
This document provides guidelines and operational protocols to ensure a safe and successful operation of the CNI clean room lab located in CEPSR building.

1. General:

1.1. About the clean room:

The CNI clean room is a class 1000-10,000 lab, approximately 5,000 sqft in area (including Nanobeam suite in NWC), located on the 10th floor of the CEPSR building. The clean room consists of Micro and Nanofabrication and Characterization equipment offering complete device fabrication access: Optical Lithography, Plasma Deposition and Etch, Diffusion Growth and Oxidation, Wet etch, Back end of line, and high resolution Metrology.

1.2. Clean room operating hours:

- Normal hours: Monday to Friday 7am-6pm
- After hours: 6pm-7am (requires special access permission and C14, some wet chemical work is not allowed, hazardous gas flow is limited). Weekends and holidays.
- Staff coverage: Monday-Friday, 7am-6pm with the exception of University holidays, extreme weather conditions, or unexpected emergencies. In a case when staff is unexpectedly not around an announcement will be sent via email to all lab users.

1.3. Clean room staff:

- Director of the Clean Room: James Vichiconti, Tel: (212) 854-9831, Cell: (845) 721-6345, Email: jv2534@columbia.edu
- Clean Room Engineer and process expert: Dr. Youry Borisenkov, Tel: (212) 851-5688, Cell: (646) 592-1514, Email: yb2471@columbia.edu.
- CNI Labs Equipment Engineer: Mike Raul Maghiar, Tel: (212) 854-3032, Email: rmm2263@columbia.edu.
- Research Operation Assistant: Melody Gonzalez, Tel: (212)-854-1916, Cell: (347) 678-9365, Email: mg3779@columbia.edu
1.4. Access Protocol for normal operation hours (7am-6pm):

1.4.1. General access (both internal and external users):

- External users complete section 1.4.2 before 1.4.1 (both are required) in order to gain a Columbia user name AKA UNI.
- New users need to subscribe to the shared facility newsletter, for important announcements and updates about the lab, by going to:
  

- Complete Columbia University training course entitled Laboratory Safety, Chemical Hygiene and Hazardous Waste Management Training (TC0950). The initial training must be taken in person (see below links for the training schedule), while the renewal training can be done on-line:
  
  https://research.columbia.edu/safety-training

- Complete Columbia University training course entitled Hydrofluoric Acid (HF) Safety Training (TC1650), as well as COVID-19 related safety training (required as of 2020) in the Columbia University 'Rascal' website and pass the post-test:
  
  https://www.rascal.columbia.edu/

- Send both safety training certificates to CNICR@lists.columbia.edu. In order to generate safety certificate log on to Rascal through: https://www.rascal.columbia.edu/tc/test/history and click on “generate certificate” for the appropriate training.

- Review and make sure you understand the clean room safety rules and guidelines on our website:
  
  https://static1.squarespace.com/static/57b26cc76b8f5b7524bf9ed2/t/624dcc44b0eff82cc9914db5/1649265735349/CRSafetyPresentationMarch2022.pdf

- Attend the clean room orientation for new users (Dates and sign up links will be published in the lab newsletter).

- To keep your access active, you must renew your safety training prior to the expiration dates and attend an annual clean room users meeting. Dates of users meetings will be announced in our newsletter. All CNI labs users must be subscribed to our mailing list.

- To subscribe go to:
  
  http://columbia.us11.list-manage.com/subscribe?u=a12eef83c27546d3eeec9f6879&id=9205f7ea97

Please send the renewed certification to: CNICR@lists.columbia.edu. Your access will not be renewed automatically if you don’t send the staff your renewal certificate.

- For equipment access please open a Badger account:
• Contact the staff member or the relevant superuser for training on any piece of equipment. A detailed list of superusers can be found on our website. Under any circumstances do not touch any equipment without training and qualification.

https://columbiananoinitiative.squarespace.com/equipment-rates

1.4.2. Access for External users (Internal users may skip to section 1.5):

• Read and sign the Shared Lab Services Agreement (updated link can be found on our external users program website):

https://cni.columbia.edu/external-user-program-1

• In order to obtain a Columbia UNI please send the signed agreement to CNICR@lists.columbia.edu and fill in the information form on-line:

https://docs.google.com/a/columbia.edu/forms/d/e/1FAIpQLSckhVgAm1hXk823r0hQzpct9mKX4iqGMZgLAFqE6cDCuLPQg/viewform?c=0&w=1

• Once you have your UNI go to Kent Hall building 2nd floor to the student services center and get your Columbia ID card

http://www.columbia.edu/files/columbia/content/morningsidemap_2015aug.pdf

• With your UNI and Columbia ID card go back to 1.4.1 and complete all safety training and steps required to gain access to the lab.

1.5 Access protocol for after hours (6pm-7am):

• Users applying for after-hours (24/7) access to the clean room must fulfill the following requirements:
  ◦ Have at least 50 hours of working in the clean room over a period of at least 3 months.

Have a Certificate of Fitness. C-14 Information can be found here (takes at least 8 weeks, plan ahead):

https://research.columbia.edu/certificate_fitness_information
Users who have fulfilled both requirements should mail a picture of their C-14 card to CNICR@lists.columbia.edu and wait for an email confirmation. It may take up to 6 weeks for FDNY to send cards to Columbia University after they are issued. If a card is needed urgently the test may be performed at FDNY offices.

Working after hours is only permitted with a buddy who is also an authorized, 24/7 clean room user with a valid C-14 certificate. Random checks of entrance to the clean room after hours will be performed and users found violating this guideline will lose their 24/7 access for two months.

2. Clean room proper conduct:

2.1. Entering the clean room:

Accessing the clean room is permitted via badge reader system with a Columbia University ID card for authorized users only. Each person must swipe her/his individual card for access. Entering behind another user without swiping the card is not allowed. Occasional reviewing of the access log will be performed by staff and violators will lose their access to the clean room for a period of time. Please do not bring your personal belongings into the clean room. Items which are needed inside the clean room should be wiped down with IPA available in the backend room to the left of the gowning room. Lockers for personal belongings are available for daily use on the 10th floor lounge of the CEPSR building (behind the clean room). Clean room notebooks and pens are available to purchase from the clean room office at minimum cost and can be kept inside the clean room on designated shelves.

2.2. Dress codes:

Long pants and closed-toe shoes are required for clean room access. No shorts, skirts, sandals, or flip flops are allowed. Make up is not allowed in the cleanroom as it creates particles and stains the garments.

2.2.1. In order to protect the clean environment in the lab, clean room garments must be worn at all times. Garments are provided, in various sizes, in the gowning room.

2.2.2. Gowning begins with

2.2.2.1. Shoe covers: applying disposables shoes covers on your shoes and
2.2.2.2. Hair cover: on your hair (and beard cover if you have a beard).
2.2.2.3. Coverall: If this is your first entrance to the clean room that week, take a clean coverall and wear it on top of your clothes making sure that the bottom part is lifted so its contact with the floor is minimized.
2.2.2.4. Hood: Wear an open face hood and tuck it in your coverall which should be zipped all the way.
2.2.2.5. Booties: Finally wear booties on top of your shoe covers and tie them properly around the shin part of the coverall.
2.2.2.6. Safety glasses and gloves (Latex or Nitrile): are required to complete the gowning process prior to entering the clean room.
2.2.3. Check your reflection in the mirror to make sure that all your hair is tucked in and that you did not forget anything.
2.2.4. After completing your work while exiting the clean room ungown in the opposite order: Safety glasses, Booties, Hood, Coverall and hang your coverall attached to the hood on a hanger with your P-touch name label (a label maker is available in the gowning room). If you need assistance please contact the staff. Please keep your shoe covers on until you exit the clean room and throw them in the trash outside. If your coverall is contaminated or dirty place it in the laundry bin. The disposable items should go into trash bins and not laundry bins. The used garments are collected from the hangers and laundry bins once a week by the clean room staff and sent to laundry.

2.3. Equipment:

The equipment in the clean room is shared by many users. Your careful consideration and mindfulness is essential when using the equipment and in returning it to its proper standby status upon completion of your work, i.e. samples are taken out and chamber is closed and pumped down.

2.3.1. Training and Certification:

For Training on equipment please contact the superusers or clean room staff members responsible for that instrument. In some cases you’ll be allowed to shadow an experienced group member until you feel comfortable to get certified on the equipment. Certification on equipment can only be done by superusers or by staff members. A complete list of superusers for the various machines in the clean room can be found on our website.

https://cni.columbia.edu/equipment-rates

2.3.2. Standard Operating Procedure (SOP):

During training or after certification and until you feel absolutely confident in using the tool you should use the SOP for each system, which is usually printed, laminated and found next to the machine. The SOP does not replace proper training and/or certification on the tool but can be very useful in the process and when using the tool after certification. Consulting the SOP is advised even for highly experienced users.

2.4. Badger (lab management software):
2.4.1. To ensure that each clean room user has proper equipment training and certification every user in the clean room must have their own Badger account. Under any circumstances do not: a) allow unauthorized personnel to access the equipment, b) share Badger accounts with other users, or c) bypass a Badger interlock. Please add your cell phone number on the Badger profile or send it to the clean room staff for safety purposes. For any Badger questions or issues please email: CNICR@lists.columbia.edu.

2.4.2. Reporting equipment problems:

Please remember to enable the tool in Badger before using it and disabling it when you’re done. If there’s any problem with the machine you’re using – STOP and let a staff member/superuser know and report the problem in Badger (by going to “equipment” and “report a problem”) and leave. Do not attempt to fix any equipment issues on your own. Users who report problems will not suffer from consequences. Please email the staff requesting to adjust the time in Badger for the use of the equipment in case of a problem so the account owner does not get charged.

2.4.3. All the tools should be left in pumped down position, clean and without samples. If there are any changes during your session that may affect the next user please record all pertinent information in Badger. If you reserved a tool and end up not using it or using it for a shorter period of time than planned, please cancel the remaining of your reservation.

3. Safety guidelines and procedures

Safety is the highest priority. When in doubt – always ask. Any safety violation will lead to clean room access restriction, suspension or revocation.

3.1. Clean room Hazards:

3.1.1. Hazardous Gases:
The CNI Cleanroom utilizes a variety of gases, some of which are toxic, highly toxic, corrosive, or flammable. Cleanroom users are reminded to never touch any gas cylinder. Cylinder changes, regulator adjustments, and any other service will be performed by the cleanroom staff.

3.1.1.1. Gas cabinets are exhausted and monitored for faults in exhaust flow. A fault condition in exhaust monitoring will shut down any gases at the closest isolation upstream of the point of detection. Each gas cabinet is equipped with an emergency power off switch which will shut off the gas. Gas cabinets with flammable or pyrophoric gases are fitted with UV/IR detection and the gas cabinet exhausts are equipped with thermal snap switches.

3.1.1.2. The following gases will be delivered from the gas cabinet to the tool location in coaxial tubing: Chlorine, dichlorosilane, ammonia, boron trichloride, acetylene, difluoromethane, silane. The interstitial space will be kept under vacuum and monitored for changes in pressure. Fault conditions will shut down the subject gas.

3.1.1.3. Toxic Gas Monitoring will occur at any location with a mechanical joint and at the user interface with the process environment, i.e. Gas cabinet, valve manifold boxes, tool gas distribution panels, outside the process chamber load lock in the laboratory environment. Any gas detection in ambient atmosphere will trigger the Schapiro CEPSR building fire alarm and shutdown all gases at the cylinder isolation valve. Gas detection in an exhausted enclosure will trigger a local alarm (CNI Cleanroom) and shut down all gases at the cylinder isolation valve.

3.1.1.4. The cleanroom is typically kept at a positive pressure in relation to the remainder of the building. This is done to prevent the particles in the air of the remainder of the building from entering the clean space. In the event of a cleanroom ambient gas detection the gas detection system will secure appropriate supply air fans, close intake dampers, and ramp up exhaust fan speed to allow the cleanroom to run at negative pressure in relation to the remainder of the building.

3.1.2. Hazardous Chemicals:

The CNI Cleanroom employs wet chemicals from the following groups: acids, caustics, and solvents. Some examples include but are not limited to: Hydrofluoric Acid, Nitric Acid, Buffered Oxide Etch (BOE), Chrome, Gold and Aluminum commercial etching solutions, Sulfuric Acid, Photoresists of various types, tetramethylammonium hydroxide (TMAH) based developers, Ammonium Hydroxide, Hydrogen Peroxide, Acetone, Ethylene Glycol, Xylene, Toluene, Ethanol and Methanol.

3.2. Operational expectations and procedures:

3.2.1. Food and drinks are not allowed in the clean room with the exception of drinking water in the gowning room.

3.2.2. Do not take or bring any chemicals from or into the clean room without specific approval from the staff. In order to bring a new material into the clean room an approval from the Clean Room Director
and/or CNI Labs Senior Director is needed. Send a request via email with information on your process and the Safety Data Sheet (SDS) of the chemical.

3.2.3. When working with chemicals make sure to familiarize yourself with the chemical prior to your work by studying its SDS. All SDSs can be found on Columbia University Environmental Health & Safety (EH&S) website. Make sure you use the right chemical container for the chemical work (e.g. plastic for HF etc.).

https://research.columbia.edu/safety-data-sheets

3.2.4. Wear proper personal protection equipment (PPE) when using acids or caustics: apron, rubber gloves, safety glasses, and face shield. Check the gloves for holes before wearing them. The appropriate PPE can be found on hangers in the wet processing or lithography bays. If you can’t find the right protective equipment or are not sure what equipment is needed or how to handle the chemicals, stop and notify the clean room staff. After you finish processing rinse your gloves prior to taking them off. Remove your face shield and your apron. If the face shield or apron got contaminated by chemicals please let the staff know.

3.2.5. When you’re mixing chemicals follow the AAA rule: Always Add Acid to water. Working with RCA or Piranha solutions require special training. Please contact staff for more information.

3.2.6. Always hold chemical bottles with both hands in a firm grip. Do not lift or hold chemical bottles by the cap.

3.2.7. When you’re done working pour the used chemicals into the appropriate waste bottle. Rinse the gloves and throw them into the appropriate chemical waste bin (Acids/Solvents). Chemicals in designated baths inside the hoods will be drained into a waste carboy below the hood.

3.2.8. Try to avoid leaving unattended chemicals in the fume hoods. When forced to do so, please leave the container with a lid, label the container with the chemical name, your name and contact information. Chemicals on hot plate cannot be left unattended.

3.2.9. Hot plates must be turned off after use. Do not take move hot plates between fume hoods and do not bring hot plates into or take them out of the clean room. If there’s a problem with a hot plate please notify the staff. Never heat HF, acetone, or flammable solvents of any type on hot plates.

3.2.10. Solid waste should be disposed in the appropriate waste bin (e.g. sharps container).

3.3. Emergency response:
At any case of an emergency press the emergency button, exit the lab as you are, and call the staff.

3.3.1. Incident reporting:

Immediately report any safety incident to the clean room staff. Incidents occurring after hours should also be reported to Public Safety:

- On campus x4-5555
- Off campus 212-854-5555

3.3.2. First Aid kits and Hydrofluoric Acid exposure kits are located inside the clean room (in the gowning room) and can be accessed should an injury has occurred. Please let the staff know of ANY incident involving personal injuries.

3.3.3. Chemical spills:

3.3.3.1. In case of a chemical spill on the floor please notify the people working in the lab as well as the staff and evacuate the lab until the spill has been cleaned and cleared.
3.3.3.2. After hours response: mark the area of the spill, call Public Safety and specify the material, location, and estimated quantity that was spilled, and evacuate the lab. Let the staff know as soon as possible.
3.3.3.3. In case of a chemical exposure – let other people in the lab know you were affected, take off your contaminated PPE and clothing (overhead emergency showers will have curtains) and use overhead emergency shower to rinse yourself for at least 15 minutes. Let the staff know.
3.3.3.4. After hours response: let your buddy know you were affected, take off your clothes and use emergency showers to rinse yourself for at least 15 minutes. Notify Public Safety and request EMS transport to the Emergency Room. Bring a copy of the SDS with you.
3.3.3.5. In case of a chemical eye exposure – let other people in the lab know you were affected. Use the eye showers to rinse your eyes for 15 minutes and let the staff know. Seek medical treatment.

3.3.3.6. **After hours response:** let your buddy know you were affected. Use the eye showers to rinse your eyes for 15 minutes, call Public Safety and request EMS transport to the Emergency Room. Bring a copy of the SDS with you.

3.3.3.7. In case of Hydrofluoric Acid (HF) exposure, take off your clothes (shower will have curtains), rinse yourself in the emergency shower for at least 5 minutes and then apply large quantities of Calgonate calcium gluconate antidote on the affected area. The calcium gluconate antidote can be found in the Hydrofluoric Acid exposure kit. Let the staff know and seek medical treatment as soon as possible. Take the laminated SDS and the Calgonate calcium gluconate antidote from the kit with you to the Emergency room. If the antidote is not available continue rinsing for at least 15 minutes.

3.3.3.8. **After hours response:** let your buddy know you got exposed. Use the overhead emergency shower for at least 15 minutes and then apply large quantities of calcium gluconate antinode on the affected area, call Public Safety and request EMS transport to the Emergency Room. Bring a copy of the SDS with you.
<table>
<thead>
<tr>
<th>Event</th>
<th>Standard hours response</th>
<th>After hours response</th>
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</table>
| Chemical spill      | • Notify people in the lab.  
• Notify Staff.  
• Evacuate the lab. | • Mark area of spill.  
• Call public safety.  
• Evacuate the lab.  
• Call staff.                                                      |
| Chemical Exposure   | • Notify people in the lab. Remove PPE and clothes.  
• Use safety shower.  
• Notify staff.  
• Sick medical assistance. | • Notify your buddy.  
• Remove PPE and clothes.  
• Use safety shower.  
• Notify public safety and go to ER. |
| HF Exposure         | • Notify people in the lab.  
• Remove PPE and clothes.  
• Use safety shower.  
• Apply Calgonate Antinode.  
• Notify staff.  
• Go to the ER with SDS and antinode. | • Notify your buddy.  
• Remove PPE and clothes.  
• Use safety shower.  
• Apply Calgonate Antinode.  
• Notify public safety and staff.  
• Go to the ER with SDS and antinode. |

3.3.4. Gas leak or fire:

3.3.4.1. In case of a gas leak the horn will go off and the blue strobes will flicker. Exit the lab immediately. Do not stop to ungown or turn off equipment. If only the blue light is flickering and the fire alarm does not go off with the gas alarm (white light), it means the leak is in an enclosed space and evacuation to the 10th floor lounge is sufficient. You may leave the lounge to go home after you called public safety and staff and made sure you are accounted for.

3.3.4.2. **After hours response:** exit the lab immediately. Do not stop to ungown or turn off equipment. Call the clean room staff and Public Safety 212-8545555. If you wish to leave campus please make sure you let the clean room staff and Public Safety know that you’re OK.

3.3.4.3. In case of an ambient gas detection the building fire alarm will go off (horns and white strobes). Exit the clean room and the building immediately and go to the building street exit, 530 W120th Street. Call clean room staff and Public Safety at 212-8545555.
3.3.4.4. **After hours response:** exit the lab and the building immediately. Do not stop to ungown or turn off equipment. Call clean room staff and Public Safety at 212-8545555.

![Emergency button](image1)

3.3.4.5. In case of a small fire that is not endangering your life follow RACE and PASS:

[https://research.columbia.edu/fire-safety-laboratory](https://research.columbia.edu/fire-safety-laboratory)

Notify the staff as soon as possible. If there is even a slight threat to your safety, push the emergency button, exit the clean room without ungowning, and call Public Safety. Notify the clean room staff.

![Fire alarm](image2)