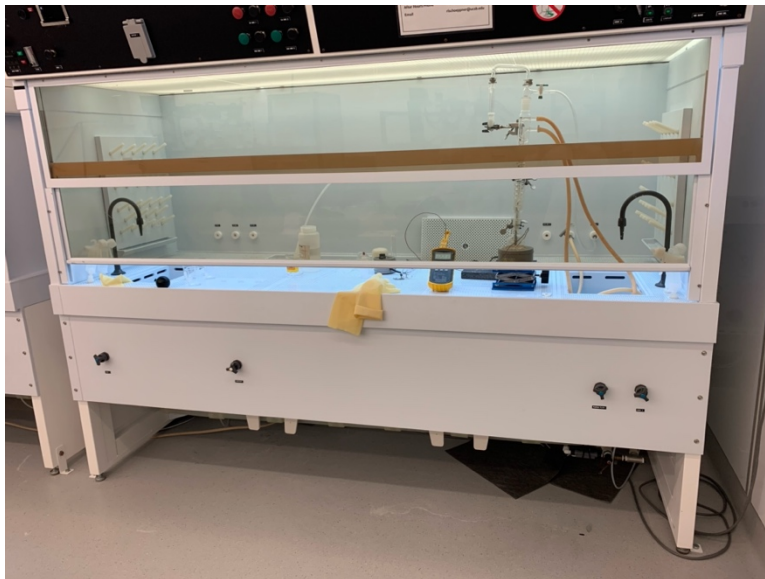
19. Wet Etch Processing

All wet processing involving acids and bases are limited to the acid/base benches.

19.1. Acid Bench #3 is reserved for HF (BOE) and heated acid baths (NanoStrip, KOH). The baths may ONLY be exchanged by QSF staff. Do NOT activate any drain valve on this bench.



Acid bench #1 is reserved for perchloric acid cleaning using custom set-up. Do not use this bench for any other process and ask for training if you want to add this clean to your process.

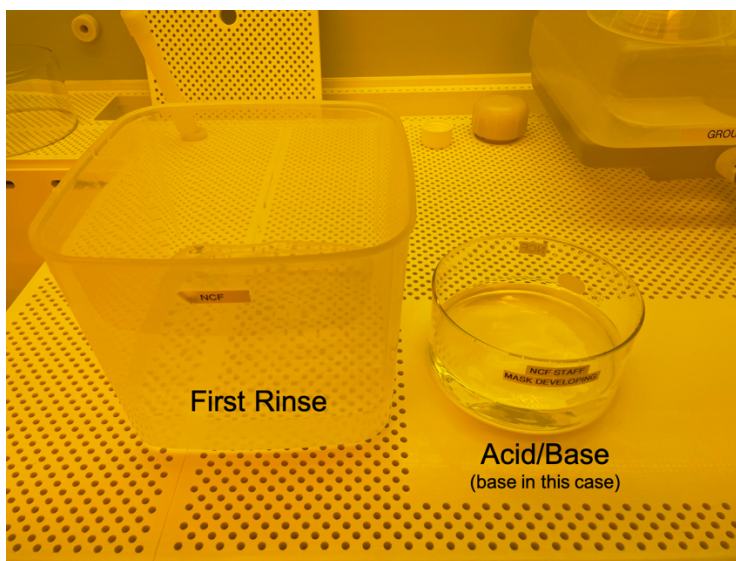


20. Chemical Waste Disposal

20.1. The correct method of disposal for any chemical waste in our inventory is posted throughout the cleanroom, and also indicated in a file titled “QSF Chemical Storage/Use/Disposal”, located on the desktops of all optical microscope computers in the QSF.



DO NOT DISPOSE
Acid/Base chemicals
or first rinse
down drains



CAUTION: DO NOT DISPOSE OF SOLVENTS IN THE ACID DRAIN, OR ACIDS AND BASES IN THE SOLVENT DRAINS DUE TO POSSIBLE EXPLOSION OR THE CREATION OF OTHER HAZARDOUS SITUATIONS.

20.2. All chemical waste is disposed of according to segregated groups designated by EH&S in Section II of the CHP:

20.2.1. In the QSF the Segregated Liquid Waste Groups are:

- A** – acids *
- B** – bases *
- C** - cyanides
- F** – fluorides *
- H** – halogenated solvents
- M** – heavy metal solutions & salts *
- O** – oxidizers *
- R** – alkali metals & other water reactives
- S** – non-halogenated solvents *
- U** - unstable

*Present in the QSF as of this revision.

Liquid Chemical Waste Group Designation			
Updated 5-20-19			
Group	Chemical	Group	Chemical
A	Acetic Acid	A	Hydrochloric Acid
S	Acetone	F	Hydrofluoric Acid
A	Aluminum etchant type A	O	Hydrogen peroxide
B	AZ 400k developer	S	Isopropanol
B	AZ 300 developer	B	Lithium hydroxide
S	AZ NMP rinse	S	Methanol
B	Barium hydroxide	O	Nano-strip
A	Benzolc Acid	O	Nitric Acid
B	Bicarbonate salts	O	Perchloric Acid
B	Calcium hydroxide	A	Phosphoric Acid
B	Carbonate salts	B	Potassium hydroxide
O	Chloric Acid	B	Sodium hydroxide
A	Chloroacetic Acid	S	SU-8 2000
S	Chloroform	S	SU-8 3000
O	Chromic Acid	S	SU-8 developer
M	Chromium etchant 1020	A	Sulfuric Acid
S	Cyclopentanone	O	Sulfuric, concentrated
S	Ethanol	S	Toluene
A	Formic Acid	A	Trifluoroacetic
A	Hydrobromic Acid	B	Triton x-100

20.2.2. All liquid chemical waste *and the first rinse* of any process will be disposed of in the appropriately labeled carboy according to the groups above. These are located under Acid Bench #2 in the Diamond Suite.



21. Photoresist Strippers

Commercial photoresist strippers can be heated, but only to a maximum of 80° C. When using a hot plate to heat commercial photoresist strippers, you must actively monitor the temperature of the stripper using a thermometer (or equivalent) and limit the hot plate surface temperature to a maximum of 80° C. Use of heated strippers is limited to Solvent Bench #2. You must be in the vicinity of the hotplate and actively monitoring the hotplate whenever you are heating photoresist strippers. The following photoresist strippers are stocked:

19.1. AZ NMP Rinse

22. Developer Benches

Developer benches are used for developing photoresists only. In general, solvents are not allowed at the developer benches because solvent fumes adversely affect the develop process. Solvent based liftoff processes are not allowed at the developer benches.

23. Hotplates

Hot plates used for heating chemicals must be attended. This means you must be in the QSF and near the hot plate whenever it is in use.



Heated Chemical
Warning



Heated Chemical
Warning

24. Disposing of Empty Acid, Base, and Solvent Bottles

Place all empty containers in the waste storage cabinets in the chemical storage room after **rinsing twice**, disposing of the rinse water in an appropriate disposal container, and deface the label with a permanent marker.

26. Notes on Particle Counts in the QSF

Reducing particle counts on substrates was investigated by the ESB Nanofab, and here are some of their findings:

The effectiveness of facemasks was investigated in the ESB Nanofab by placing the particle counter directly under a person's neck while the person moved his head back and forth. Facemasks reduced particle counts, from the equivalent of class 500 without masks to class 100 with masks. Again, this was sampling just below the neck, not at typical substrate surfaces.

The choice of wipes used in the lab has a more pronounced effect on particle counts. In general, wipes trade absorbency for low particle generation. The Spec-Wipe 3 is the stocked polyester/cellulose blend, high absorbency wipe designed for use in class 100 cleanrooms. Dragging the sampling tube across the surface of a Spec-Wipe 3 resulted in a class 1000 level particle counts. The Berkshire Valuseal 1500 wipe is the stocked low particle count, 100% knit polyester wipe. This wipe is not as absorbent as the Spec-Wipe 3, but generates fewer particles. Dragging the sampling tube across the surface of a Berkshire Poly 1200 wipe resulted in lower than class 100 level particle counts.

To summarize, if you would like to further reduce particles on your substrates, you may implement the following practices, in order of effectiveness:

1. Use only Berkshire Poly 1200 wipes if your process requires placing your substrate on a wipe.
2. Use a facemask if your process requires you to work above your substrate on a table. Facemasks do not reduce particle counts on substrates in wet benches.