CARLETON LABORATORY
Columbia University | Engineering

User Policy & Training Manual

Robert A. W. Carleton Strength of Materials Laboratory
Columbia University in the City of New York

Revised 17 July 2023

[PAGE LEFT INTENTIONALLY BLANK]

Table of Contents

Location

Contact Information

Robert A. W. Carleton Strength of Materials Laboratory
500 West 120th Street, MC4709
161 Engineering Terrace
New York, NY 10027

Phone: +1.212.854.3158
Fax: +1.212.854.4084
Email: carleton@civil.columbia.edu

Operating Hours: 9:00 am to 5:00 pm, Monday through Friday, excluding university holidays.

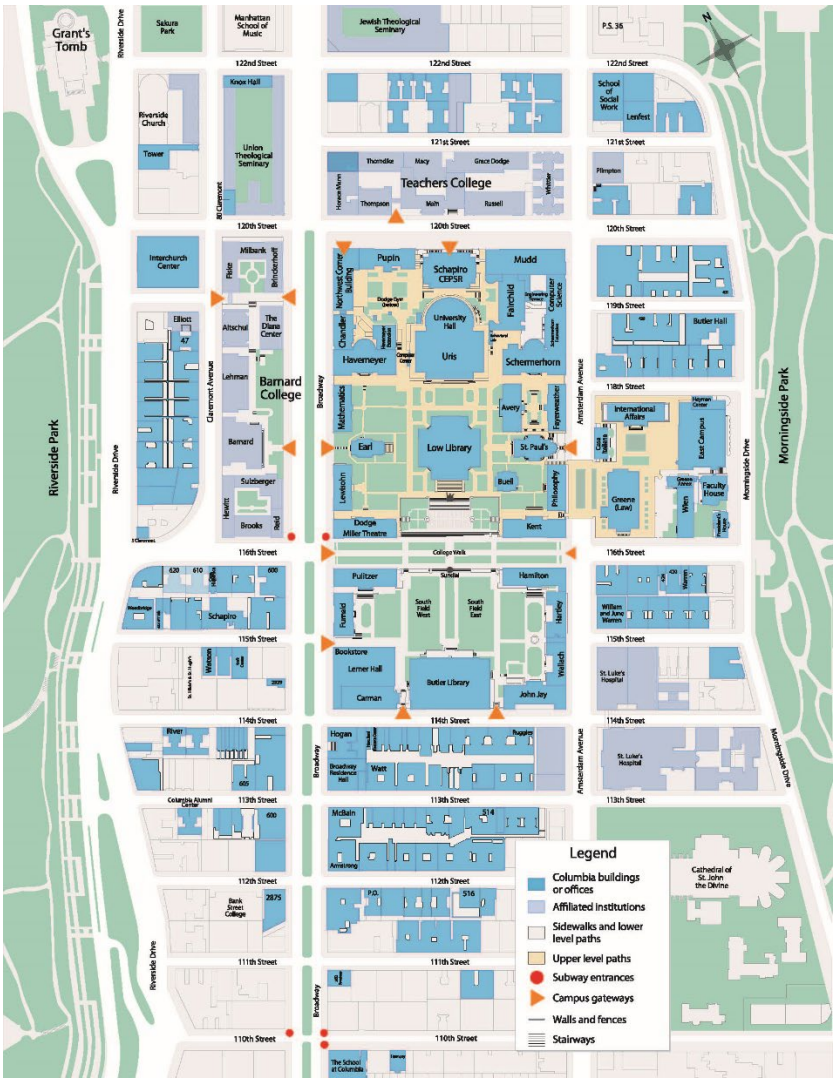


Figure 1: Campus Map

Directions

The main entrance of the Carleton Laboratory is on the first floor of the Engineering Terrace Building, Room 161.

From the street, the lab can be reached via the Seeley W. Mudd Building entrance on 120th Street, between Broadway and Amsterdam Avenue. Once in the elevator lobby, walk through the automatic double doors, and turn left immediately after the doors to find the main entrance to the Carleton Laboratory.

From campus, the lab may be accessed via the Seeley W. Mudd Building entrance (4th Floor entrance) in the northeast corner of the quad. Take the elevator down to the 1st floor. Turn left, walk through the automatic double doors, and turn left immediately after the doors to find the main entrance to the Carleton Laboratory.

Loading Dock

The Carleton Lab loading dock is located between 119th and 120th Street on the western side of Amsterdam Avenue, immediately south of the bus stop. The loading dock is a short dock with a vertical clearance of 11'-10" (3.6m) with a dock height of 40" (1.0m) and will not accommodate full-size box trucks.

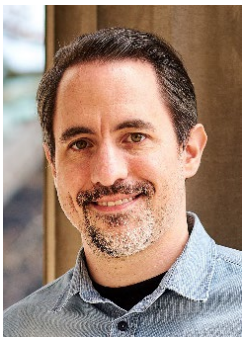
Trucks that do not clear dock dimensions must park curbside immediately south of the loading dock to be serviced by the forklift, if necessary.

Call one hour in advance to announce all delivery to allow staff to ready the dock for delivery.

IMPORTANT: This loading dock is operated on an ad-hoc basis. Lab staff will receive only announced deliveries made to researchers of the Carleton Laboratory during operating hours. No third party deliveries will be accepted. Deliveries for other departments must be managed by the respective consignee. Dock access should be arranged through the SEAS Facilities Manager.

Directory of Staff

Officers

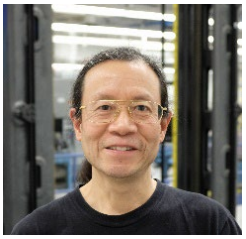


Adrian Brügger
Director of Research
500 West 120th Street, MC 4709
656 S.W. Mudd Building
New York, NY 10027

Phone: +1.212.854.3369
Fax: +1.212.854.6267
E-Mail: **brugger@civil.columbia.edu**

Will Hunnicutt
Manager, Carleton Laboratory
500 West 120th Street, MC 4709
161 Engineering Terrace
New York, NY 10027

Phone: +1.212.854.3158
Fax: +1.212.854.4084
E-Mail: **hunnicutt@civil.columbia.edu**



Liming Li
Manager, Centrifuge Laboratory
500 West 120th Street, MC 4709
151 Engineering Terrace
New York, NY 10027

Phone: +1.212.854.4823
Fax: +1.212.854.4084
E-Mail: **li@civil.columbia.edu**

Freddie Wheeler Jr.
Senior Laboratory Engineer
500 West 120th Street, MC 4709
151 Engineering Terrace
New York, NY 10027

Phone: +1.212.854.4823
Fax: +1.212.854.4084
E-Mail: **wheeler@civil.columbia.edu**

Amos Fishman-Resheff
Senior Laboratory Engineer
500 West 120th Street, MC 4709
151 Engineering Terrace
New York, NY 10027

Phone: +1.212.854.4823
Fax: +1.212.854.4084
E-Mail: resheff@civil.columbia.edu

Staff

Jamie Basirico
Senior Laboratory Technician
500 West 120th Street, MC 4709
155 Engineering Terrace
New York, NY 10027

Phone: +1.212.854.4461
Fax: +1.212.854.4084
E-Mail: basirico@civil.columbia.edu

Directory of Laboratories

Centrifuge Laboratory
B53 Engineering Terrace
Phone: +1.212.854.0107

Graduate Researcher Office
271 Engineering Terrace
Phone: +1.212.853.0414

Heffner Laboratory
B54 Engineering Terrace
Phone: +1.212.854.6036

Library
265 Engineering Terrace
Phone: +1.212.854.5896

Locker Room
157 Engineering Terrace
Phone: +1.212.854.3153

Main Testing Floor
159 Engineering Terrace
Phone: +1.212.854.4461

Machine Shop
155 Engineering Terrace
Phone: +1.212.854.4461

SMaRT Laboratory
264 Engineering Terrace
Phone: +1.212.854.1059

Mindlin Laboratory
153 Engineering Terrace
Phone: +1.212.854.6662

Shake Table Laboratory
159 Engineering Terrace
Phone: +1.212.854.3442

Access Policy

General Policy

Access to Carleton Lab is controlled by Columbia University's proximo access system as well as closed-circuit cameras. It is a violation of policy to swipe in unauthorized persons, which will result in disciplinary action and loss of laboratory access.

Access authorization must be granted explicitly by lab management. Access granted by other individuals or mere admittance via the proximo access system on the main door do not equate to authorized access. Access will be rescinded if any of the required RASCAL Trainings expire.

Anyone entering the lab must have access as authorized by lab management. Authorization is granted through the access application system described herein. Persons without such access are required to report to the Laboratory Management office (161 Engineering Terrace).

Access Permission Levels

All users are required to receive a Carleton Lab sticker in order to complete the access authorization process. Stickers appear as follows:

- Faculty + Staff: 

- General & Research: 

-
- Visitor: 

Faculty & Staff

Access level provided to CEEM Faculty and Staff as well as employees on payroll with the lab, under supervision of laboratory management. Faculty & Staff permissions provide unrestricted access to all points of entry of the laboratory. Per regulatory requirements faculty performing active research in the laboratory are subject to the same training and certification requirements as other users.

Research Access

Research Access is defined as any access to the Laboratory to perform independent work utilizing laboratory equipment that is not directly associated with a laboratory class. Research includes undergraduate and graduate independent research, and Ph.D. research. Standard research access entitles a user to access the laboratory Monday to Friday between the hours of 9AM and 5PM. The following requirements must be fulfilled:

- Legitimate academic need to use Laboratory.
- Faculty sponsor: all students and student groups must have a faculty advisor/sponsor.
- Registration in the FOM Lab Management system with a valid Chartstring.
- The user must be sufficiently conversant in English to follow written and oral instructions from staff and fellow users and communicate effectively in case of potential incidents and emergency situations.

- Completion of the following three RASCAL Trainings: Carleton Laboratory Site-Specific Training, Shop Safety Training, and Lab Safety, Chemical Hygiene, and Hazardous Waste Management Initial Training (or Refresher Training if the Initial Training has been completed).
- For 24/7 access, users must hold a valid FDNY issued C-14 Certificate of Fitness, which must be in possession of the user when they are in the Lab.

General Access

Undergraduate and graduate students taking a class that contains a laboratory teaching component, student club participants, and SEAS-sponsored tour group leaders must apply for General Access via the Carleton Laboratory website after meeting the following requirements:

- Legitimate academic need to use Laboratory.
- Faculty sponsor: all students and student groups must have a faculty advisor/sponsor.
- The user must be sufficiently conversant in English to follow written and oral instructions from staff and fellow users and communicate effectively in case of potential incidents and emergency situations.
- Completion of the following three RASCAL Trainings: Carleton Laboratory Site-Specific Training, Shop Safety Training, and Lab Safety, Chemical Hygiene, and Hazardous Waste Management Initial Training (or Refresher Training if the Initial Training has been completed).

No instruments/equipment may be used independently by the user; all work requiring the use of instruments/equipment must be directly supervised by university faculty, lab staff, or teaching assistants that are trained on the specific instrument/equipment.

Visitors

Visitors must fulfill the following requirements to be considered for access to the Carleton Laboratory:

- Legitimate academic need to use Laboratory.
- Faculty sponsor: all visitors must have a faculty sponsor.
- Visitor Appointment: all visitors must have a University appointment in order to be allowed perform experimental work in the Laboratory.
    - Visitors with Salaried Appointment (non-zero $ appointment) will be considered for access.
    - Visitors with Zero-Salary Appointment: only specific cases will be considered for access.
        - Faculty from outside academic institutions spending sabbatical at University
        - Undergraduate and graduate researchers participating in a University-recognized academic exchange/internship program
- CU Affiliate Liaison: appointed visitors perform must be assigned a CU affiliate liaison by their host at the time of application. It is the responsibility of the liaison to directly supervise (i.e. be in direct line of sight) all work performed by the appointed visitor. If an appointed visitor is found performing work in the Laboratory without supervision, both the visitor and their liaison are considered in breach of policy and will be reprimanded per the statutes of the Laboratory Disciplinary Policy.

The Laboratory reserves the right to deny visitor access privileges in light of confidentiality and conflict-of-interest considerations of ongoing University research and testing.

High School-level students may be sponsored by faculty and allowed access to the Laboratory if and only if sponsored through a University-recognized internship/exchange program. Additionally, their arrival must be announced and coordinated with the School, Department, and Laboratory at least two months prior to arrival.

Training requirements for all visitors are equivalent to Research level access. All visitors must be sufficiently conversant in English to follow written and oral instructions from staff and fellow users and communicate effectively, e.g. in case of potential incidents and emergency situations. Absolutely no work may be performed by the visitor until all training requirements are fulfilled; visitors without appropriate training may not enter the Laboratory.

Visitors without a University appointment will not be considered for Laboratory access.

Certifications & How to Apply for Access

Machine Shop Safety Training – required for all persons.

Laboratory Safety/Chemical Hygiene/Hazardous Waste/Laboratory Fire Safety Training – required for all persons.

Carleton Laboratory Site-Specific Training, Shop Safety Training – required for all persons

Certificate of Fitness (C-14) - required for all persons requesting access outside of laboratory business hours. Students using only office space within the laboratory (marked blue) must not obtain a certificate of fitness but are strictly limited to these spaces outside of laboratory operating hours.

Access Application – fill out online application for the appropriate level of access and upload your training certificates

Carleton Lab Sticker – after filling out the application, go to the management office to receive your "Carleton Lab" sticker.

Access Issues

Users who have lost access are encouraged to review this access policy to determine if their access status may have changed.

Should the access policy not clarify the situation, users are to contact lab management to resolve the issue.

Access Revocation

Access will be rescinded if any of the required RASCAL Trainings expire. All required trainings must be valid for the entire academic year during which access is requested.

Visits and Tours

Individuals without lab access wishing to access the lab to conduct business related to the lab may announce themselves via the doorbell at the main entrance. Once they have entered the lab, they must register with the lab management office (161 Engineering Terrace). Visitors may not conduct lab work without appropriate training.

Any individuals or groups interested in receiving a tour of the laboratory should contact the lab management directly.

Recurring tours using third-party tour guides may be arranged by contacting lab management. Tour guides are expected to apply for General access. The lab reserves the right to refuse tour access without prior notice due to privacy, disclosure, or safety reasons.

Safety Trainings

Carleton Laboratory Site-Specific Training

This training (see Appendix A) introduces Carleton Lab users to the policies and procedures pertaining to safety, hazard communication, equipment use, and emergency response. It also provides an outline to user amenities, equipment-specific training protocols, equipment reservation, machine shop use, fabrication requests, and guidance to obtaining all necessary trainings to work safely in the lab.

This training program is required of all laboratory users.

At the conclusion of this course you must take a short quiz to verify that you have completed the course and understands its contents. Upon passing the quiz, you should save the training transcript as a proof of course completion and upload to the lab access application.

Please go to the Rascal Training Center to take the Carleton Laboratory Site-Specific Training course. The training course can be found: Training Center > Safety Courses > Carleton Laboratory Site-Specific Training.

Shop Safety Training

Hand and power tools are routinely used in various machine shops at Columbia University. When not used properly they can cause serious and sometimes fatal accidents and injuries. Due to the presence of heavy machinery in the lab, all lab users are required to complete this training. Understanding of potential hazards and observing proper safety guidelines can help to reduce accidents and injuries.

This training program is required of all laboratory users and provides a basic overview of hazards associated with the use of hand and power tools that are found in academic machine shops. The training covers types of hazards, general shop safety rules, ways to keep the shop clean, usage of safe work practices and use of proper personal protective equipment for the task. This training, however, is not a substitute for a machine specific safety training that must be provided by laboratory staff before you use any machine in the shop. The course also meets the training requirements of various OSHA Standards and University policy (see Appendix B).

At the conclusion of this course you must take a short quiz to verify that you have completed the course and understands its contents. Upon passing the quiz, you should save the certificate PDF as a proof of course completion and upload to the lab access application.

Please go to the Rascal Training Center to take the Machine Shop Safety training course. The training course can be found: Training Center > Safety Courses > Shop Safety Training.

Laboratory Safety/Chemical Hygiene/Hazardous Waste/Laboratory Fire Safety Training

Environmental Health & Safety policy (see Appendix C) requires that all persons with Access attend an initial training session and perform a refresher training every two years thereafter. Due to the presence of chemicals in the laboratory, any user with Research or General level access is required to take this training. A refresher course must be taken every 2 years.

Certificate of Fitness (C-14) Training

Carleton Laboratory is required to have a C-14 Certificate of Fitness holder present at any time when the laboratory is in operation. This is a simple certification by the FDNY that verifies an understanding of

basic fire safety in a laboratory environment. All officers of the laboratory hold C-14 certifications, so all activities performed during normal operating hours of the lab do not require any individual user to be certified.

Any researcher who works in the Carleton Laboratory (including Burmister Laboratory) outside of normal operating hours (9:00am to 5:00pm M-F) must obtain a C-14 Certificate of Fitness. The certification process is sponsored by Columbia University, so the application process is free to all students, faculty, and staff. Please see the EH&S Website for further information on the C-14 Certificate of Fitness.

Other Trainings

Laboratory users may be working with specific chemicals or hazards which require their own safety trainings. These include, but are not limited to: Hydrofluoric Acid, Cryogenic Gases, Formaldehyde, and Lasers.

Environmental Health and Safety provides a list of and administers these safety trainings. Users requiring hazard specific safety trainings should contact lab management to confirm that the Carleton Lab is capable of accommodating said additional hazard with appropriate engineering controls and PPE. Upon approval, lab management will refer the user to EH&S to receive the appropriate trainings and forward all training certificates to lab management.

If for any reason a lab user feels that they require safety training of any kind that is not currently provided by EH&S, the user should contact lab management.

Machine-Specific Training

FOM Lab Management System

All Research Access users must register using FOM Lab Management Software in order to be trained to operate any lab equipment independently. Training and access control is managed utilizing FOM at the discretion of Lab Management. Once a user is trained on a machine, they will be granted access through FOM.

Machine Tools

All users are required to receive machine-specific training prior to the operation of most machine tools. Machine shop equipment may only be operated by trained CEEM students, staff, or faculty. Absolutely no other persons are allowed to operate said machines. As an alternative, the Carleton Laboratory offers “Machine Shop Fabrication” services for non-CEEM projects, performing the work at a standardized hourly “Machine Shop Fabrication” rate.

The following machine tools require machine specific training; other machine tools may also require training:

- Haas CNC mill
- Clausing CNC mill
- Bridgeport mill
- Clausing Colchester lathe
- Browne & Sharpe grinder
- DoAll vertical bandsaw

- Baileigh horizontal bandsaw
- Clausing drill press
- Clausing Ibarmia drill presses
- Micro Precision drill press
- Diversitech downdraft benches
- Flott drilling and tapping center
- All welders
- All grinders
- All sanders
- Bridge cranes

Users wishing to obtain machine-specific training on any of the above machine tools should contact lab management or staff directly. Upon completion of the training, users will receive a written training certification from the trainer, which is to be given to lab management for registration.

Users are expected to understand how to responsibly operate any tool that they use. Should a user have any questions about the operation of any tool, whether or not it is listed above, the user should consult the Senior Lab Technician. Use of any machine tool without proper training is not only a Class III Violation (see Disciplinary Policy), but risks injury to both the user and other laboratory users.

Testing Equipment

All users are required to receive machine-specific training prior to the operation of most testing equipment. Absolutely no other persons are allowed to perform testing on these machines. As an alternative, the Carleton Laboratory offers “Staffed Testing” services for projects, performing the work at a standardized hourly “Staffed Testing” rate. Operation of Faculty-Owned equipment (marked with green asset tag) is at the discretion of the owner.

The following testing equipment requires machine specific training, other testing equipment may also require training:

- Atlas Solar Simulator
- Freeze-Thaw Machine
- Instron 1500 HDX 300k UTM
- Instron 5984 34k UTM
- Instron 600DX 135k UTM
- Instron MT2 Torsion Tester
- Keyence IM-7001 Image Dimension Measuring System
- Keyence VHX-5000 Microscope
- LECO Hydrogen Analyzer
- MTS 220k UTM
- MTS 22k UTM
- MTS 50k Axial-Torsion UTM
- MTS 7k UTM
- Q-Fog Weathering Chamber
- Rockwell Hardness Tester
- Shake Table

- SPECTROMAXXx Spark OES
- TA Instruments DMA 850
- TA Instruments Isothermal Calorimeter
- TA Instruments Q50 TGA
- TA Instruments Vertical Dilatometer

Users wishing to maintain machine-specific training on any of the above testing equipment should contact lab management or staff directly. Upon completion of the training, users will receive a training certification, which is to be given to lab management.

Users are expected to understand how to responsibly operate any testing equipment that they use. There are many pieces of testing equipment that are not listed above that, when not used properly, can provide unreliable results, can be damaged, and can present harm to the user. Users are to always consult lab staff or officers before using any piece of equipment for the first time. Should a user have any questions about the operation of any machine, whether or not it is listed above, the user should consult the lab staff or officers.

The following testing equipment is to be operated by Lab staff only:

- Geotechnical Centrifuge
- Southwark-Emery 600k UTM

Improper operation of this equipment may present a significant hazard to the user and their environment, and may cause considerable damage to the equipment.

Safety Policy

Rules of Conduct

Guests must register with lab management. “Browsing” of the lab is dangerous and is not permitted.

No person is allowed outside of white lines without a Carleton Lab sticker, unless authorized by lab staff.

No laboratory property may be removed from the premises unless authorized by lab management.

The entire lab is an active forklift and crane area. Persons without rigging training must always yield to cranes and the forklift.

Open shoes, loose clothing, shorts and short skirts are prohibited in active lab spaces.

Eating and drinking is strictly prohibited in active lab space.

Active machinery may only be approached under the express permission of the operator.

Proper Attire

Open shoes, loose clothing, shorts, and short skirts are prohibited in active lab space. Any user wearing prohibited attire will be instructed to leave the laboratory immediately.

Attire must satisfy the following requirements for the entire laboratory area:

- Closed-toed flat shoes
    - Sandals and flip-flops are prohibited.
    - Open heels (high heels) are prohibited.

- Long pants or long skirts
    - Legs must be covered to protect the user against hot particles and chemical spills.
    - Shorts and short skirts are prohibited.
- Form-fitting clothing
    - Baggy/loose shirts and pants are prohibited
    - Shawls, necklaces, loose jewelry and neckties are prohibited, unless tucked into clothing
- Natural fiber clothing is required if performing hot work such as grinding, welding, brazing, etc. Synthetic fibers are prohibited, as they can be highly flammable.
- Long hair is to be tied back or otherwise contained
- Over-the-neck ID card holders/lanyards must be secured in a pocket and may not dangle. Only tear-away safe holders/lanyards are allowed.
    - If you are unsure if your tag-holder satisfies this requirement, do not use it until authorized by lab management
    - The ID tag holders sold in the Columbia University Bookstore do not satisfy OSHA requirements.

The only exception to these rules is a visit or tour of the lab space, where the visitor does not leave the white lines.

Jumpsuits

Jumpsuits are to be worn by users at their own discretion and/or training instruction to provide protection against cuts and abrasions and to protect a user's body and clothing from lab hazards and materials. Jumpsuits are provided at no cost by the lab and are suitable when working with materials or fixtures that are dirty or could cut or a scrape a user or their clothing. No reservations are necessary and jump suits can be taken on a first-come first-serve basis from the hangers on the east wall of the locker room. Used jump suits are to be placed in the appropriately labeled bins directly next to the hangers for laundry service.

Lab Coats

Lab coats are to be worn by all users when they are handling or in proximity to someone handling chemicals. Lab coats are provided at no cost by the lab. No reservations are necessary and lab coats can be taken on a first-come first-serve basis from the hangers on the east wall of the locker room. Used lab coats are to be placed in the appropriately labeled bins directly next to the hangers for laundry service.

The provided lab coats are made of a polyester/cotton blend. They are not flame resistant and while they provide general chemical resistance, they do not provide specific chemical resistance. Any user requiring flame resistant chemical protection or a specific chemical resistant protection should contact lab management.

Hard Hats

Hard hats are to be worn by all users working on the main test floor when cranes are being used or rigged or when other hazardous falling objects may be present. The lab provides ANSI Z89 compliant hard hats to all users at no cost. Hard hats are color coded as follows:

- White – Visitors (first-come first-serve)
- Baby Blue – Students (first-come first serve)
- Royal Blue – Researchers (see lab management to reserve a hat)

- Dark Blue – Faculty (see lab management to reserve a hat)
- Gray – Student Lab Assistants (see lab management to reserve a hat)
- Black – Lab Staff and Officers

Other PPE

Beyond the proper attire, and when engineering and administrative controls are either infeasible or do not completely eliminate hazards, proper PPE is necessary to ensure user safety when working with various machines and materials. In accordance with OSHA regulations, the lab offers PPE at no cost to users.

Eye protection, laser safety goggles, N-95 respiratory protection (both disposal facemasks and half-face cartridge respirators) and various types of gloves are available in multiple locations throughout the laboratory. The lab management is the designated PPE Responsible Party and should be consulted regarding the selection, use and maintenance of all PPE.

PPE may not be used as a substitute for engineering controls including fume hoods, glove boxes, process enclosures, etc., or for good work practices and personal hygiene. PPE complements such hazard control measures.

Floor Markings

Floor markings are often provided through lines affixed to the floor. However, a line of colored cones, colored chain, or a colored adhesive floor mat serves the same function as a floor line.

White – main traffic routes through lab; keep area clear of obstructions; beware of moving vehicles. Persons without safety training or proper attire are to remain in these areas unless authorized by lab staff (see Figure 2).

Figure 2: White Floor Lines

Yellow – this area contains a physical hazard, entry with express permission by laboratory staff only (see Figure 3).

Figure 3: Yellow Floor Lines

Blue – enter only with clean clothes and shoes, and do not bring tools, chemicals into space. Food and drink are allowed in this area (see Figure 4).

Figure 4: Blue Floor Lines

Exits

100 Level – Main Level

The first floor of the laboratory contains two exits. The main exit is the same door as the main entrance, located in the west of the laboratory (see Figure 5). There is also an exit in the southeast corner of the laboratory near the machine shop (see Figure 5).

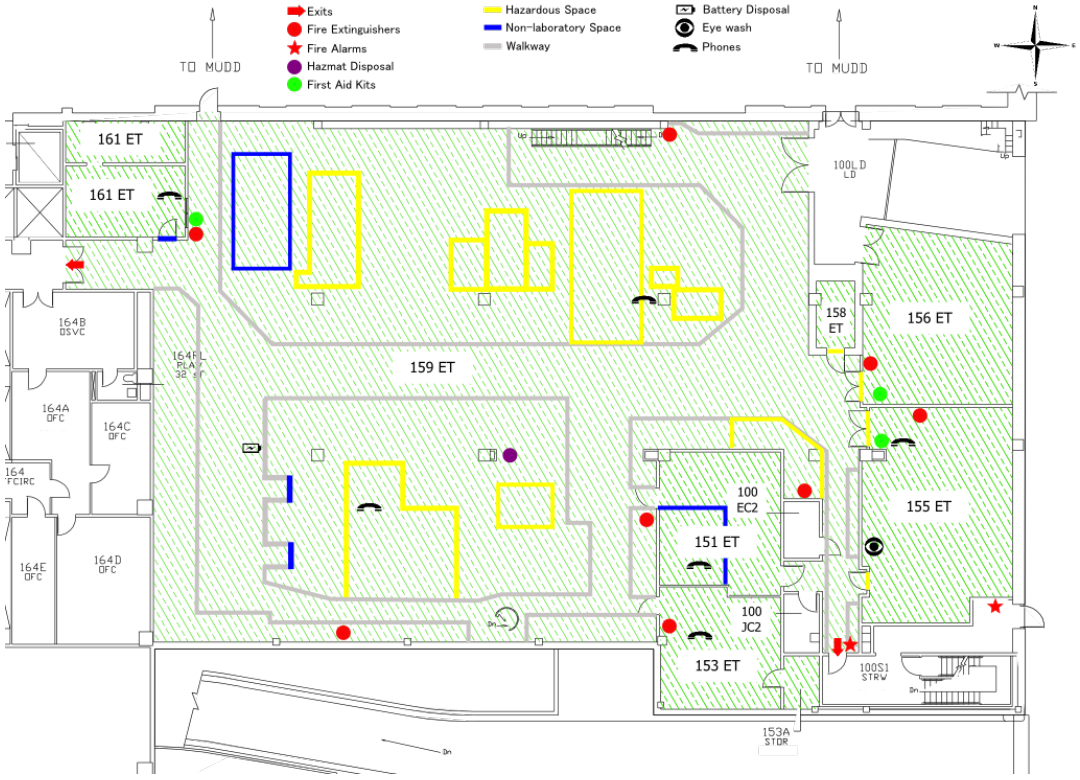


Figure 5: 100 Level Floor Plan

The large double doors in the northeast corner of the lab (Figure 6) are not an exit. These doors and all of the surrounding doors have different access restrictions than the main entrance to the laboratory and it is possible to get locked in the loading dock should a lab user attempt to use these doors as an exit.

Figure 6: The Loading Dock Entrance (Not an Exit)

200 Level - Mezzanine

The second floor of the lab has two exits, both located on the south wall of the lab (see Figure 7).

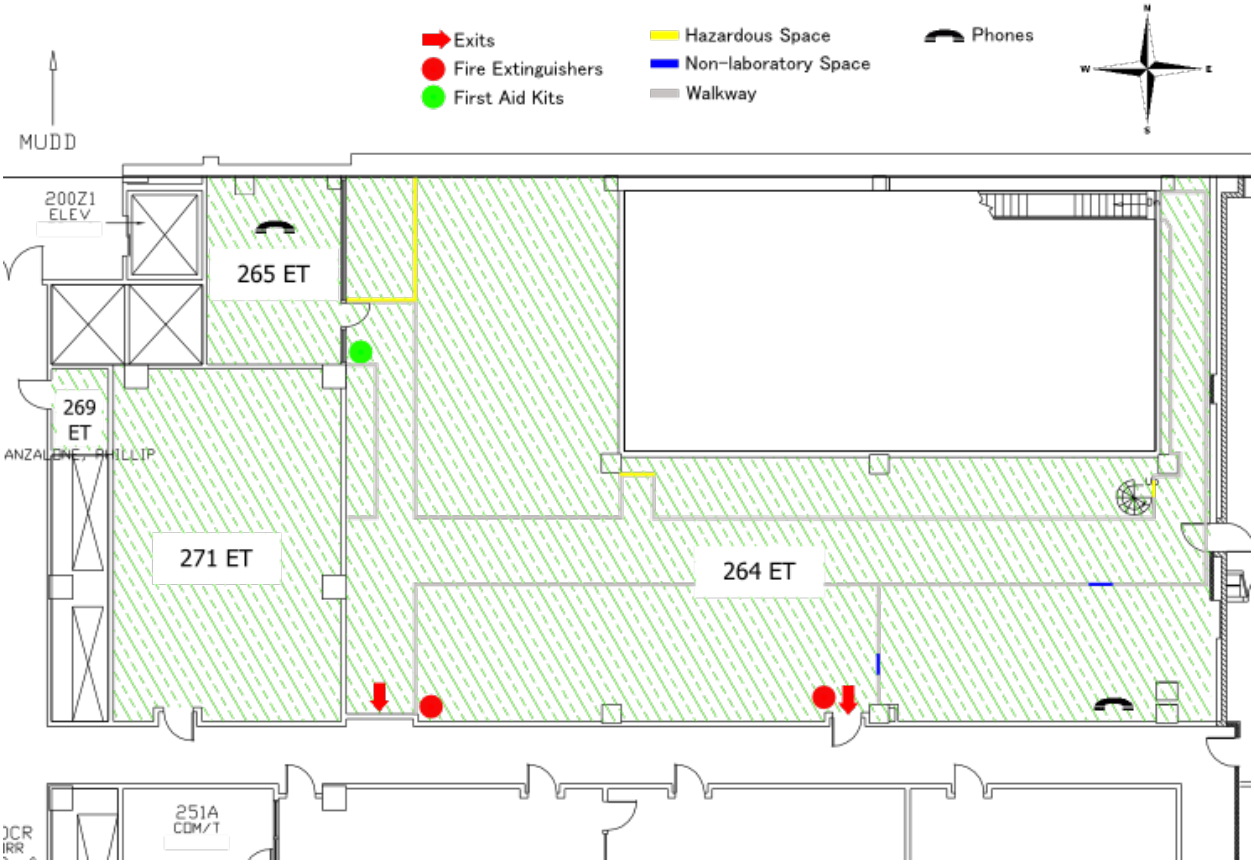


Figure 7: 200 Level Floor Plan

B00 Level - Basement

The basement of the lab has no direct exits from the space. Two staircases provide access to the first floor, where users can exit the lab. These staircases are a standard staircase in the north of the basement and a spiral staircase in the south of the basement (see Figure 8). Persons with limited mobility may have trouble negotiating the tight spiral staircase and should opt for the standard staircase to the north.

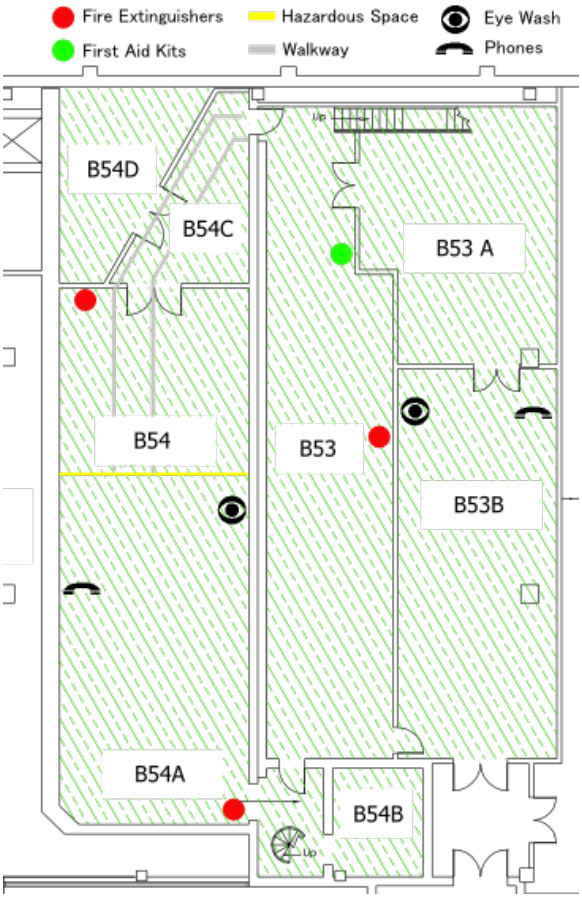


Figure 8: B00 Level Floor Plan

700 Level – Burmister Lab

Burmister lab has one exit; the main entrance serves as the exit (see Figure 9).

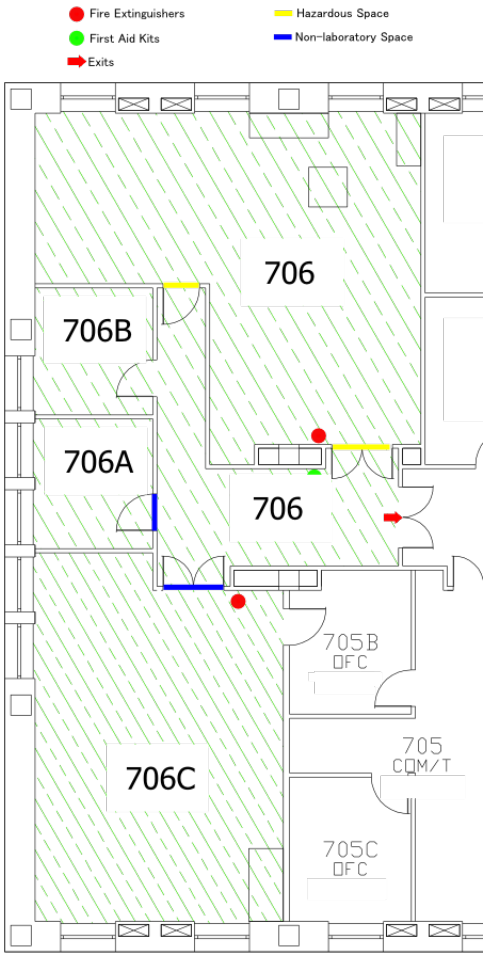


Figure 9: 700 Level Floor Plan

Muster Point

In case of an emergency requiring laboratory evacuation, all lab users should convene on the sidewalk in front of the 500 West 120th Street entrance to the Mudd building, indicated by a black star in Figure 10.

Should this area be inaccessible due to emergency conditions or any other reason, all lab users shall convene on 120th St directly in front of the Northwest Corner Building, illustrated by a gray star in Figure 10.

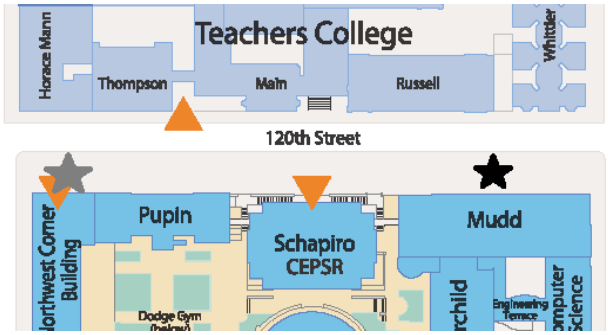


Figure 10: Rally Point

Ceiling Lights

Red – Fire equipment such as fire extinguishers, fire blankets, and/or fire alarm pull stations

Green – First aid kit

Blue – Campus phone location, dial 99 in case of medical, fire, or police emergency

Strobe Lights

Amber – active forklift and/or crane, yield to horizontal/vertical transportation and rigging at all times.

Green – hazardous test in progress, enter area only with express staff permission. Tests may be automated, so staff may not be present.

White – fire alarm, evacuate building immediately, close but do not lock all doors on the way out. Fire policy is addressed in the Event Response section of this Manual.

Audible Warnings

Siren (high pitch) – rapid burst signal when remote control crane is activated. Operator may also blow siren to signal users to clear area.

Buzzer (low pitch) – signal used to warn persons of active testing

- One blow – prepare for test, clear area
- Two blows – area clear, test commencing – blown before each test
- Three blows – test completed, area safe

Eye-piercing Siren – fire alarm, evacuate building immediately, close but do not lock all doors on the way out. Fire policy is addressed in the Event Response section of this Manual.

Important: The Engineering Terrace building is equipped with a NYC Code Fire Alarm System. All personnel must evacuate, even if the alarm stops ringing. Close but do not lock all doors on your way to the exit.

Forklift Safety

In the lab pedestrians must yield to the forklift (see Figure 11). Due to the limited line of sight of the forklift operator in many loading and lifting situations, you must assume that the forklift operator cannot see you. If the driver is forced to make a sudden stop or turn, the load may dislodge from the forklift, topple, and crush bystanders.

Figure 11: Forklift

Never walk directly in front of, behind, or beside the forklift when it is in motion. The forklift steers from the rear, so walking next to the driver is hazardous, as the forklift may swing out and run over feet or pin/crush incautious pedestrians.

Rigging Safety

The lab is equipped with a number of remote-controlled gantry cranes (see Figure 12). Be aware of their presence at all times. The hi-bay area contains three trambeam cranes that can move within the entire hi-bay space and parts of the mezzanine.

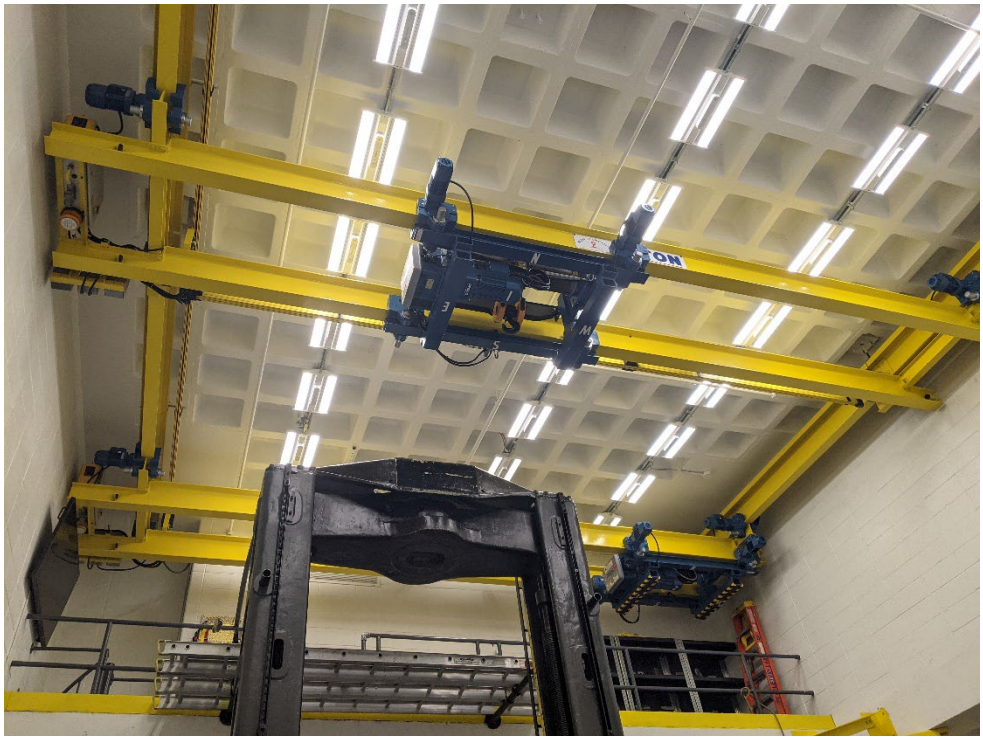


Figure 12: Bridge Crane

Never step under a crane, be it loaded or unloaded.

Never step on a load that is hanging from a crane.

Always look up and check for the position of cranes before entering the high-bay area. A flashing amber strobe indicates that the crane is active. Hard hats must be worn by all persons in the high bay once the crane becomes active. Due to the nature of the space and the fact that the cranes are remote controlled, the operator may be standing out of sight. Unless direct eye and voice contact has been made with the operator, never cross the path of an active crane. The crane operator owns the space once the crane becomes active; all other users must yield to their operation.

Crane operators are trained to communicate in cardinal directions. Use the compass on the high bay wall as the standard coordinate system. If communicating with the operator, use cardinal directions; directions such as left, right, forward, back, etc. will cause confusion and potentially cause significant injury.

The lab also has a number of removable floor panels. Beware of these when walking. Never cross an area that is cordoned off with yellow cones. This is a warning that hazards lie beyond this point. Ask the lab staff for a safe path in case a normal route is obstructed.

Beware of the following hazards:

- Crushing hazard due to falling load – never put any part of your body underneath a load being rigged. Especially take notice of your hands and feet.
- Crushing hazard due to traveling load – never enter a space between the crane and an immovable obstruction. The crane may travel in your direction and crush you with the load.
- Falling hazard due to traveling load – never step between a precipice and a load. The crane may travel in your direction and push you over the edge of the precipice.

Machine Safety

Active machinery should be approached only with the permission of the operator of the machine. Appropriate Personal Protective Equipment (PPE) – i.e. earplugs, safety goggles, face shield, etc. – must be worn.

Only authorized persons are allowed to use the machinery in the laboratory and in the machine shop. Machines may be used only by staff and users who have been properly trained by lab personnel. Long hair must be tied back, loose clothing, and neckties are strictly prohibited. Universal Testing Machines, the Shake Table, Machine Shop Equipment, and any other machine that poses a safety hazard may only be operated during normal business hours when staff are present. Access is controlled to these machines via locked doors and the FOM Lab Management System

Only trained and authorized persons are allowed to use laboratory testing machinery and equipment. Requests for machine specific training should be directed to lab staff via FOM. Once trained, testing equipment can be reserved via FOM.

Fire Safety

The lab operates under and adheres to the Environmental Health & Safety Manual – Fire Safety (Appendix D.)

Fire Extinguishers

Fire extinguishers are located throughout the laboratory (Figure #2). The location of fire extinguishers is designated by red ceiling lights.

The lab contains two different types of fire extinguishers:

Type BC extinguishers (see Figure 13) are CO_2 based. They are to be used for electrical fires, oil fires, and on people.

Figure 13: BC Fire Extinguisher with the typical large cone spray nozzle

Type ABC extinguishers (see Figure 14) are dry chemical based. They are to be used for liquids, wood, paper, textiles, rubber, and oil.

Figure 14: ABC Fire Extinguisher with the typical small spray nozzle

Fire Blankets

The welding booth immediately across from the Machine Shop (155 Engineering Terrace) is equipped with a fire blanket (see Figure 5). Fire blankets are designed to combat emergencies involving persons on fire, and can also be used for other emergency response. See the EH&S fire policy (Appendix D) for further information.

Active Shooter

The laboratory operates under and abides by the community response guidelines of Public Safety (Appendix E).

Chemical Safety

The laboratory operates under and abides by the chemical spills policy of the Environmental Health & Safety Manual – Chemical Hygiene Plan (Appendix C) as well as the Environmental Health & Safety Chemical Spills and Explosions Procedure (Appendix F).

All wet chemistry work must be approved by lab staff before work commences by filling out and email the Wet Chemical Procedure form to carleton@civil.columbia.edu. Once approved, the form must be printed and posted adjacent to the work space while the procedure is being performed.

When requesting a purchase of chemicals, the requestor must provide a plan to store said chemicals. Any user requesting the purchase chemicals must complete the Chemical Storage and Segregation 101 training.

Acids are to be stored in the blue acids cabinet located in the southeast corner of the lab. Acids are to be separated as organic or inorganic as labelled within the acids cabinet and stored in the provided secondary containment.

Flammables are to be stored in the yellow flammables cabinet located directly southwest of the machine shop.

Refrigerated non-flammable chemicals are to be stored in the refrigerator marked “CHEMICALS ONLY – NO FOOD” in Room 151. Food is not to be stored in this refrigerator.

Refrigerated flammables are to be stored in the flammables-certified refrigerator in the southwest corner of the lab.

Chemicals stored in the lab are property of the individual or group that purchased the chemicals. Lab users must label their chemicals with their name and the date the chemical was received in a manner that does not interfere with any existing labeling. Use of chemicals belonging to another user is strictly prohibited and, in some cases, illegal. Users wishing to use lab owned chemicals should contact lab management. Unlabeled chemicals will be disposed of at the discretion of Lab Management.

Users are responsible for the disposal of their individual-owned chemicals prior to the conclusion of projects to avoid legacy wastes and unknown materials.

Environmental Safety

The lab operates under and adheres to the Environmental Health & Safety Manual – Environmental Safety (Appendix G).

The lab recycles waste whenever possible. Green-lidded paper recycling bins are positioned throughout the laboratory.

The following are acceptable green recycling:

- White, colored and glossy paper (Staples OK, but not spiral bindings.)
- Mail and envelopes
- Wrapping paper (Remove ribbon and tape.)

- Smooth cardboard (Shoe boxes, tubes from paper towel and toilet paper rolls, cardboard from product packaging. For food boxes, remove inside and outside plastic wrappers.)
- Paper bags
- Cardboard egg cartons and trays
- Newspapers, magazines and catalogs
- Phone books, soft-cover books (Paperbacks, comic books, etc.)
- Corrugated cardboard (If flattened boxes are large, place them next to the recycling bin.)

The following are trash:

- Hardcover books (Recyclable, if the cover is removed.)
- Used napkins, paper towels or tissues
- Soiled paper cups or plates
- Heavily soiled paper
- Plastic- or wax-coated paper or cardboard (Candy wrappers, take-out containers, etc.)

Blue-lidded bins for can and plastic recycling can be found near the entrance of the laboratory.

The following are acceptable blue recycling:

- Glass bottles and jars (Glassware from laboratories is recyclable under a separate program.)
- Metal cans (Tuna cans, empty aerosol cans, empty and dried-out paint cans with lids removed, for example.)
- Aluminum foil wrap and trays
- Household metal (Wire coat hangers, pots, pans, for example.)
- Plastic bottles, jugs, caps, lids, food containers (yogurt, take out), non-food containers, packaging, and houseware (tupperware, flower pots)
- Beverage cartons and drink boxes (Milk and juice.)

The following are trash:

- Any glass items other than glass bottles and jars (Mirrors, light bulbs, ceramics, and glassware, for example.)
- Any plastic items other than plastic bottles, jugs and containers (plastic toys, cups, bags and wrap, for example.)
- Styrofoam (Cups, egg cartons, trays, for example.)

Scrap metal is to be disposed of in the gray scrap metal dumpster located directly south of the Southwark-Emery 600k Universal Testing Machine. The dumpster is marked with the label of Figure 15.

Figure 15: Scrap Metal Dumpster Label

Hazardous materials are to be disposed of according to the Environmental Health & Safety Manual – Environmental Safety, including all labeling, collection compatibility and container management requirements. The hazmat disposal area can be seen on the map of Figure 5 and is show in Figure 16.

Figure 16: Hazmat Disposal Area

Used oil and oily materials are to be disposed in the oil drums appropriately labelled by laboratory management just north of the hazmat disposal area (see Figure 17.) A liquid waste drum is available for oil waste, labeled “WASTE OIL” and sporting a red fire-proof funnel. An oily solids drum is located immediately adjacent to this drum. All oil-drenched solids such as oily rags and oily hazmat pickup grains must be disposed in this drum. The drum and/or funnel must be mechanically closed after waste is

dumped.

Figure 17: Oil Disposal Drums, showing fire-proof funnel in the foreground

Sharps, including all used and unused needles and other materials identified in the University's Bloodborne Pathogens Exposure Control Plan (http://www.ehs.columbia.edu/ExposureControlPlan.pdf) are to be disposed in the pink sharps disposal bins located throughout the laboratory (see Figure 18). Lids must be closed after sharps are dumped.

Figure 18: Sharps Disposal Container

Alkaline and lithium (household) batteries are to be disposed of in the battery disposal bin south of the management office. All battery terminals are to be insulated before disposal. This can be accomplished by terminal guards or electrical tape. Multiple batteries may be placed in one bag, as long as all battery contacts remain isolated. Any batteries leaking electrolytic material shall be treated as hazmat and disposed of accordingly. Lead-acid batteries are to be disposed as hazardous material.

Concrete Laboratory

Wet cementitious materials cannot be poured down the drain; this includes washing of tools and containers with cementitious residue. This is reflected in the signs of Figure 19. Any items with cementitious residue must be washed over the slop buckets until the residue is removed. These buckets are routinely serviced by lab staff when full.

Figure 19: Concrete Materials Laboratory Sink

If the slop buckets (see Figure 20) are full, notify lab staff immediately.

Figure 20: Slop Buckets

Cleaning materials in the Concrete Lab are to remain in the concrete lab. Outside cleaning materials are not to be brought into the Concrete Lab.

Tools for use in the Concrete Lab are identifiable by yellow markings on their handles and are to be stored and used only in the Concrete Lab. External tools and equipment are not to be brought in without explicit permission from the lab staff.

Equipment Lockout-Tagout

Under 29 CFR 1910.147 and 29 CFR 1910.333, the lab implements and enforces a lockout-tagout policy. Equipment being maintained and serviced may have the appropriate lockout or tagout devices (see Figure 21) affixed to energy-isolating devices in said equipment when operation of the equipment may pose a threat to the user, other lab users, lab personnel or the equipment itself.

Figure 21: Lockout-Tagout Station in the Machine Shop

Lockout-tagout devices are only to be removed by the lab personnel who installed the device. Removal by any other individual is a violation of federal code and lab procedure. Such violations are considered Class IV Violations (see Disciplinary policy).

Machine Reservation System

No testing equipment may be used without a reservation. Reservations are managed by the FOM Lab Management System. The use of any testing equipment without a reservation is prohibited and is considered a Class III Violation (see Disciplinary Policy.)

To reserve or access equipment not listed on the lab website or FOM, users are to contact the lab staff.

Incident Response

All permanent laboratory staff are trained and certified in first-aid, CPR and AED.

Minor Injury

In the event of a minor injury, such as a minor cut, bruise, etc., see lab management immediately. Should lab management not be present, there are several first aid kits throughout the laboratory. These are mounted on the wall and are designated by green ceiling drop lights as well as wall mounted first aid signs.

All injuries, be they minor or major, must be reported to lab management.

Major Injury

In the event of a major injury, see lab management immediately. Lab management are trained in first aid, CPR and AED and will be able to act as first responders to a major injury. Should lab management not be present, contact Public Safety by calling 99 from any lab phone or +1.212.854.5555 from any external phone. Do not call 911, as 911 operators are not familiar with the Columbia University campus and buildings and will not be able to route emergency personnel to your location.

Disciplinary Policy

General Policy

Carleton Lab is an active heavy civil engineering testing lab. This lab is not only subject to the standard safety regulations for chemical labs, as mandated by EH&S and FDNY, but also further safety regulations that are common in manufacturing facilities and construction sites.

Carleton Laboratory management is responsible for the safety of all persons working in the Laboratory and is authorized by University policy to stop work, suspend access, and initiate formal disciplinary proceedings against any person on Laboratory premises. It is the responsibility of every user to familiarize himself/herself with the pertinent safety regulations of the Laboratory, as clearly posted at the entrances and noted in the various training modules, to follow all such rules, regulations and requirements and to conduct themselves and their activities in a safe manner. The failure to attain appropriate trainings is in itself a violation of laboratory policy. Laboratory management shall act fairly, per the guidelines outlined in this policy. All judgments are final.

Repeated offenses will be met with escalated disciplinary action, as outlined in this policy.

No University affiliation grants any user immunity from this policy.

The laboratory disciplinary policy is enforced by laboratory management to ensure a safe and functional working environment for its users. The disciplinary policy is to be enforced by lab management at its discretion. Disciplinary violations have been separated into separate classes. Specific incidents are to be assigned a class by lab management. Any specific incident which cannot be classified will be dealt with by lab management on an ad-hoc basis.

Definitions

- Aggregation – disciplinary actions are added to each other.
- Escalation – subsequent violation to be met with the next higher (+1) level of disciplinary action.
- De-Escalation – subsequent violation to be met with the next lower (-1) level of disciplinary action.
- Probation – period of time for which the user is subject to a +1 escalation for all violation classes.
- Suspension – period of time for which the user may not enter the Carleton Laboratory premises. Exceptions must have advanced written approval by Management and must be justified with extenuating circumstances.
- Expulsion – indefinite suspension of user from Carleton Laboratory premises.

Aggregation

Disciplinary action in response to multiple violations cited in the same instance will aggregate but not escalate.

Escalation

Repeated offenses in different instances within the same violation class shall escalate for every instance that a violation is cited.

De-Escalation

If a user was previously cited in a violation class but is not cited for further offenses in the same class within a year, the escalation of the original offense shall rescind.

> *Example: If a user performs a Class II violation on 1 January 2013 and another Class II violation on 7 March 2013, the second violation will be considered a 2nd offense. If the user is reprimanded for another Class II violation on 15 February 2014, that offense is again considered a 2nd offense since the initial violation from 1 January 2013 rescinded on 1 January 2014, de-escalating the user to Class II 1st offense status.*

Probation

At its sole discretion, Management may impose a probationary period on a user. During the probationary period, all violation classes are escalated by one step (+1).

Class I Violations

Definition – a lack of sufficient training and/or certification to be present in the laboratory.

Violations

- Working in the laboratory without a Carleton Lab Sticker.
- Working in the laboratory outside of operating hours without a C-14 holder's direct supervision.
- Working in the laboratory when explicitly told not to by laboratory staff.

Disciplinary Action

- 1st offense: Verbal Warning, Order to Vacate Premises Until Trained
- 2th offense: 1 Month Suspension

Class II Violations

Definition – actions which potentially endanger the offender and create an unsafe working environment

Violations

- Eating and drinking outside of blue marked areas
- Improper laboratory attire: shorts, open shoes
- Improper PPE: safety goggles, face shields, proper gloves, ear protection, dust masks, respirators.
- Failing to label chemical or HazMat containers
- Light misuse of tools and machines: ex., using screwdriver as chisel

Disciplinary Action

- 1st offense: Verbal Warning
- 2th offense: Written Warning
- 3rd offense: 1 Day Suspension
- 4th offense: 1 Week Suspension

Class III Violations

Definition – actions which create a significant and immediate hazard to the offender, and potentially other users. Actions which can potentially damage laboratory property. Willful disregard of posted policy.

Violations

- Providing lab access to unauthorized persons
- Using machine shop or testing equipment without authorization
- Using equipment without previous online reservation
- Heavy misuse of tools and machines: grinding aluminum or other flammables
- Removing laboratory property from premises without prior permission
- Propping open doors without prior authorization outside of operating hours
- Improper disposal of hazardous materials: pouring chemicals down drain, etc.
- Failing to evacuate laboratory during a fire alarm

Disciplinary Action

- 1st offense: 1 Day Suspension
- 2th offense: 1 Week Suspension
- 3rd offense: 1 Month Suspension
- 4th offense: Expulsion

Class IV Violations

Definition – egregious violations, which cause damage to the Laboratory, its users, and the University as a whole

Violations

- Working in the Laboratory under the influence of drugs and/or alcohol
- Removing a lockout/tagout tag without authorization of the tag owner
- Petit larceny of laboratory property (<$1,000)

Disciplinary Action

- 1st offense: 1 Semester Suspension + Report to Disciplinary Committee
- 2th offense: Expulsion + Report to Disciplinary Committee

Class V Violations

Definition – egregious violations, which cause willful damage to the Laboratory, its users, and the University as a whole

Violations

- Grand larceny of laboratory property (>$1,000)
- Gaining unauthorized access to the lab while under access suspension

Disciplinary Action

- 1st offense: Expulsion + Report to Disciplinary Committee/Law Enforcement

Visitor Violations

Definition – use of the lab by a visitor without direct supervision by a research access level user

Violations

- Use of the lab by a visitor either alone or with a supervisor that does not have at minimum research level access and is a graduate student or higher

Disciplinary Action

- 1st offense: 3 week suspension for both visitor and assigned supervisor
- 2nd offense: Expulsion + Report to Disciplinary Committee for both visitor and assigned supervisor

Appendix A – Carleton Laboratory Site-Specific Training

The most up to date version of the training should be accessed via RASCAL: TC2600 - Carleton Laboratory Site-Specific Training.

Appendix B – Environmental Health & Safety Academic Machine Shop Safety Policy

COLUMBIA UNIVERSITY		
ACADEMIC MACHINE SHOP SAFETY	**Procedure: 6.01** **Version: 3.0**	**Created: 7/2011** **Revised: 3/8/2016**

A. Purpose

This policy establishes safe work practices for students, staff and visitors working in any Academic Machine Shop. It defines safety guidelines, training requirements and response procedures in case of emergency to minimize injuries and illness when working in a machine shop.

B. Applicability/Scope

Applicability: This policy covers users of all Academic Machine Shops irrespective of their location or department. Facilities and Research Machine Shops are not covered by this policy. Additionally, this policy does not apply to Facilities activities related to infrastructure maintenance and custodial support in academic shops. These activities are arranged in advance or regularly scheduled by the Shop Manager.

This policy is applicable to all University campuses including Morningside (MS), Lamont-Doherty Earth Observatory (LDEO), Medical Center (CUMC) and Nevis.

C. Definitions

Academic Machine Shop means any shop for academic pursuits or research are the primary function and students, faculty and staff may work with shop equipment under the supervision of a Shop Supervisor. Such work may include instruction, required machine work for Columbia University curriculum, or research activities by Columbia University students, faculty, or approved visitors under the supervision of a Shop Supervisor. Laboratories with large pieces of machinery with the potential to cause serious harm may qualify as an academic machine shop. Equipment users in these labs would be subject to this policy.
Buddy System is a term used to describe working with a partner to ensure the safety of both parties. For the purposes of this policy, Buddy System signifies NOT working alone in a Machine Shop.
Facilities Machine Shop means any shop staffed and used by Columbia University Facilities employees. No students are permitted to work in these shops, as these shops primary function is for use by professional trades.
Research Machine Shop means any department shop working for research projects. These shops are usually staffed by trades. Students, faculty, and other non-shop workers are not permitted to perform work on machinery in such shops.
Superuser is an experienced equipment user, other than a shop supervisor, who can provide technical support to students in the shop.
Visitors who are not affiliated with Columbia University may occasionally use machine shops.
Other users of machine shops include faculty, staff and visitors. All users must comply with section D of this policy.

D. Responsibilities

1. **Students**
   a. Never work alone in the shop.
   b. Complete General Shop Safety Training on RASCAL, present the training certificate to the Shop Supervisor to arrange machine-specific training before using any machine.

c. Adhere to the clothing standard set forth in each shop – including a minimum expectation of long pants, closed-toe and back shoes, and protective eyewear.
d. Observe all shop safety rules in this policy when working in the machine shop.
e. Observe all shop-specific rules beyond the scope of this policy.
f. Report all injuries to a Shop Supervisor promptly, regardless of seriousness.
g. Promptly report unsafe conditions, actions or near-miss incidents to Shop Supervisor.

2. Other Users

a. Obtain a valid Columbia UNI or arrange anoter means to take general shop safety training.
b. Complete general shop safety training and machine specific training provided by the Shop Supervisor before using any machine.
c. Observe all shop safety rules when working in the machine shop.
d. Never work alone in the shop.
e. Report all injuries to the Shop Supervisor promptly, regardless of seriousness.
f. Work with a Shop Supervisor for specific needs.

3. Shop Supervisor

a. Ensure that all users of shop are familiar with general and shop-specific safety rules.
b. Enforce all safety rules and make all users aware of the consequences of rule violations.
c. Ensure that all users of shop have attended general shop safety and machine-specific training before starting their work in the shop.
d. Provide tool/equipment specific training to each user of the equipment they will be using.
e. Investigate all accidents and near-miss incidents and ensure timely correction of unsafe conditions.
f. Give full support to all safety procedures, activities and programs.
g. Maintain all training records
h. Maintain access to Safety Data Sheets for all chemicals used in the shop.
i. Clearly display Shop Safety Rules signs and shop hours on the shop door.

4. Department

a. Ensure that adequate supervision is provided for the shop staff.
b. Provide adequate resources for maintenance, repairs and safe guarding equipment.
c. Direct all shop users to adhere to University policy and safety rules.

5. Environmental Health and Safety (EH&S)

a. Periodically review and update this policy and training.
b. Conduct periodic audits of various shops.
c. Provide respirator fit testing, if deemed necessary.

E. Procedures

Training.
Anyone using an academic machine shop at CU is required to attend two types of training:

1. **General Shop Safety Training**
   A web based RASCAL training is available at the (www.rascal.columbia.edu, Course No. TC 0600). After completing training the user must complete the test, print a certificate of completion and provide a copy to the Shop Supervisor to arrange for machine-specific training.
2. **Machine Specific Training**
   Hands on training is provided by the Shop Supervisor before using a machine. This training will NOT be offered unless general safety training is completed. The training should involve instructions and hands-on demonstration in the following:
   - Description and identification of the hazards associated with a particular machine;
   - Proper safety precautions when working with a particular machine;
   - Limitations of the tools/equipment and when and what NOT to use;
   - Safeguards, protection they provide, and ensuring their presence before using a machine;
   - What to do (e.g., contact supervisor, tag the machine) if a damaged guard, missing part, unusual noise, etc., is noticed.
   - How to use emergency buttons and other measures, when needed.
   - Maintenance and cleaning procedures

General Shop Safety Guidelines

Columbia University Environmental Health and Safety (EH&S) has developed General Shop Safety Guidelines for those who currently, or might in the future, use power tools and heavy machinery in shops and laboratories. These guidelines do not serve as a replacement for formal training in lab techniques or shop safety. Only trained personnel should use shop equipment after they have been trained by their supervisor. Failure to follow proper precautions can result in serious injury or death.

1. **Never Use a Machine without proper training**
   In addition to general safety training, shop users must attend specific training on the machine to be used.
2. **Never Work Alone**
   At least two adults must be in the shop when power tools are being used. You must get permission from your Supervisor for off-hours and weekend work.
3. **Never Use a Machine When Impaired**
   The use of alcohol or drugs prior to the use of shop machinery is strictly forbidden and is grounds for suspension or termination of shop access privileges. Shop users must also be aware of other situations which cause impairment. These include: illness, tiredness, stress, or the use of medications.
4. **Always wear proper work attire in the shop**
   a. **Footwear**: Closed-foot shoes only. Sandals, flip-flops or other open-toe and/or open-back shoes are prohibited at all times in machine shops.
   b. **Eye Protection**: The minimum standard for protective eyewear is safety glasses

with side-shields. Eyewear which offers additional protection against splashing or other hazards may be indicated based on a risk assessment of the process or procedure. Prescription glasses with plastic lenses must meet ANSI Standard Z87.1 for safety

c. **Clothing and Accessories**: long pants must be worn in machine shops. Remove or secure any items that can can become entangled in a machine. These items include: loose clothing, Long hair, gloves, ID badges, jewelry, etc.

5. **Maintain Good Housekeeping**
   Maintaining a clean and orderly workplace reduces fire hazards as well as slip & fall hazards. Good housekeeping promotes safety and professionalism in the shop.
6. **Excersise Caution When Working With Machines**
   Maintain awareness of moving parts and sharp edges which can cause injury.
7. **Be aware of dust and fume hazards**
   Any procedure in which the operation of a machine produces dust or fumes must be conducted in an appropriately ventilated area
8. **Always consult the shop supervisor or an equipment superuser for troubleshooting or other uncertainties with a machine**
   Adjustments or repairs must only be made under the supervision of a competent professional who is highly familiar with the safe operation of the machine
9. **Never Remove Safety Guards**
   Machine guards are present for the protection of the user and must not be removed or altered
10. **Always report damaged equipment to the shop supervisor**
    Broken parts or equipment can result in serious injuries. compromised machines must not be usesd until reparis have been made.

Shop Hours

Machine shops are open during regular working hours. Access to shops may be limited during scheduled classes, holidays or other reasons. Contact Shop Supervisor for timing and additional information.

During busy periods in the semester the shop may be opened by Shop Supervisor or other staff in the evening and/or on weekends. Always check with Shop Supervisor for a change in schedule.

Visitors Use of Shops

Any visitor user of a machine shop who is not CU employee must obtain a written permission from the Shop Supervisor and adhere to all rules applicable to students, staff and faculty. Visitor users must follow guidelines delineated in the Responsibilities section for "Other Users." No exceptions are made for visitors.

Working Safely with Solvents, Resins and Other Chemicals

1. Be aware of the hazards associated with each chemical. Review safety data sheets and manufacturer instructions.
2. When possible, work with less hazardous chemicals. For example, water based cleaners could be used in place of solvents.
3. Minimize the potential for exposure using all available controls
   i. Work with chemicals in a fume hood whenever possible. Always work in

well ventilated areas

ii. Follow proper handling and storage procedures for all chemicals. Consult Standard Operating Procedures and work accordingly in a manner that minimizes the potential for exposure.

iii. Proper work attire must be used when working with chemicals. Consult the shop supervisor for the proper eyewear and gloves for the chemical you are using.

4. Any use of a respirator must be in accordance with the Respiratory Protection Policy
5. Never work with chemicals when impaired. Conditions which can cause impairment include: the use of alcohol or drugs, illness, tiredness, stress, or the use of medications.
6. Minimize the risk of fire. No smoking is permitted in the shop. Never work with chemicals near ignition sources such as electrical outlets, hot surfaces or open flames
7. Collect all chemical waste for removal by EH&S
8. Wash hands thoroughly after work to minimize the potential for contamination.

Emergency Procedures

1. Be familiar with the location and use of all emergency equipment present in the shop, including fire extinguishers, eye washes and spill kits, etc. Know the location of all exits and stairwells near the shop.
2. Each user must have a plan of action in case of emergency based on shop-specific emergency procedures, standard operating procedures, safety data sheets and guidance from the shop supervisor
3. Any injuries must be immediately reported to the shop supervisor. Medical attention is available and should be sought for injuries
4. In the event of a chemical exposure, remove contaminated clothing and rinse the affected area. Follow first aid guidelines from the chemical's safety data sheet. When seeking medical attention, bring a copy of the safety data sheet. Report exposures immediately to the shop supervisor
5. Report and clean up any manageable spills immediately. For unmanageable spills contact Public Safety

F. Emergency Contacts

- MS Campus: Call 99 or (212) - 854- 5555 from a cell phone
- CUMC Campus: Call (212)-305-7979 or (212)-305 -8100
- Lamont Campus: Call 555 or (845)-359-2900 from a cell phone
- Nevis Campus: Call 911

In case of serious injury or if Public Safety cannot be reached, call 911.
Always notify your Supervisor as soon as possible. You may be required to complete an Accident Form.

G. Medical Surveillance –n/a

H. Recordkeeping

- **General safety records** shall be maintained by the RASCAL.
- **Machine specific training records** shall be maintained by the Shop Supervisor using form comparable to that in Appendix II.

I. Appendices

Appendix I. Sample Machine Specific Training Record Form
Appendix II. Carleton Lab - Floor Marking Guidelines
Appendix III. Mechanical Motions and Actions

J. Forms

K. References

1. OSHA Standard 29 CFR 1910.22 General requirements
2. OSHA Standard 29 CFR 1910.35. Means of Egress
3. OSHA Standard 29 CFR 1910.133. Eye and Face Protection
4. OSHA Standard 29 CFR 1910.134. Respiratory Protection
5. OSHA Standard 29 CFR 1910.135. Hand Protection
6. OSHA Standard 29 CFR 1910.136. Foot Protection
7. OSHA Standard 29 CFR 1910.178. Powered Industrial Trucks
8. OSHA Standard 29 CFR 1910.212.General Requirements for all Machines
9. OSHA Standard 29 CFR 1910.242. Hand and Power Tools and Equipment, General
10. OSHA Standard 29 CFR 1910.243. Guarding of Portable powered Tools.
11. OSHA Standard 29 CFR 1910.252. General requirements for Welding
12. UCSB and U of Florida Shop Policy Guidelines

COLUMBIA UNIVERSITY		
ACADEMIC MACHINE SHOP SAFETY	**Procedure: 6.01** **Version: 3.0**	**Created: 7/2011** **Revised: 3/8/2016**

APPENDIX I
COLUMBIA UNIVERSITY
SAMPLE MACHINE SPECIFIC TRAINING RECORD FORM

The employee listed below has satisfactorily been trained on the safe use and operation of the specified shop equipment.

Employee Name	UNI	Shop Equipment	Date	Signature	Shop Supervisor Signature

COLUMBIA UNIVERSITY		
ACADEMIC MACHINE SHOP SAFETY	**Procedure: 6.01** **Version: 3.0**	**Created: 7/2011** **Revised: 3/8/2016**

APPENDIX II
Carleton Lab - Floor Markings Guidelines

1. **Traffic Area** – main traffic routes through lab; keep area clear of obstructions; beware of moving vehicles.

2. **Physical Hazard Area** – this area contains a physical hazard, entry by laboratory staff only (yellow cones are equivalent to yellow lines).

3. **Clean Area** – enter area only if authorized by lab staff. Enter only with clean clothes and shoes, and do not bring soiled tools into space.

COLUMBIA UNIVERSITY		
ACADEMIC MACHINE SHOP SAFETY	**Procedure: 6.01** **Version: 3.0**	**Created: 7/2011** **Revised: 3/8/2016**

APPENDIX III
Hazardous Mechanical Motions and Actions

A wide variety of mechanical motions and actions may present hazards to the worker. These can include the movement of rotating members, reciprocating arms, moving belts, meshing gears, cutting teeth, and any parts that impact or shear. These different types of hazardous mechanical motions and actions are basic to nearly all machines, and recognizing them is the first step toward protecting workers from the danger they present. The basic types of hazardous mechanical motions and actions are:

Motions

- rotating (including in-running nip points)
- reciprocating
- transverse

Actions

- cutting
- punching
- shearing
- bending

Brief examination of each of these basic types:

Motions:

Rotating motion can be dangerous; even smooth, slowly rotating shafts can grip clothing, and through mere skin contact force an arm or hand into a dangerous position. Injuries due to contact with rotating parts can be severe.

Collars, couplings, cams, clutches, flywheels, shaft ends, spindles, and horizontal or vertical shafting are some examples of common rotating mechanisms which may be hazardous. The danger increases when bolts, nicks, abrasions, and projecting keys or set screws are exposed on rotating parts.

In-running nip point hazards are caused by rotating parts on machinery. There are three main types of in-running nips.

1. Parts can rotate in opposite directions while their axes are parallel to each other. These parts may be in contact (producing a nip point) or in close proximity to each other. In the latter case the *stock* fed between the rolls produces the nip points. This danger is common on machinery with intermeshing gears, rolling mills, and calendars.
2. Another nip point is created between rotating and tangentially moving parts. Some examples would be: the point of contact between a power transmission belt and its pulley, a chain and a sprocket, or a rack and pinion.
3. Nip points can occur between rotating and fixed parts which create a shearing, crushing, or abrading action. Examples are: spooked hand wheels or flywheels, screw conveyors, or the periphery of an abrasive wheel and an incorrectly adjusted work rest.

Reciprocating motions may be hazardous because, during the back-and-forth or up-and-down motion, a worker may be struck by or caught between a moving and a stationary part.

Transverse motion (movement in a straight, continuous line) creates a hazard because a worker may be struck or caught in a pinch or shear point by the moving part.

Actions

Cutting action involves rotating, reciprocating, or transverse motion. The danger of cutting action exists at the point of operation where finger, head, and arm injuries can occur and where flying chips or scrap material can strike the eyes or face. Such hazards are present at the point of operation in cutting wood, metal, or other materials. Typical examples of mechanisms involving cutting hazards include bandsaws, circular saws, boring or drilling machines, turning machines (lathes), or milling machines.

Punching action results when power is applied to a slide (ram) for the purpose of blanking, drawing, or stamping metal or other materials. The danger of this type of action occurs at the point of operant where stock is inserted, held, and withdrawn by hand. Typical machinery used for punching operations are power presses and iron workers.

Shearing action involves applying power to a slide or knife in order to trim or shear metal or other materials. A hazard occurs at the point of operation where stock is actually inserted, held, and withdrawn. Typical examples of machinery used for shearing operations are mechanically, hydraulically, or pneumatically powered shears.

Bending action results when power is applied to a slide in order to draw or stamp metal or other materials, and a hazard occurs at the point of operation where stock is inserted, held, and withdrawn. Equipment that uses bending action includes power presses, press brakes, and tubing benders.

Appendix C - Environmental Health & Safety Chemical Hygiene Plan

1.1 Chemical Hygiene Plan Scope and Application

The Chemical Hygiene Plan (CHP) applies to faculty, staff and students on all campuses engaged in the laboratory use of hazardous materials, including those covered under the Occupational Health and Safety (OSHA) Standard 29 CFR 1910.1450, Occupational Exposure to Hazardous Chemicals in Laboratories, also referred to as the Laboratory Standard.

The CHP consists of two parts. The first part outlines the University policy for chemical hygiene and management in research laboratories by providing guidance for the safe use of chemicals, health hazards and routes of exposure, controlling or minimizing potential exposure, medical surveillance, training, waste disposal and emergency procedures. The second part, an essential component of the CHP, is a web-based Laboratory Assessment Tool for Chemical Hygiene (LATCH) developed by EH&S, designed to help individual laboratories prepare a laboratory-specific CHP, as required by OSHA. The PI and/or his/her designee is responsible for completing the laboratory –specific LATCH and reviewing and updating it no less frequently than annually.

The PI must ensure that all laboratory personnel:

a. Are knowledgeable about the contents of the University's CHP and his/her laboratory-specific LATCH and how to access these plans.
b. Have attended Laboratory Safety, Chemical Hygiene & Hazardous Waste Training, and other necessary function-specific trainings.
c. Are trained in laboratory- or job-specific procedures and use of equipment before handling hazardous chemicals and equipment.
d. Are familiar with the hazards in the laboratory and understand emergency procedures.

1.1.1 Chemical Hygiene Officer (CHO)

The Chemical Hygiene Officer (CHO) is an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the CHP. EH&S's Director of Occupational Safety Programs, who serves as the University CHO, is responsible for:

a. Keeping the senior administration informed on the progress of continued implementation of the CHP and bringing campus-wide issues affecting laboratory safety to their attention.
b. Reviewing the University's CHP, at least annually, with University stakeholders and recommending revisions and improvements based on regulatory changes, external or internal lessons learned, and best practices designed to improve laboratory practices and the CHP.
c. Providing expert guidance to the laboratory community in the area of chemical safety and serve as a point of contact for inquiries.
d. Ensuring that guidelines are in place and communicated for particularly hazardous substances regarding proper labeling, handling, use, and storage, selection of PPE, and facilitating the development of standard operating procedures for laboratories using these substances.
e. Serving as a resource for reviewing SOPs developed by PIs and laboratory personnel for the use, disposal, spill cleanup, and decontamination of hazardous chemicals, and the proper selection and use of personal protective equipment.
f. Reviewing reports for laboratory incidents, accidents, chemical exposures, and near misses and recommending follow up actions where appropriate.
g. Maintaining records of exposure monitoring and medical examinations.

h. Consulting on a laboratory worker's return to work following a chemical exposure requiring medical consultation.
i. Advising on the acquisition, testing and maintenance of fume hoods and emergency showers and eyewashes in laboratories where hazardous chemicals are used.
j. Staying informed of plans for renovations or new laboratory construction projects and serving as a resource in assisting with the design and construction process.
k. Assisting in the overall administration of the University's research safety training programs.

1.2 Health Hazards of Chemicals

OSHA broadly defines hazardous chemical as any chemical that is classified as a health hazard or simple asphyxiant in accordance with the Hazard Communication Standard (29 CFR 1910.1200). Health hazard means a chemical that is classified as posing one of the following hazardous effects: acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); aspiration hazard. The criteria for determining whether a chemical is classified as a health hazard are detailed in Appendix A of the Hazard Communication Standard (§1910.1200).

1.2.1 Chemical Hazard Identification and Labelling

The CHP ensures that information about chemical and physical hazards is communicated to laboratory personnel and students who may potentially come into contact with hazardous materials in laboratories. Effective hazard communication includes, but is not limited to: maintenance of current chemical inventories, providing ready access to Safety Data Sheets (SDS) for hazardous chemicals, proper labelling of chemical containers, posting of hazard signs where relevant, and training of laboratory personnel with regard to relevant hazards.

1.2.2 Safety Data Sheets

Chemical manufacturers are required to evaluate the hazards of chemicals they produce or import, and to provide this information to purchasers, at the time of shipment, through SDS's. Under OSHA's recently adopted Globally Harmonized System of Classification and Labelling of Chemicals (GHS), all hazardous chemicals manufactured in or imported to the United States of America will have accompanying SDS's in a standardized 13 section format. SDS's provide important information about a chemical's constituents, emergency aid/response measures, hazards, exposure control/protective equipment, among other information.

Laboratory staff are required to have immediate access to SDS's to aid them in evaluating the potential hazards of a substance prior to its use, as well as in the event of an emergency. SDS access and management is made available to all Columbia University research laboratories via ChemWatch. ChemWatch is a web-based database of more than 10 million SDS's, available in English and 30+ foreign languages, for immediate access by the Columbia University staff. Personnel or students who desire a copy of the SDS for any hazardous chemical with which they work or may be exposed can also contact their PI, supervisor, instructor or EH&S for a copy.

1.2.3 Labels

Commercial suppliers of chemicals label chemical containers with the chemical name, hazard information, and safe storage conditions. These labels must never be defaced or obstructed unless an

emptied and rinsed container is to be used for another purpose. Chemicals produced within laboratories must also be labeled in English to meet these requirements.
When chemicals are transferred from primary, labeled containers to portable, secondary containers/vessels, the New York City Fire Code requires labeling of the portable, secondary container with a chemical name(s). OSHA also requires labeling of portable, secondary containers under certain conditions, however it is good chemical hygiene practice to label all laboratory containers/vessels with a chemical name(s).

1.2.4 Other Chemical Information and Safety Data Sheet Resources

- Agency for Toxic Substances and Disease Registry
- American Chemical Society: Chemical Health and Safety Resources
- ChemWatch: Chemical Safety Information and Safety Data Sheets
- Centers for Disease Control and Prevention: Chemical Safety
- Fisher Scientific: Chemical Safety Information and Safety Data Sheets
- Occupational Health & Safety Administration: Laboratory Safety Guidance
- Occupational Health & Safety Administration: Occupational Chemical Database
- Safety Information Resources Inc (SIRI): Safety Data Sheets
- Sigma-Aldrich: Chemical Safety Information and Safety Data Sheets
- VWR International: Chemical Safety Information and Safety Data Sheets

1.2.5 Chemical Exposure Routes

A hazardous chemical's SDS will identify likely routes of exposure (see Section 1.2.3 above). In general, hazardous chemicals can enter the body via inhalation, skin (or eye) absorption, ingestion, and injection.

- Inhalation: For most chemicals in vapor, gas, mist, or particulate form, inhalation is the major route of entry. Once inhaled and deposited in lungs they can cause serious damage, from simple irritation to tissue destruction.
- Skin (or eye) absorption: Dermal or skin contact can cause simple redness or mild dermatitis to severe damage like destruction of skin tissue.
- Ingestion: Chemicals that inadvertently get into the mouth and are swallowed may harm the gastrointestinal tract or be absorbed and transported by the blood to internal organs where they can cause damage.
- Injection: Substances may enter the body if the skin is penetrated or punctured by contaminated objects. Effects can then occur as the substance is circulated in the blood and deposited in the target organs.

Section 1.4 Minimizing and Controlling Chemical Exposure provides important information on reducing exposure to hazardous chemical in the laboratory.

1.2.6 Toxicology/Health Effects of Chemical Exposure

While the subject of toxicology is quite complex, it is necessary to understand the basic concepts in order to make logical decisions concerning the protection of personnel from the effects of hazardous substances. Toxicity of a substance can be defined as the relative ability of that substance to cause adverse effects in living organisms. This ability is dependent upon several conditions. The quantity or the dose of a substance determines whether the effects of the chemical are toxic, nontoxic or even beneficial. In addition to dose, other factors influence the toxicity of a substance such as the route of entry, duration and frequency of exposure, and inherent variations between species and within species.

Understanding the basic concepts of chemical toxicity and the routes by which chemicals enter the human body can help in making critical decisions about the manner in which a hazardous substance should or should not be used. Decisions such as whether a hazardous substance can be substituted by a less hazardous one, or whether it should be used only with an engineering control, such as in a chemical fume hood, glove box and what PPE is necessary to protect the user from potential exposure.

1.3 Guidelines for Working with Chemicals

Good laboratory hygiene relies on adherence to protocols, procedures policies and best practices. Ensuring that proper work practices are followed will limit the probability of occupational exposure to hazardous chemicals, thus reducing the possibility of injury and illness.

1.3.1 General Housekeeping and Laboratory Hygiene

Disorderly laboratories and unsafe practices contribute to accidents and can hinder emergency response activities. The following list of general rules must be adhered to in every laboratory:

- Keep all aisles, doorways and emergency exits free from obstructions.
- Keep all emergency equipment including fire extinguishers, fire blankets, overhead emergency showers, eye-face wash/drench hose, and chemical spill kits free from obstructions.
- Remove gloves and wash hands and arms before leaving the laboratory or handling the telephone, door handle/knob; remove lab coat before leaving the laboratory.
- Remove gloves before handling common items like phones, instruments, door knobs, etc.
- Keep all work areas clean and uncluttered. Wipe benches with cleaners or disinfectants regularly.
- Avoid storing chemical containers, particularly glass bottles, on the floor. If unavoidable, it is required that all chemical containers on the floor be stored in a deep, corrosion-resistant plastic tray and placed away from high-traffic areas.

1.3.2 Food, Beverage, Smoking and Cosmetics Use in the Laboratory

The consumption or storage of food and drink, as well as smoking, and the application of cosmetics, in any laboratories where chemical, biological, or radiological materials are used or stored is strictly prohibited.

1.3.3 Unattended Work

The unattended operation of laboratory equipment or experiments is strongly discouraged. Unattended work can lead to laboratory accidents and property damage. If unattended work must be performed, the National Research Council's publication, Prudent Practices in the Laboratory: Handling and Disposal of Chemicals, recommends that laboratory personnel design these experiments so as to prevent the release of hazardous substances in the event of interruptions in utility services such as electricity, cooling water, and inert gas. Laboratory lights should be left on, and signs should be posted identifying the nature of the experiment and the hazardous substances in use. Arrangements should be made for other laboratory personnel to periodically inspect the operation. Information should be posted indicating how to contact the responsible individual in the event of an emergency.

1.3.4 Working Alone/Working "Off Hours"

Working with chemicals alone, at night, or otherwise in isolation, places individuals at special risk and should be avoided whenever possible. The PI is responsible for ensuring that employees and students perform only those tasks for which they are qualified by training and experience, especially during off-hours when they may be unsupervised or unaccompanied. PIs must also define for their staff any

prohibited activities for laboratory personnel working alone or during off-hours, based on the hazard of the materials used or the activity performed, such as the use of pyrophoric materials. All personnel working alone in the laboratory must hold an applicable FDNY Certificate of Fitness.

1.3.5 Chemical Storage and Segregation

Proper storage of chemicals in laboratories is a critical safety concern. Chemicals that have been stored improperly could react, forming hazardous products or resulting in a fire. Follow good storage practices no matter where the chemicals are stored (i.e. cabinets, refrigerators, or shelves). Carefully read the SDS and container label before storing a chemical as these will indicate any special storage requirements, as well as incompatibilities.

Good Storage Practices

- Chemicals shall be segregated in accordance with good practice and the Columbia University Chemical Segregation and Storage Chart.
- Chemicals should be stored in approved, compatible containers.
- Chemicals should be stored below eye level with heavy objects stored on lower shelves.
- Corrosives should not be stored on bare metal shelves. Instead, use plastic storage bins or shelves, or cover metal surfaces with protective, plastic-backed paper (Bench-Kote) and change frequently.
- When practical, chemicals in the same hazard class should be stored in corrosion-resistant secondary containers.
- DEA controlled substances shall be stored in locked containers as specified in the Policy for the Acquisition, Use, and Disposal of Controlled Substances in Research.

1.3.6 Hazardous Substance Management Standards and Guidelines

Federal, state and local regulations, as well as University policy, prescribe certain requirements for hazardous substances.

OSHA Regulated Substances

OSHA defines Permissible Exposure Limits (PELs) for several hundred hazardous substances. Additionally, there are numerous OSHA substance-specific standards requiring specific safety programs to reduce exposure to workers who may be exposed.

The OSHA substance-specific standards typically require training of laboratory personnel in safe handling and disposal practices, implementation of engineering controls (e.g., chemical fume hoods), work practices, administrative procedures (e.g., medical surveillance), PPE and other approaches will be used to reduce exposure and minimize personal risk, procedures for monitoring of airborne concentrations when any PELs* may be exceeded, and communication of monitoring results to employees and retention of data for a specified time period.

*A PEL may refer to any of the following:
Time weighted average (TWA) - the maximum allowable airborne concentration, averaged over an eight-hour workday, to which a person may be legally exposed.

Action level (AL) - a concentration below the TWA, at which some of the requirements of a substance-specific regulation must take effect.

Ceiling (C) - the airborne concentration that must never be exceeded. This largely applies to compounds that may be fatal or cause permanent impairment upon even brief exposures, such as carbon monoxide

Short-term exposure limit (STEL) - the maximum allowable exposure for (typically) a fifteen-minute period. A limited number of excursions over the TWA may be permissible (if they do not exceed ceiling) provided that the day's average exposure is below the TWA.

Formaldehyde/Formalin
Formaldehyde is a potential carcinogen and its use is strictly regulated by OSHA. To ensure the hazards associated with formaldehyde and formalin use are anticipated, recognized, evaluated, controlled and that information concerning these hazards is communicated to affected employees consistent with the OSHA Formaldehyde Standard, a Formaldehyde Exposure Control Policy and Formaldehyde training program have been established. All formaldehyde and formalin users must be familiar with the policy and safe work practice, as well as attend training.

Pyrophoric Chemicals
Pyrophoric reagents, such as organolithiums, aluminum alkyls and metal hydrides, are extremely reactive to oxygen and moisture. Precautions must always be taken to prevent contact with air or water. Despite their inherent hazards, pyrophoric materials can be safely manipulated and stored if the proper techniques and precautions are carefully followed. However, the consequences of even the smallest error during the manipulation of these substances can be catastrophic.
The importance of experience and comprehensive knowledge of the correct techniques for using pyrophoric and air-sensitive reagents cannot be overstated. Only qualified and experienced laboratory workers should ever manipulate these materials, and only after they have attained a complete understanding of the hazards involved and received hands-on instructions from knowledgeable peers regarding correct handling techniques. Some additional information regarding the safe handling of pyrophoric materials should be reviewed by all laboratory personnel where such substances are used or stored.

Hazardous Gases
Laboratory storage or use of hazardous gases must be in accordance with pertinent regulations and University procedures. This may include storage in a ventilated enclosure and/or leak detection equipment. EH&S must be consulted when hazardous gases are considered for laboratory use

Cryogenic Materials
Cryogenic materials such as liquid nitrogen present both a thermal and an oxygen displacement hazard. Laboratories possessing more than 60 gallons (generally two tanks or more) of liquefied cryogenic gases, such as liquid helium or liquid nitrogen, are required to have an oxygen monitor present in the laboratory. Oxygen monitor alarms must always be acknowledged by lab personnel and taken seriously as a matter of health and safety. The Policy for Response to Oxygen Sensing Equipment in Laboratories. It is essential that laboratory personnel wear appropriate PPE, which will be specified in the laboratory-specific LATCH, when handling or using cryogenic materials.

Particularly Hazardous Substances (PHS)
OSHA has established a category of chemicals known as particularly hazardous substances (PHS) for which additional precautions beyond normal standard operating procedures may be required. Included in the PHS definition are select carcinogens, reproductive toxins, and substances with a high degree of

acute toxicity. Laboratory personnel must follow laboratory-specific procedures to avoid exposure to PHSs.

Before these substances are used, laboratory personnel must be fully aware of the risks involved and be fully trained in the appropriate storage, handling, and disposal procedures prior to using the substance. PHS use and storage must be assigned to designated areas with the laboratory. EH&S can evaluate PHS procedures, prescribe special limitations, necessary equipment and facilities or operating conditions, PPE and additional personnel training requirements, as needed.

Controlled Substances in Research
The acquisition, use and disposal of controlled substances in New York State are strictly regulated by the New York State Department of Health (NYS DOH) Bureau of Narcotic Enforcement and the United States Department of Justice Drug Enforcement Administration (US DEA). These regulations are aimed at preventing diversion of controlled substances through a variety of administrative and physical controls. To assist researchers in understanding and meeting their individual obligations under these regulations, Columbia University has established a Policy for the Acquisition, Use and Disposal of Controlled Substances in Research (http://www.ehs.columbia.edu/ControlledSubstances.html)
In addition to the Policy, several Appendices, Resources and Reference Documents have been prepared to assist researchers in navigating the requirements for controlled substances.

Nanoparticles
Nanomaterials are substances that are manipulated at the atomic or molecular level and have at least one dimension between 1 and 100 nanometers. Research into the health effects of exposure to engineered nanomaterial is ongoing. Until the health effects of various nanomaterials are better characterized, it is recommended that their handling be approached with caution, accompanied by the use of the standard engineering controls, administrative controls, and PPE used for manipulating other hazardous materials in the laboratory setting, and that waste resulting from nanomaterials be managed as hazardous waste.

1.3.7 Chemical Substitution
One of the most effective ways to reduce the risk of exposure to a hazardous material is to eliminate it entirely from the work environment. This can be accomplished by replacing hazardous materials with safer, less hazardous ones capable of performing the same function. EH&S can assist laboratory personnel in evaluating work practices to identify candidates for substitution. MIT offers a valuable tool for assisting laboratory personnel in choosing safe substitutions for hazardous chemicals and processes. Visit the Massachusetts Institute of Technology Green Chemical Alternatives Wizard for more information.

1.3.8 Mercury-Containing Devices
Mercury is a toxic metal, and must be carefully cleaned up if it is spilled. To minimize exposure to mercury vapors and hazardous waste generated from broken thermometers, EH&S has established a mercury substitution program. EH&S will replace a mercury thermometer with an alcohol thermometer, at no cost to the laboratory, with the understanding that the laboratory will order mercury-free thermometers thereafter.

The Mercury Device Registration Program, which is a complement to the perennial mercury thermometer exchange program, will allow for improved tracking of mercury-containing devices and allow EH&S to focus its efforts helping those who absolutely must maintain a mercury device(s), to

establish safe storage and handling procedures, prepare them with necessary knowledge about immediate, defensive actions when a mercury release occurs, and ensure EH&S has adequate resources at the ready to assist laboratories in the event of an incident.

1.3.9 Discarding Used Laboratory Equipment

Prior to disposal of any laboratory equipment, the end-users must ensure that equipment is free of any contamination prior to handling by Facilities Operations or any outside contractors. The equipment clearance process details the necessary steps.

1.3.10 Vacating Laboratory Space

Research Scientists vacating University facilities or relocating within the University are responsible for leaving laboratories in a state suitable for re-occupancy or renovation by following the Procedures for Vacating a Laboratory. EH&S Research Safety Specialists will assist laboratories in completing the vacating process. Laboratory space must not be re-occupied and no renovation work started until the space has been issued final clearance EH&S.

1.4 Minimizing and Controlling Chemical Exposure

Occupational hygiene is the science devoted to the anticipation, recognition, evaluation, prevention, and control of environmental factors or stresses arising in or from the workplace which may cause sickness, impaired health and well-being, or significant discomfort among workers. This applies to all workplace hazards, including chemical exposures. Understanding the hazards of chemicals and how exposures can occur is critical to minimizing and controlling exposures. The recognized hierarchy of controls dictates that the elimination of a hazardous substance or its substitution with a less hazardous substance should be first approach. If elimination or substitution is not feasible, or does no completely eliminate a potential hazard, then engineering controls must be implemented to minimize the potential exposure hazard. If a hazard is not completely controlled following the implementation of engineering controls, then administrative and work practice controls must be employed, followed by the careful selection and use personal protective equipment in accordance with the University's Policy for Personal Protective Equipment in Research Laboratories.

1.4.1 Elimination and Substitution

Removing the hazard from the workplace is the most effective methods of minimizing exposure. Elimination of a hazardous substance from a process (aka “engineering out the hazard”,) or substitution of a hazardous substance with a less hazardous substance should always be the first approach in trying to minimize chemical exposures. The American Chemical Society Green Chemistry Institute and the USEPA’s Green Chemistry website are two resources offering information focused on minimizing the use and generation of hazardous substances.

1.4.2 Engineering Controls

If a chemical hazard cannot be eliminated, the next best strategy for its control is at its source with the use of engineering controls. Engineering controls are devices or actions that automatically isolate or physically limit exposure to a hazard, thereby reducing the risk to personnel. For this reason, engineering controls are often considered the “first line of defense” for reducing exposure to hazardous substances. Engineering controls must only be used as designed and not be modified unless appropriate testing and certification clearly indicates that protection of personnel will be equal to or greater than the original protection afforded by the control device.

The following is a summary of the most common engineering controls employed in academic research laboratories to control chemical hazards:

Chemical Fume Hood

A Chemical Fume Hood (CFH) is a device, integrated into the ventilation system of a laboratory, which serves to isolate airborne contaminants from laboratory workers by means of unidirectional, exhausted airflow. Typically considered the primary engineering control for hazardous chemicals in the laboratory, CFHs must be properly used and maintained to afford the user proper containment of hazardous airborne contaminants. For specifics on the proper use and maintenance of CFHs, please refer to the University's Chemical Fume Hood Policy.

The following general guidelines must be observed when using a CFH:

- Use a ducted CFH for work with hazardous gases, volatile or potentially airborne hazardous substances, malodorous chemicals and OSHA Particularly Hazardous Substances, such as acute toxins, carcinogens, mutagens, and reproductive hazards.
- Avoid storage of materials in chemical fume hoods as it disrupts air flow, creating turbulence and the potential for exposure to airborne hazards.
- Work only within the sash height range certified by EH&S. Containment of airborne hazards cannot be assured outside of this range. Do not use a CFH unless it has been certified within the past twelve months by EH&S, which can be determined by observing the Fume Hood Certification sticker affixed to the hood.
- A fume hood that is identified as not functioning properly must be reported immediately to Facilities Operations (CUMC: 305-7367, Morningside: 854-2222 and LDEO: 845-365-8822) and a laboratory representative should place an "Out of Service-Do Not Use" sign on a hood. Do not use a CFH that is posted with an "Out of Service-Do Not Use" sign or is otherwise believed to be not functioning properly.
- Tip: Tape a Kim-Wipe to the bottom of the sash to verify the direction and qualitative force of the airflow.

Other Local Exhaust Ventilation

When hazardous chemicals cannot be used in a CFH, extractor arms/ventilation may be needed to minimize exposure. Extractor arms allow for capture and exhaust of hazardous substances close to the source of use, before their release into the laboratory environment. Although not as effective as a CFH, as CFHs have a high degree of containment, these devices, if properly designed and used, can be effective. These devices must be properly designed and installed to ensure their efficacy. Ventilated hazardous gas cabinets are another type of local exhaust ventilation, in which hazardous gases are stored and used to ensure segregation from the laboratory environment and ventilation of the hazardous gas(es) in the event of a leak.

Glove Box

A Glove Box is a sealed enclosure designed for the manipulation of high hazard substances in a safe manner. Built into its sides are gloves arranged to allow the user to place their hands into the gloves and perform tasks inside the box without breaking containment. The glove box is usually transparent to allow the user to see the materials being handled within. It is important to avoid wearing hand jewelry, watches or long nails or using sharp objects, such as needles, blades, etc., as they may puncture the gloves and breach containment.

1.4.3 Administrative Controls

Chemical labeling (see Section 1.2.4), training (see Section 1.8) and laboratory-specific standard operating procedures (SOPs) are the most common administrative controls in academic research laboratories. The Columbia University Guidelines for Laboratory Design, developed by the Columbia University Laboratory Design Work Group (LDWG), is an additional administrative control for the safe, efficient and consistent design of research laboratories. The Guidelines are primarily intended for the design and construction of new "wet" laboratories or renovations in which significant modifications will be made and where building systems and infrastructure are adaptable to the Guidelines. Although not primarily intended for "dry" or computational laboratories, components of the Guidelines may apply and should be incorporated in the design of these laboratories. The Guidelines do not take the place of code requirements or standards, but rather serve as a supplement in aiding the project team define and detail the scope of design.

Equipment Evaluation and Maintenance

Laboratory and emergency equipment shall be evaluated and maintained in accordance with regulation, University policy and, where appropriate, recognized industry standards. Refer to the appropriate sections of the Manual for equipment specific information.

Work Practices and Standard Operating Procedures

Adhering to proper work practices reduces the chance of occupational exposure to hazardous substances. Laboratory-specific SOPs should be developed by knowledgeable laboratory personnel and reviewed with all laboratory personnel to ensure a thorough understanding of the procedures. The Safety Rules and Policies noted in Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards and those listed below can help minimize employee exposure to hazardous chemicals and should be employed in conjunction with laboratory-specific SOPs:

- Attend all required safety training courses.
- Establish and follow laboratory SOPs when conducting laboratory work involving hazardous substances or equipment.
- Never eat, drink, chew gum or tobacco, smoke or apply cosmetics in the laboratory.
- Select, use and maintain all personal protective equipment in accordance with the University's Policy for Personal Protective Equipment in Research Laboratories.
- Store/segregate hazardous materials according to hazard class.
- Report unsafe conditions to a laboratory supervisor, PI and/or EH&S.
- Keep all work areas clean and uncluttered.
- Scale the size of the experiment and use the smallest amount of the material that is necessary for the work to be done.
- Remove gloves and wash hands and arms with soap and water after removing gloves and before leaving the work area or handling common items like phones, instruments, door knobs, etc.
- Properly manage and dispose of all hazardous substances.

1.4.4 Personal Protective Equipment

Personal Protective Equipment (PPE) represents the "last line of defense" against potential exposure. PPE should never be used as a substitute for proper engineering controls and prudent work practices, but only as an additional measure of protection once all other reasonable precautions have been taken. The University's Policy for Personal Protective Equipment in Research Laboratories delineates requirements for the selection, use and maintenance of PPE in all laboratories where hazardous substances are stored or used.

1.5 Measuring Chemical Exposure

1.5.1 Determination of the Need for Exposure Measurements

The vast majority of chemicals used in research laboratories, when used in research quantities, do not pose a significant health hazard if SOPs and good laboratory hygiene practices are employed. Laboratory staff must not be exposed to OSHA regulated substances above permissible exposure limits. An exposure assessment, performed by EH&S, is designed to evaluate the chemical(s) used in terms of its concentration and quantity, frequency of use, manner in which it is used along with the available engineering controls, in an effort to determine the potential exposure to a user. An exposure assessment will be accompanied by recommendations on methods to reduce exposure, where exposure may exist, and will typically follow the hierarchy of controls (see Section 1.4). The exposure assessment is an important component of the CHP in protecting University employees from potential exposure to hazardous substances.

1.5.2 Exposure Assessment Strategy

EH&S utilizes information from various sources to develop its exposure assessment strategy, including laboratory chemical inventories (see Section 1.2.2), laboratory safety surveys, chemical purchase records, and chemical waste identification. Exposure assessments are carefully planned and coordinated with laboratory personnel to ensure that work activities representative of the exposure potential being assessed are being performed during the assessment. Laboratory hygiene practices will be reviewed and may be qualified and/or quantified with surface wipe sampling and analysis. Personal and area air sampling/monitoring studies may be used to quantify the airborne concentration of a hazardous substance, since inhalation is typically the primary route of concern for exposure to hazardous chemicals. The results of the assessment will be reviewed and evaluated in comparison to accepted Occupational Exposure Limits (OELs).

1.5.3 Frequency of Exposure Measurements

As noted in Section 1.5.2, an initial exposure assessment may include personal air sampling, with samples collected in the employee's breathing zone to represent an employee's exposure during a full shift [e.g., 8-hour time weighted average (TWA)] and/or 15 minute Short-Term Exposure Limit (STEL). EH&S will consult with laboratory personnel to determine which groups of employees have potential exposure to establish similar exposure groups (SEGs) so representative exposure samples can be collected.

Depending on the results of the exposure assessment, monitoring may need to be repeated, as required by OSHA or determined EH&S. An exposure assessment may also be repeated if the laboratory makes a substantive change (i.e., change in chemicals, equipment and/or control measures) to the process under which a prior exposure assessment was performed. If substantive changes do occur, laboratory personnel must contact EH&S for a re-evaluation. Additionally, an exposure assessment may be repeated at the request of an employee or when any employee reports signs or symptoms of exposure. EH&S will advise the laboratory when exposure monitoring can be discontinued.

1.5.4 Notification of Exposure Measurement Results

EH&S will provide a report of the exposure assessment within 15 days of receiving exposure assessment results. If the results are below the accepted OELs, the PI or laboratory supervisor will be notified and asked to post results in the laboratory and/or inform affected employee(s) of the results. If the results are above the accepted OEL, the affected employee(s) and PI and/or laboratory supervisor will be

notified and asked to meet with EH&S to discuss the results and next steps, which may include enrollment in a medical surveillance program.

1.6 Medical Surveillance

Columbia University has established a medical surveillance program to address certain work place hazards, including occupational exposure to biological, chemical and physical hazards. Medical surveillance is intended to provide medical consultation in case of exposure to hazardous substance(s) above an accepted Occupational Exposure Limit (OEL) and/or an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory. All required medical examinations and consultations shall be provided to laboratory personnel at no cost, without loss of pay, and at a reasonable time and place.

When a laboratory employee(s) is exposed to an OSHA regulated substance, the laboratory worker shall be required to obtain medical consultation and examination, under the following conditions:

- an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory.
- an exposure assessment reveals exposure above the OSHA Action Level (AL), Permissible Exposure Limit (PEL) or Short-term Exposure Limit (STEL).
- an event takes place in the work area such as a spill, leak, explosion, or other occurrence resulting in the likelihood of an exposure above OSHA defined limits.
- working with certain biological, chemical, and physical agents including employees who work with patients, laboratory animals, bloodborne pathogens, other potentially infectious materials, certain chemicals, or whose work requires the use of a respirator.
- See the Medical Surveillance Policy for further guidance.

The physician or other licensed healthcare professional shall keep written records of all such medical examinations and must maintain these records for the duration of the employee's employment, plus 30 years. Employees shall have access to their medical records in accordance with OSHA's Access to employee and medical records standard (29CFR1910.1020).

1.7 Chemical Purchase, Receipt, Inventory and Shipment

1.7.1 Chemical Purchase and Inventory Control

Purchase chemicals in the smallest quantity sufficient for your work. While it is often possible to save money by purchasing materials in bulk, these quantities are usually much more than are necessary for most research laboratories. When these chemicals are stored with no foreseeable use, or to the point that they become degraded, they are considered to be inherently waste-like and must be disposed as hazardous waste.

1.7.2 Chemical Inventory

Each laboratory or laboratory group shall compile and maintain a chemical inventory of all hazardous chemicals normally used or stored in the laboratory. The list shall include relevant information about each chemical, including where it is normally used or stored. This inventory shall be updated as needed, but not less than annually. Refer to your laboratory's LATCH for additional information about chemical inventory requirements.

On the Morningside campus, the Chemical Tracking System (ChemTracker) is used to maintain

inventories of chemicals used by laboratories and is accessible @ http://www.ehs.columbia.edu/cms.html. At the Lamont Doherty Earth Observatory (LDEO), the LDEO Chemical Hazardous Materials Database is used and is accessible @ http://admin.ldeo.columbia.edu/lhmd/lhmd.php. At Columbia University Medical Center (CUMC) and Nevis, laboratories should follow the instructions in the LATCH for completing preparing a chemical inventory.

1.7.3 Movement/Transport of Chemicals

Movement of hazardous materials within the laboratory or about the campus must receive careful consideration. Secondary containers/totes and/or utility carts must be used whenever hazardous substances are transported. Secondary containers/totes can be made of rubber, metal, or plastic, and should be large enough to hold the contents of the primary container should it break, and must be resistant to reacting with the hazardous material being transported. Secondary containers/totes are available commercially through laboratory equipment suppliers and should be standard laboratory equipment. At the Morningside campus, a limited supply of secondary containers/totes are available on loan from the Biological Stock Room and the ChemStore. Use both hands when moving chemicals, one under the vessel and the other around the neck of the bottle.

Before moving any compressed gas cylinder, ensure that the valve is protected by securing the cap to the cylinder and securely strapping the cylinder to a cylinder cart.

The following items and hazardous substances are to be transported via freight elevators and may not be transported using passenger elevators when a freight elevator is available.

- Animals, animal bedding, and animal equipment;
- Hazardous chemicals and samples, including dry ice;
- Radioactive materials;
- Chemicals in open containers;
- Biological materials and samples;
- Compressed gas cylinders and cryogenic liquids;
- Laboratory items requiring the use of a cart or hand truck.

1.7.4 Shipment of Hazardous Substances

The packaging, documentation and transportation of Hazardous Materials and/or Dangerous Goods by air, ground, or water is highly regulated by the Federal Aviation Administration (FAA), International Air Transport Association (IATA), United States Department of Transportation (USDOT) and International Maritime Dangerous Goods (IMDG). These regulations are aimed at preventing transportation accidents and protecting the public through a variety of administrative and physical controls. These federal regulations also apply to inter-campus transportation and shipments on public roadways. In order to perform any function associated with the transportation of Hazardous Materials or Dangerous Goods, individuals must be trained.

Researchers planning to send a shipment that may contain a hazardous material must first determine the nature of the hazard. EH&S has developed resources for shipping hazardous materials which can be used as a starting point for determining the proper procedures required for shipping a hazardous material, including radioactive materials, infectious substances, or chemicals, and subsequently the steps that should be taken to begin the shipping process. Based on the results of a preliminary classification, researchers may be directed to complete specialized training(s) prior to offering

shipments of certain dangerous goods such as dry ice or limited categories of biological materials to carriers, or researchers may be required to complete the Intent to Ship Hazardous Materials Form and submit it to EH&S for further instructions.

1.8 Training and Information

Training is the cornerstone of any successful health and safety program and is the fundamental element of EH&S's commitment to ensuring Columbia University maintains and promotes a safe workplace. Many activities that take place in the course of research, academia and/or clinical care require specialized instruction on how these activities can be conducted safely and with minimal exposure to workplace hazards.

Every member of the University community engaged in laboratory operations is obligated to participate in the University's safety training program. This obligation may be established by a regulatory agency, a condition of a grant, a University policy, a departmental requirement or as a combination of two or more of these mandates. Safety training course requirements and training frequency can be determined by visiting EH&S's Safety Training webpage.

EH&S provides a wide range of safety training programs, presented in multiple formats and media, which are dynamic, highlighting newly identified hazards, hazard mitigation strategies and regulatory requirements in an effort to maintain pace with the ever evolving landscape of scientific research. The Laboratory Safety/Chemical Hygiene/Hazardous Waste Management training is required of all laboratory personnel working in a laboratory of with chemicals. This course is designed for developing an understanding of the Columbia University Chemical Hygiene Plan and the laboratory-specific LATCH and establishing good laboratory hygiene practices, as well as identifying methods for detecting the presence or release of a hazardous chemical and the physical and health hazards of exposure along with effective measures for protecting laboratory personnel, including appropriate work practices, emergency procedures, and PPE selection, use and maintenance.

EH&S provides supplemental information to help keep the Columbia University research community informed about the potential hazards in research laboratories, including EH&S's quarterly newsletter SafetyMatters, safety brochures, FDN(wh)Y me?, Lessons Learned Bulletins from incidents and near-miss incidents, and various other guidance documents.

1.9 Recordkeeping

1.9.1 Personal Exposure Monitoring

EH&S shall maintain accurate records of any measurement taken to monitor employee exposures for the duration of employment plus 30 years in accordance with the requirements of OSHA's Access to employee and medical records standard (29CFR1910.1020). EH&S shall also keep any results of routine and non-routine personal and/or area monitoring and evaluations of worker exposures to chemicals as a result of accidents, spills, fires, or explosions.

1.9.2 Training Records

All personnel training records are maintained in Rascal, including records of "live" training, provided that attendees note their attendance on the sign-is sheet at the time of training.

1.9.3 Medical Surveillance/Consultation Records

The physician or other licensed healthcare professional shall keep written records of all medical examinations and maintain these records for the duration of the employee's employment, plus 30 years.

1.9.4 Availability of Records

Employees shall have access to their medical records in accordance with OSHA's Access to employee and medical records standard (29CFR1910.1020).

1.9.5 Availability and Annual Review of the Chemical Hygiene Plan

The University's CHP shall be made available to all laboratory personnel via the University Health & Safety Manual at www.ehs.columbia.edu. The laboratory-specific Laboratory Assessment Tool and Chemical Hygiene Plan (LATCH) shall be made available to all laboratory personnel in paper within the individual laboratory for which the LATCH applies.

To determine the effectiveness of the CHP, EHJ&S's Research Safety Specialists and laboratory personnel will conduct periodic laboratory inspections to review laboratory safety practices and CHP practices. The CHP shall be reviewed and updated by the Chemical Hygiene Officer (CHO) at least annually, or more frequently based on findings, observations and procedural changes.

1.10 Waste Management

Federal, state and local regulations, as well as Columbia University policy, prescribe procedures for the management of biological, chemical and radioactive wastes. The University's Policy on Drain Disposal of Chemicals, 5Ls of Hazardous Waste Management, Biological Waste Management and Radioactive Waste Management procedures comprise the guidelines laboratory personnel must follow to safely manage waste products from research activities. All laboratory staff should be familiar with the guidelines for biological (regulated medical waste), chemical and radioactive waste management and disposal at http://www.ehs.columbia.edu/WasteMgt.html. Please review these guidelines regularly and utilize the online chemical pickup request form and radioactive waste request form for requesting waste removal from your laboratory by EH&S.

1.11 Emergency Procedures

1.11.1 Chemical Spills

Laboratory personnel must know what procedures to follow in the event of a chemical release. They must know how to report the incident and clean up the spill, if possible. Inappropriate actions or inaction by personnel can delay appropriate response activities and worsen the situation. Proper emergency response depends upon knowledge of the chemicals present in the lab. For this reason, laboratories at the Columbia University Medical Center are required to submit a complete inventory of all the hazardous chemicals in their laboratories. Inventories must be reviewed annually and/or whenever new chemicals are acquired. At the Morningside campus, online inventories are maintained centrally through the ChemTracker System

Chemical spills must be cleaned up promptly, efficiently, and properly. The immediate cleanup of a spill limits exposure to toxic materials prevents possible slips and falls, as well as fire and explosions.

Spills are classified as manageable or unmanageable. Manageable spills are spills that do not spread rapidly, do not seriously endanger people or the environment, and can be managed safely by lab personnel familiar with the hazardous properties of the chemical without the assistance of EH&S personnel. All other spills are considered unmanageable. See the EH&S guidelines for response to Chemical Spills and Explosions at http://www.ehs.columbia.edu/chemspill.html.

Manageable Spills
In the event of a manageable spill, the following procedure must be followed:

- Alert people in the immediate area. Avoid breathing vapors and quickly determine the identity and quantity of the spilled material.
- Consult the Safety Data Sheet (SDS) for hazardous properties, incompatibilities, and don appropriate PPE (such as safety glasses, gloves, long sleeve lab coat).
- If the spill involves a flammable liquid, turn off all ignition and heat sources.
- If the spill involves finely divided solids such nitrates, permanganates, perchlorates, they must not be allowed to come in contact with combustible materials such as wood and paper, or reducing agents. Use a scoop or dustpan and hand broom to collect finely divided solids in a plastic bag. Use an appropriate solvent to clean up residues.
- Attend to persons contaminated by chemicals by adhering to the instructions in 1.7.
- Confine spill to small area. Absorb and neutralize spill with appropriate material and create a dam around the perimeter. Use spill kit materials and components appropriate for the spilled material. Collect residue, place in a container, and dispose as hazardous waste through EH&S.
- Clean spill area with soap and water. Notify the Laboratory Supervisor and/or the Principal Investigator. EH&S must also be notified of any release of any chemicals in the laboratory, even if it is deemed manageable. Telephone numbers to call in emergencies are posted on telephones in every laboratory and on the Laboratory Signage at the entrance to each lab.

Unmanageable Spills
In the event of an unmanageable spill, the following procedure must be followed:

- Do not attempt to clean up unmanageable spills.
- If spill involves a flammable liquid, turn off ignition and heat sources, if you can do this safely.
- Hold your breath and leave the spill area immediately.
- Alert people in the immediate area and post warning signs to inform others of hazard.
- Evacuate personnel and close doors leading to affected area. Keep personnel away from affected area until EH&S can evaluate the situation.
- Call EH&S and Public Safety for assistance and notify Lab Supervisor and PI.
- Determine the identity and quantity of material that has been spilled and consult SDS for hazardous properties, incompatibilities.
- Attend to persons contaminated by chemicals by adhering to the instructions in 1.7.
- After-hour spills should be immediately reported to Public Safety, which will contact EH&S for instructions. Be prepared to give the chemical name, volume spilled, location (building and room), and any other pertinent information.
- Ensure a person knowledgeable of the incident is available to provide information to emergency personnel.

1.11.2 Chemical Spill Kit
All Columbia University laboratories shall have access to a chemical spill control kit, capable of

controlling a spill of any hazardous material in the lab. A spill kit can be assembled by the laboratory and include an organized collection of absorbent pads, corrosive neutralizers, handheld broom and dustpan and other equipment suitable for addressing manageable laboratory spills or a laboratory can purchase a commercially available spill kit from laboratory supply company. The goal is for each laboratory to have immediate access to a spill kit for the hazardous substances used or stored in the laboratory. All laboratory personnel must be familiar with the spill kit storage location and use of the spill kit.

1.11.3 Emergency Drench Equipment

Eye-Face Wash/Drench Hose - Laboratories where hazardous substances are used or stored shall be equipped with an eye-face wash/drench hose as detailed in the Columbia University Guidelines for Laboratory Design. The devices are intended to provide a continuous stream of clean, flushing fluid to rinse the eyes or body in the event of a hazardous substance exposure. Laboratory personnel shall perform a weekly test by activating the device for a period long enough to verify operation and ensure that clean flushing fluid is available.

Overhead Emergency Shower - Laboratories where hazardous substances are used or stored shall be equipped with an overhead emergency shower as detailed in the Columbia University Guidelines for Laboratory Design. The devices are intended to provide a continuous stream of clean, flushing fluid to rinse the body in the event of a hazardous substance exposure. Facilities Operations shall perform an annual test by activating the device for a period long enough to verify operation and ensure that clean flushing fluid is available.

1.11.4 Accidents, Injuries and Medical Emergencies

Accidents, injuries and medical emergencies in and around the laboratory require immediate attention. Such emergencies must be reported immediately to the campus' appropriate emergency contact and the laboratory supervisor and/or PI. All emergencies involving personal injury must be reported using the Columbia University Accident Report Form.

When hazardous substances are involved in an accident, injury of medical emergency, EH&S must be contacted immediately. EH&S can advise on the best approaches to immediate action and measures to avoid the spread or cross-contamination of hazardous materials. Information about the hazardous substance(s) should be readily available (i.e., name, concentration, quantity, etc.) and a SDS should accompany any injured personnel when seeking medical assistance.

1.11.5 Fire

Research laboratories differ from other work environments in that they usually contain a variety of fire hazards. Laboratories are equipped with multi-purpose, dry chemical (ABC) or CO2 extinguishers, which can be used on all types of fires with the exception of reactive metals, which must use extinguishing agents suitable for the particular metal. Laboratory workers are trained by EH&S in the RACE and PASS procedures. Refer to the Fire Safety Manual for additional information.

Appendix D – Environmental Health & Safety Fire Safety Manual

4.1 Introduction
Research laboratories differ from other work environments in that they usually contain a variety of fire hazards. In addition to the 'ordinary' (Class A) fires, those fueled by wood, paper and textiles; hazards include the presence of flammable and volatile solvents such as petroleum distillates that are not miscible with water; reactive metals such as sodium and potassium; flammable metal powders such as magnesium, titanium, and zirconium; metal hydrides such as lithium hydride, lithium aluminum hydride and sodium borohydride; as well as many kinds of electrical equipment.

Complications arise when fighting these fires because each type of fire must be fought with the extinguishing agent and procedure appropriate for it; the use of the wrong technique or extinguisher can be catastrophic. EH&S has simplified fire-fighting in the laboratories by recommending laboratories be equipped with multi-purpose (ABC) dry chemical fire or CO2 type extinguishers, which can be used on all types of fires with the exception of reactive flammable metals (which must use extinguishers suitable for the particular metal). Laboratory workers must be trained in the RACE and PASS procedures outlined below. Annual fire drills reinforce this training. Fire extinguishers are inspected monthly and tested annually. If a fire extinguisher in any laboratory, chemical storeroom, or nearby location requires inspection or recharging, call Facilities Operations at CUMC (305-7367) or EH&S at Morningside (854-8749) to replace. A monthly inspection of the fire extinguisher pressure gauge by laboratory personnel is strongly recommended as a further safeguard to ensure the extinguisher is properly charged.

Before attempting to extinguish, the fire must first be judged as being controllable by laboratory personnel. This depends on the judgment of the person making the decision and the factors involved: the size, intensity of the fire, the nature of the burning material, proximity of other flammable or explosive materials, availability of escape routes, availability of proper fire-fighting equipment, and the safety of personnel in the area.

4.2 Classification of Fires
Should the nature and size of the fire make it controllable, use the appropriate available extinguisher and proceed with the methods described below. Should the fire be judged "uncontrollable", follow the "Evacuation Procedures for Uncontrollable Fires". In all cases, call Public Safety at 854-5555 (Morningside) or 305-7979 (CUMC) to report the incident. Public Safety can, along with notifying emergency responders, direct emergency responders quickly to your location.

CLASS A. (Wood, paper, textiles, rubber). The ABC extinguisher can extinguish this type of fire.

CLASS B. (Flammable or combustible liquids, greases, petroleum products, solvents)
Carbon dioxide or dry chemical ABC extinguishers should be used. Carbon dioxide extinguishers do not leave any residue, whereas dry chemical devices do. Pressurized water units should not be used since the immiscibility of solvents and water may result in spreading of the fire.

CLASS C. (Live electrical equipment involved in a fire). If possible, turn off the electrical power to the devices, and then use either the dry chemical extinguisher or a carbon dioxide or halon extinguisher, if available.

CLASS D. (Sodium, potassium, magnesium, titanium, zirconium and other metals)
If sodium, potassium, magnesium, or any other flammable metal powders are to be used in a laboratory, call EH&S for guidance on the appropriate dry powder-extinguishing agent. A specific "Class D" **(**dry powder) extinguishing agent such as graphite, limestone, sand or sodium carbonate must be made available for fire emergency before work is started.

DO NOT USE pressurized water, carbon dioxide, dry chemical or halon extinguishers on metal or organometallic fires. The use of these extinguishers may introduce substances that are very reactive with the burning metal that may either make the fire grow or trigger an explosion. For more details recommendations on safely handling or fighting fires with pyrophoric materials, see the EH&S bulletin Safe Use of Pyrophoric Reagents.

4.3 Race and Pass

IF YOU DISCOVER A FIRE – REMEMBER:

RACE and PASS
R - RESCUE anyone in immediate danger
A - Activate the ALARM
C - CONFINE the fire (close the door)
E - EXTINGUISH small controllable fires/or EVACUATE

P - PULL the pin
A - AIM the nozzle at the base of the fire
S - SQUEEZE handle
S – SWEEP from side to side

4.4.1 – Extinguishing a person engulfed in flames:

- If a person's clothing is on fire, he/she must not be allowed to run, as this will fan the flames and cause a more serious burn. **Remember! STOP, DROP and ROLL**. Clothing fires must be extinguished immediately, before anything else is done, in order to minimize skin burns. Try not to use your hands for they will also burn.
- Roll the person on the floor if necessary.
- Wrap him/her in a fire blanket, coat or whatever is available to smother the flames. Put the person under a shower or use an extinguisher, or whatever is available to smother the flames.
- After calling the emergency numbers, place clean, wet, ice-packed cloths on small burned areas. Wrap the person warmly to avoid shock, and secure medical assistance.

4.4.2 - Evacuation Procedures for Uncontrollable Fires

- Leave the area of danger. **DO NOT** stay to fight a large fire. Rescue anyone in immediate danger. On your way out, if it can be done safely, turn off equipment and move any explosive or flammable materials away from possible contact with hot surfaces or other sources of ignition. Using the laboratory circuit breaker or Emergency Power Off switch (EPO) is often the quickest and most effective way to turn off all laboratory electrical equipment simultaneously. For this reason, the circuit breaker or EPO must always be readily accessible. Your safe exit, however, must be given the highest priority.

- Transmit the fire alarm by pulling the alarm box in the hallway, notify personnel on the floor and call the Public Safety Office. (854-5555 at MS or 305-7979 at CUMC)
- Leave by means of one of the predetermined evacuation routes for your laboratory area. If possible, confine the fire by closing doors as you leave. Evacuate promptly and meet outside the building away from the entrance at a pre-determined place. Conduct an attendance/person count of workers and make sure all are accounted for. If not, notify the Fire Department immediately.

Remember! RACE
Rescue
Alarm
Confine
Evacuate/Extinguish

4.4.3 - Fire-fighting Procedures for Controllable Fires

- For all fires, the fire alarm must be transmitted immediately to ensure Fire Department response.
- The decision of whether to fight the fire oneself or to wait for fire-fighting help must be made according to the type and size of the fire, its location and the circumstances of the fire. A small fire in a container may be easily snuffed out by the placement of a nonflammable cover across the container opening. A small fire in an area free of other fuels can be extinguished with appropriate available extinguishers before calling for help. When extinguishing a burning solid, direct the extinguisher discharge at the base of the flame; in the case of burning liquids, direct it at the leading edge. Larger or rapidly growing fires are best left to the Fire Department.
- To extinguish a minor fire with an extinguisher:

Remember! PASS
Pull Pin
Aim nozzle at base of fire
Squeeze handle
Sweep from side to side

- In the case of an occurrence of any fire, the fire must be reported to the Public Safety Office (854-5555 at MS or 305-7979 at CUMC).
- If your extinguisher needs to be replaced, call Facilities Operations at CUMC (305-7367) or EHS at Morningside (854-8749).

Remember! – If you *pull the pin, call it in!*

4.4.4 – Emergency Procedures for Fires Caused by Explosions

- Immediately transmit the building alarm.
- Alert and evacuate all personnel in the immediate area.
- Close all doors leading to the affected area and secure area until Public Safety or other personnel arrive to evaluate the situation. Do not attempt to re-enter the space.

- Call Public Safety (854-5555 at MS or 305-7979 at CUMC) and EH&S (854-8749 at MS and 305-6780 at CUMC) for instructions. Be prepared to give the chemical name, location (building and room), and any other pertinent information.
- Attend to any persons contaminated by chemicals by removing contaminated clothing, and when feasible, flush the affected body area with water. A University Accident Form should be completed.
- At CUMC refer the employee to Workforce Health and Safety located on Harkness Pavilion One South (305-7580) during working hours, and at all other times, to the NYPH Emergency Room. Affected students are to report to Student Health Services located on 60 Haven Avenue (telephone 795-4181).
- At Morningside refer the employee to Student Health Service located at John Jay Hall during working hours, and at all other times, to the Saint Luke's Hospital Emergency Room.
- Have a person knowledgeable of the incident and laboratory available to provide information to emergency personnel, including the SDS.

Appendix E – Public Safety Community Response Guidelines – Active Shooter Incident

COLUMBIA UNIVERSITY PUBLIC SAFETY — PRIDE • PROFESSIONALISM • SERVICE

Community Response Guidelines
-Active Shooter Incident-

The following guidelines are intended to reduce your personal risk in the unlikely event that an Active Shooter Incident should occur on campus.
If you are outside a building when an event occurs, you should take immediate cover, preferably inside a building, circumstances permitting:

If you are inside a building where an event occurs, you should EVACUATE the building immediately if possible. If unable to do so:

Secure immediate area:

- Lock and barricade doors
- Do not stand by doors or windows
- Turn off lights
- Close blinds
- Block windows
- Turn off radios and computer monitors
- Keep yourself out of sight and take adequate cover/protection (i.e., concrete walls, thick desks, filing cabinets - cover may protect you from bullets)
- Silence cell phones

Un-Securing an area:

- Consider risks before un-securing rooms
- Remember, the shooter will not stop until they are engaged by an outside force
- Attempts to rescue people should only be attempted if it can be accomplished without further endangering the persons inside a secured area.
- Consider the safety of masses-vs-the safety of a few
- If doubt exists for the safety of the individuals inside the room, the area should remain secured
- Know all alternate exits in your building

Revised September 2012

Contacting Authorities:

- Dial 4-5555 from any Morningside phone
- Dial 5-7979 from any C.U.M.C. phone
- Use Emergency 911
- publicsafety@columbia.edu

Be aware that the Public Safety numbers will likely be overwhelmed. Program the alternate Public Safety numbers (854-2797, 305-8100) into your cell phone for backup or consider 911 or e-mail. Remember, most cell phones provide the ability to make an emergency call, even if they have a lockout feature. E-mail may also be an option if, under the circumstances, you are unable to speak. E-mail is monitored by Public Safety personnel.

What to Report:

- Your specific location-building name and office/room number
- Number of people at your specific location
- Injuries-number injured, types of injuries
- Assailant(s)-location, number of suspects, race/gender, clothing description, physical features, type of weapons (long gun or hand gun), backpack, shooters identity if known, separate explosions from gunfire, etc

Police Response:

- Objective is to engage assailant(s) immediately
- Evacuate victims
- Facilitate follow up medical care, interviews, counseling
- Investigation

Appendix F - Environmental Health & Safety Chemical Spills and Explosions Procedure

Definitions: Manageable spills are spills that do not spread rapidly, do not seriously endanger people or the pictures/environment, and can be managed safely by lab personnel familiar with the hazardous properties that the chemical may have and without the assistance of EH&S personnel. All other spills are considered unmanageable spills.

Responsible Department: Environmental Health & Safety (EH&S)

For MS: Telephone: (212)854-8749 (9am-5pm weekdays) or (212)854-5555 (all other times) Hours: 24 hours/7 days

For CUMC: Telephone: (212)305-6780 (9am-5pm weekdays) or (212)305-7979 (all other times) Hours: 24 hours/7 days

Manageable Chemical Spill Procedure:

- Alert people in the immediate area. Avoid breathing vapors and quickly determine what chemical and the quantity of material have been spilled. Notify the laboratory supervisor and/or principal investigator.
- Consult safety data sheet (SDS) for hazardous properties, incompatibilities, and don appropriate protective equipment (safety glasses, gloves, long sleeve lab coat)
- If the spill involves a flammable liquid, turn off all ignition and heat sources.
- Attend to any persons contaminated by chemicals by removing contaminated clothing, and when feasible, flush the affected body area with water. An incident form should be completed and the employee referred to:
    - MS: the Saint Luke's Hospital Emergency Room (1111 Amsterdam Avenue at 114th Street). Affected students are to report to Student Health Services located 519 W 114th St.
    - CUMC: Workforce Health and Safety located on Harkness Pavilion one South (212)305-7580 between 8am-4pm and the NYPH Emergency Room at all other times. Affected students are to report to Student Health Services located on 60 Haven Avenue (212)305-3400.
- Confine spill to small area. Absorb and neutralize spill with appropriate material and create a dam around the perimeter. Use appropriate spill kit or sodium bicarbonate for acids; citric acids for caustics; and vermiculite, dry sand, or diatomaceous earth for other chemicals. Collect residue, place in a container, and dispose as chemical waste through EH&S.
- Clean spill area with soap and water.

Unmanageable Chemical Spill Procedure:

- Alert people in the immediate area. Avoid breathing vapors and quickly determine what chemical and the quantity of material, if it can be done safely, has been spilled. Notify the laboratory supervisor and/or principal investigator.
- Consult SDS for hazardous properties, incompatibilities, and don appropriate protective equipment (safety glasses, gloves, long sleeve lab coat)
- If the spill involves a flammable liquid, turn off all ignition and heat sources.

- Evacuate all personnel and close all doors leading to affected area. Keep all personnel away from affected area until EH&S can evaluate the situation. · Attend to any persons contaminated by chemicals by removing contaminated clothing, and when feasible, flush the affected body area with water. An incident form should be completed and the employee referred to
    - MS: the Saint Luke's Hospital Emergency Room (1111 Amsterdam Avenue at 114th Street). Affected students are to report to Student Health Services located 519 W 114th St.
    - CUMC: Workforce Health and Safety located on Harkness Pavilion one South (212)305-7580 between 8am-4pm and the NYPH Emergency Room at all other times. Affected students are to report to Student Health Services located on 60 Haven Avenue (212)305-3400.

Call EH&S (212)854-8749 at MS or (212)305-6780 at CUMC for instructions between 9am-5pm weekdays and Security (212)854-5555 at MS or (212)305-7979 at CUMC at all other times. Be prepared to give the chemical name, volume spilled, location (building and room), and any other pertinent information. Have a person knowledgeable of the incident and laboratory available to provide information to emergency personnel.

In the event that Custodial, Maintenance, or Security personnel discover a spill when no laboratory personnel are present, notify their supervisor immediately and follow the above procedures for handling unmanageable spills.

Chemical Explosions in Laboratories:

- If the explosion causes a fire or structural instability, transmit building fire alarm immediately.
- Alert and evacuate all personnel in the immediate area.
- Close all doors leading to the affected area and secure area until safety personnel arrive to evaluate the situation. Try to determine which material has exploded.
- Call EH&S (212)854-8749 at MS or (212)305-6780 at CUMC for instructions between 9am-5pm weekdays and Security (212)854-5555 at MS or (212)305-7979 at CUMC at all other times. Be prepared to give the chemical name, location (building and room), and any other pertinent information.
- Consult SDS for hazardous properties, incompatibilities and don appropriate protective equipment (safety glasses, gloves, long sleeve lab coat).
- If the spill involves a flammable liquid, turn off all ignition and heat sources.
- Attend to any persons contaminated by chemicals by removing contaminated clothing, and when feasible, flush the affected body area with water. An incident form should be completed and the employee referred to:
    - MS: the Saint Luke's Hospital Emergency Room (1111 Amsterdam Avenue at 114th Street). Affected students are to report to Student Health Services located 519 W 114th St.
    - CUMC: Workforce Health and Safety located on Harkness Pavilion one South (212)305-7580 between 8am-4pm and the NYPH Emergency Room at all other times. Affected students are to report to Student Health Services located on 60 Haven Avenue (212)305-3400.
- Have a person knowledgeable of the incident and laboratory available to provide information to emergency personnel.

Appendix G - Environmental Health & Safety Environmental Safety Manual

3.1 Introduction

Columbia University's environmental programs operate under the guidelines of an Environmental Management System (EMS). Although the EMS was initially developed for the Morningside campus and the Lamont-Doherty Earth Observatory, the EMS now provides structure and function for many of the environmental management programs University-wide. The EMS includes many policies and procedures, which serve as the framework for CU's laboratory compliance program. Central to the success of the EMS are elements including the "5 L's of Hazardous Waste Management," the "*No Drain Disposal Policy*" and numerous recycling programs, which allows the University the properly and proactively manage laboratory waste operations to minimize health, safety and environmental impacts.

To ensure that laboratory waste is properly managed, it is essential that laboratory personnel have completed the University's "Laboratory Safety and Hazardous Waste Management" program prior to commencing work. The program will provide important guidance regarding environmental regulations and University policies and procedures, which will assist laboratory personnel in making critical decisions about waste identification, collection, labeling and storage.

3.2 Waste Identification

Every type of waste that is generated needs to be managed in a manner specifically appropriate to that waste stream. The application of incorrect or inappropriate waste management techniques, or the deliberate commingling of incompatible waste streams, can have significant adverse consequences for both the individual laboratory and the Columbia University community. The following sections detail the waste handling procedures for Chemical/Hazardous Waste (section 3.3), Radioactive Waste (section 3.5), and Regulated Medical Waste (section 2.12). Information on handling special waste streams can be found in section 3.4. For clarification on any of these procedures, or for more information, contact the EH&S office.

3.3 Chemical/Hazardous Waste

EH&S coordinates the disposal of all chemical waste generated at Columbia University. The following procedures apply to all chemical substances generated during laboratory activities, as well as all other University business operations, that are classified as hazardous based on the information below. Radioactive Waste (see section 3.5) or Regulated Medical Waste (section 2.12).

3.3.1 No Drain Disposal Policy

Columbia University has a *No Drain Disposal* policy for Chemical/Hazardous Waste. Any chemical or material that matches any of the characteristics described in section 3.3.2, or is a possible carcinogen, mutagen, or reproductive toxin, or may otherwise be harmful to the human health or the environment, regardless of quantity, must never be drain disposed. If you are unsure, call EH&S for assistance.

3.3.2 Classification and Identification of Hazardous Waste

Hazardous Waste is any unwanted material with properties that make it potentially harmful to human health or the environment. The definition of waste materials includes spent reaction products, expired virgin materials, and materials that have no reasonably foreseen intended use. A Hazardous Waste may be any material that is specifically listed in the federal or state regulations or exhibits at least one of four characteristics—ignitability, corrosivity, reactivity, or toxicity.

- **3.3.2.1 Listed Hazardous Waste** - Listed Hazardous Wastes are specifically defined in federal and state regulations (See NYSDEC Part 361 and 40 CFR 265). They include chemicals from specific processes such as cleaning solvents or degreasers (i.e., acetone, ethyl acetate, methylene chloride, xylene), toxic chemicals (i.e. heavy metals), and acutely toxic chemicals, (i.e., cyanides, osmium tetroxide, epinephrine).

- **3.3.2.2 Characteristic Hazardous Waste** - In the EPA scheme of classification, there are four types of Characteristic Hazardous Waste.
    - Ignitable Waste: chemicals likely to cause a fire or exhibit the characteristic of a strong oxidizing agent, such as solvents.
    - Corrosive Waste: chemicals with a high or low pH and which can also severely damage skin or corrode metal.
    - Reactive Wastes: chemicals that react with air and/or water to produce toxic gases or are explosive.
    - Toxic Waste: heavy metals, and certain solvents.

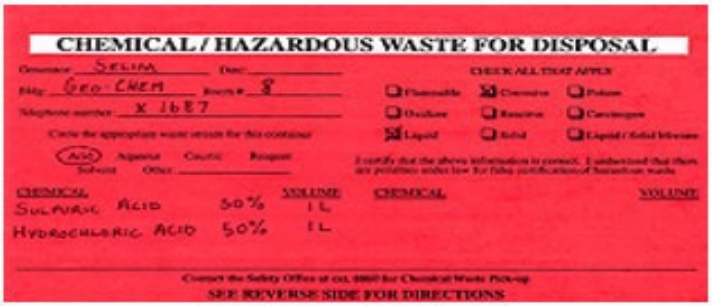
- **3.3.2.3 Wastes Not Defined as Hazardous by USEPA but Prohibited from Drain Disposal by Columbia University Policy**- Any materials with the potential to harm human health or the environment must be collected and managed as a Chemical/Hazardous Waste, even if not specifically cited as such by the USEPA or NYSDEC. Examples include, but are not limited to, solid sodium hydroxide and gels containing ethidium bromide.

3.3.3 Procedures for the Collection and Removal of Hazardous Waste

All Hazardous Wastes must be managed in accordance with USEPA and NYSDEC regulations; no volume of waste is excluded from these requirements including trace amounts of reagents used for sterilization, such as alcohol. Since the hazardous waste management regulations are complex and lengthy, EH&S created the 5 L's as a quick reference guide for complying with these regulations.

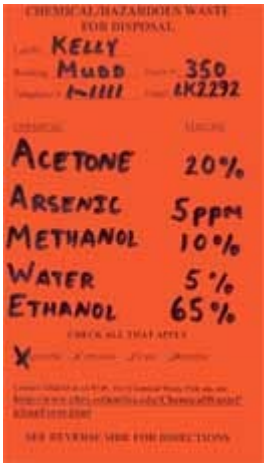
- **3.3.3.1 Hazardous Waste Collection Requirements** – Hazardous Waste must be collected in sealable, labeled containers that are compatible with the waste being collected. Waste containers must bear an official EH&S Hazardous Waste Label that is completed in its entirety. The Hazardous Waste Label must contain complete information about container contents at all times; for example, no abbreviations or formulas are permitted. The Hazardous Waste collection containers must be periodically checked for leaks and may not be moved from one laboratory room to another lab. Hazardous waste must be stored at the "point of generation" near to where the waste is generated (i.e. hazardous waste may not be stored in hallway closets).

LDEO sample Hazardous Waste label



CUMC sample Hazardous Waste label

Morningside & Nevis sample Hazardous Waste label



- **3.3.3.2 Hazardous Waste Removal** - Hazardous Waste may only be removed from laboratories by EH&S personnel or EH&S approved vendors. Hazardous Waste pickup requests should be submitted to EH&S via online chemical waste pickup request prior to completely filling the containers to prevent overflow, typically when 80% - 90% full. Pickups may be requested via the online pickup request form on the EH&S website. It should be noted that at LDEO and Morningside, the chemical waste pickup request may be used to request regulated medical waste supplies and services. At the Medical Center campus, this request must be placed with Facilities Operations office via an online service request. At Nevis, this request must be made directly by the laboratory to the vendor.

3.3.5 Laboratory Glassware and Chemical Containers

Containers that held acutely toxic (P-list) materials must be treated as hazardous waste (see section 3.3.3).

Empty chemical bottles make excellent hazardous waste collection containers, but lab employees must ensure that the waste stream being collected is compatible with the container. If reusing a container for this purpose at the Morningside campus, ensure that the ChemTracker barcode is not covered by the waste label. The barcodes for chemical bottles that will be reused for waste collection must have the barcodes removed prior to reuse. These barcodes must be removed by lab employee and submitted to ChemTracker staff for removal from the ChemTracker system.

To dispose of unwanted empty chemical containers, rinse the container with tap water, if necessary, and deposit it in specially designated plastic-lined cardboard Glassware Disposal Box located in the lab. The Glassware Disposal Boxes may be obtained through ChemStores or the Biology Stock Room staff at Morningside. For all other campuses, the boxes may be purchased directly from a general supplier of laboratory materials. Glassware and containers must be completely empty of chemicals and residue. Close the box once filled and place it in the hallway for Facilities Operations to recycle. At the Morningside campus, empty barcoded chemical containers must be collected in order to be removed from the Principle Investigator's ChemTracker inventory by being placed in the hallway yellow bins. See the Morningside Chemical Container and Labware Disposal Policy for more information.

3.4 Special Waste Streams

Certain waste streams generated at Columbia University have alternate handling procedures, compared with those listed in section 3.3.3.

3.4.1 Aerosol Cans – All empty/unwanted aerosol cans generated at Columbia University must be handled as Hazardous Waste, as outlined in section 3.3.3. Many aerosols contain hazardous constituents that can damage the environment when improperly disposed of in the trash or can explode if compacted or incinerated.

3.4.2 Batteries – Used batteries are collected for recycling at various locations throughout Columbia University and are managed as Universal Waste. Please visit the EH&S Universal Waste webpage for information on where to deposit unwanted batteries throughout campus. Leaking or damaged batteries must be handled as Hazardous Waste, as outlined in section 3.3.3 and must not be deposited with other batteries. If the battery is leaking, place it in a container and label it as hazardous waste per the above requirements in section 3.3.3.2. Federal regulations require covering electrical contacts on batteries other than alkalines prior to transportation. One such method of compliance is taping the battery terminals to prevent contact and the generation of heat which could cause a potential for fire. Therefore, EH&S has installed tape dispensers on all battery collection containers to facilitate compliance with this requirement, please see photo.

3.4.3 Computer Monitor Recycling – Computer monitors and other cathode ray tube devices contain quantities of lead that can be harmful to the environment. Most municipal landfills will no longer accept computer monitors for disposal, as EPA considers them hazardous waste. Columbia University maintains a recycling program to prevent this hazardous waste stream from entering landfills. If you have a non-functional or obsolete computer monitor that can be recycled, please contact Facilities Operations (212) 305-4357 at CUMC or 854-2222 at MS) for assistance. For LDEO please contact the

Safety Office at 1-845-365-8860 or x8862. For Nevis contact the Facilities Safety Manager onsite to arrange for removal.

3.4.4 Controlled Substances – Controlled substances require specific management procedures detailed on the Columbia University Use and Management of Controlled Substances website.

3.4.5 Dark Room and Photo Processing Waste – Effluent fixer from photo processing contains silver halide, a hazardous material that must be excluded from the sewer discharge. EH&S coordinates installation of maintenance-free silver-recovery units on all photo processors; if you suspect a problem with the unit attached to the processor, or are missing a recovery unit, please contact EH&S. A Darkroom Log sheet is required to be completed with each use of the darkroom for tracking and maintenance purposes. Scrap film must also be collected in specially marked containers. Contact EH&S to obtain a Scrap Film Container.

3.4.6 Ethidium Bromide Waste – Ethidium bromide is mutagenic, requiring gels and debris to be managed accordingly. This waste must be collected in a EH&S provided, pre-labeled container marked as such:

"Nonhazardous Waste label: Ethidium Bromide Gels & Debris"

3.4.7 Fluorescent Lamps – Fluorescent lamps, including the germicidal lamp in Biological Safety Cabinets (see section 2.4.1) may contain mercury and must be handled carefully. Contact Facilities Operations (212) 305-7367 ext. 3 at CUMC or (212) 854-2222 for MS and Nevis. At LDEO please submit a chemical waste pickup request to arrange for the disposal of fluorescent lamps.

3.4.8 Mercury-Containing Devices – Broken mercury-containing devices, such as thermometers, are a leading cause of chemical spill cleanup responses at Columbia University. Every effort should be made to replace mercury-containing temperature and pressure sensing devices with safer alternatives. See 5.4.1.1.1 for information on replacing mercury thermometers with safer alternatives. Contact EH&S to take advantage of this program or submit a chemical waste pickup form to discard of mercury containing devices through EH&S.

3.4.9 Nanotechnology Waste – Nanomaterials are substances that have at least one dimension between 1 and 100 nanometers. Currently, health effects of exposure to engineered nanomaterials are poorly understood, though recent research has indicated that exposure is likely to cause adverse effects similar to those caused by ultrafine particles with similar chemical and physical characteristics. Nanomaterials should be collected and managed as hazardous waste until the health effects of various nanomaterials are better characterized. It is recommended that their handling be approached with caution, accompanied by the use of the standard engineering controls, administrative controls, and personal protective equipment used for manipulating other hazardous materials in the laboratory setting, and that waste streams be managed accordingly as hazardous waste.

3.4.10 Piranha Waste – A highly reactive mixture of sulfuric acid and hydrogen peroxide, piranha solution is commonly used as an etchant in clean rooms. Due to its tendency to evolve gas, piranha solution must always be stored in a plastic waste container outfitted with a vented cap (EH&S can provide vented caps for 5 gallon waste collection containers) to prevent a dangerous buildup of pressure that could cause a sealed container to rupture. Piranha waste must be segregated from all other waste streams and collected in dedicated containers. When collecting waste, the solution should be allowed to cool before being added to a plastic waste container.

3.4.11 Reactive materials – Highly explosive, shock, temperature or friction sensitive materials such as pyrophoric material, water and air-reactive materials or highly toxic compressed gases must be managed with extreme care. Please consult with EH&S prior to purchasing these materials to ensure the lab is outfitted with the necessary safety equipment such as appropriate fire extinguisher and laboratory procedure specific training.

3.4.12 Refrigerant Reclamation - Old laboratory refrigerators/freezers, ice machines, window air-conditioning units, and the like may contain refrigerants that are harmful to human health as well as the environment. Prior to final disposal, it is required that each item is safely vacuumed of its refrigerant. EH&S has partnered with Facilities Operations to ensure that the safe collection of ozone-depleting refrigerants is performed on each appliance by an *EPA Certified Technician* using *EPA Certified Equipment*. Once complete, each item is "tagged" to identify that the refrigerant has been removed and that it is ready for disposal.

3.4.13 Solder Waste – Labs and shops that use solder must collect the solder waste as a hazardous waste if it contains lead. All applicable hazardous waste guidelines apply to lead based solder. Non-lead based solder must be collected for metal recycling through EH&S.

3.4.14 Solvent contaminated rags and debris – Rags and debris contaminated with solvents require a hazardous waste determination to be made by EH&S. Specific solvents are treated for flammability and others for both flammability and toxicity, therefore, specific containers and labels are required. Prior to generating this waste please contact EH&S for guidance. Always use nontoxic, nonflammable solvents whenever possible.

3.4.15 Solvent Recovery - Columbia University laboratories have been recycling several thousand gallons of spent solvent (i.e., xylene and alcohol) annually since 2001. In 2008, the Morningside campus began recycling acetone and in 2011 methanol and ethanol. Please see the information posted on the solvent recycling webpage for further information. Additionally, over the years several newsletter articles have appeared in the Safety Matters EH&S newsletter that further illustrates the details of the successful program.

3.4.16 Used Oil – Used pump oil and other oils must be collected in closed containers marked "Used Oil." These containers must be kept closed at all times. To schedule a pickup of Used Oil, submit a chemical waste pickup form. If the laboratory area requires large volumes of oil, such as >55 gallons, it must also comply with University Storm Water Pollution Control Countermeasures (SPCC) requirements, specifically the use of secondary containment &/or spill containment pallets and weekly inspections.

3.5 Radioactive Waste Services

The Radioactive Waste program is mirrored after the hazardous waste program. Please refer to the Radiation Safety manual for specific guidance on safely working with radioactivity in labs. Radioactive Waste services such as radioactive waste pickups and supplies may be requested through an online radioactive waste pickup request form.

3.5.2 Radioactive Waste - Radioactive wastes have a unique set of requirements for collection and storage. The unshielded exposure rate at any surface of the container shall not exceed 2 mR/hr. Please consult the Radiation Safety Program for additional guidance on shielding applications. All isotopes must be separated by type and isotope, except H-3 and C-14 which may be commingled providing it is the same type of waste (please see below sections for brief descriptions of radioactive waste types). All activities must be listed per isotope and totaled on the radioactive waste label. Shared spaces must have separate waste collection containers per PI. All radioactive waste collection containers must be labeled and closed when not in active use (immediately upon adding waste to container). Short-lived isotope wastes may be stored for decay by the lab or submit a radioactive waste pickup request form. Please consult the radioactive waste brochure for additional information.

3.5.2.1 Animal Carcasses – Animal carcasses including and heavily soiled debris must be stored frozen. Radioactive animal carcasses must be placed in labeled, sealed, clear bags. Animal carcasses containing 3H &/or 14C < 0.05 µCi/g are exempt and may be disposed of as regulated medical waste. After clearance by RSO, radioactive warning labels must be removed prior to disposal.

3.5.2.2 Dry Solid Waste – Dry solid waste may contain bench pads, gloves and empty stock vials. Dry Solid waste may not contain check sources, animal carcasses, liquid scintillation standards, sharps or liquid scintillation vials or any other liquids. This includes even small quantities in test tubes or in company supplied stock bottles. Ninety-six well plates or beta plates must be managed separately from other solid wastes and liquid scintillation vials.

3.5.2.2 Liquid Waste - Liquid waste including liquid scintillation vials must include on the radioactive waste label all liquid constituents and percentages. This includes the trade name of any buffer solutions and liquid scintillation cocktails. Liquid scintillation cocktails chosen by the laboratory should have a flash point >140oF and pH range <2 and >12. Please note the trade name of the liquid scintillation cocktail in chemical constituents section of the radioactive waste label.

3.5.2.3 Mixed Waste - All mixed waste (chemically hazardous and radioactive containing) must be managed in accordance with all hazardous waste requirements. A hazardous waste label and radioactive waste label must be completed and affixed to the container upon collecting the first material in the collection container. Please refer to the Mixed Waste policy for additional information.

3.5.3 Radioactive Wastes Stored Pending Disposal

Wastes stored pending disposal shall be kept in a manner approved by the Radiation Safety Officer. No radioactive waste may be stored in open hallways.

3.5.4 The Disposition of Unused Radionuclides

The disposition of unused radionuclides remaining at the completion of an investigation shall be arranged by agreement with the Radiation Safety Officer. Please contact the Radiation Safety Officer for additional guidance at CUMC at 212-305-0303 or at Morningside, LDEO and Nevis at 212-854-8749.

Other Environmental Programs

EH&S has partnered with several schools to create uniquely tailored information and training programs specific to safety and waste management. Please refer to the following school-specific websites for additional information:

- College of Dental Medicine (http://www.ehs.columbia.edu/CDM.html)
- School of the Arts (http://www.ehs.columbia.edu/Arts.htm)