



Science and Engineering Building Cleanroom Users Protocol

TABLE OF CONTENTS

CLEANROOM GENERAL INFORMATION.....4

- I. What is a Cleanroom and its Purpose?
- II. How Does a Cleanroom Stay Clean?
- III. Cleanliness classes
- IV. Types of Contamination

CLEANROOM PROTOCOL NOTIFICATION.....7

- Purpose of Cleanroom Users Protocol
- How to Become a Cleanroom User

CLEANROOM PROTOCOL: OPERATING POLICIES AND PROCEDURES.....8

- I. Introduction
- II. Buddy System Into The Cleanroom
- III. Visitors
- IV. Bringing Items Into The Cleanroom
- V. Cleanroom Pre-gowning Procedure
- VI. Entrance Courtesies
- VII. Cleanroom Garments
- VIII. The Need For Gowning
- IX. Cleanroom Gowning Procedure
- X. Proper Behavior In The Cleanroom
- XI. Habits To Avoid While In The Cleanroom
- XII. Tools And Repairs
- XIII. Cleanroom Etiquette 1001
 - A. Broken & Un-cleanable Glassware And Other Sharp Objects
 - B. Disposal Of Solvent & Photoresist-soaked Materials
 - C. What Are The Procedures For Cleaning Up
 - D. How To Store Things
 - E. What If I See Someone Else Doing Something Wrong?
- XIV. Exit Courtesies and Clean-up Procedure
- XV. Cleanroom Exit Protocol: Un-gowning Procedure
- XVI. Cleanroom Utility Chase Entrance Procedure
- XVII. Policies and Procedure Enforcement
- XVIII. Cleanroom Rules
 - 1. Authorized User For The Equipment
 - 2. Granting Access

3. Safety Equipment
4. Proper Gowning And De-gowning Procedures
5. Removing Supplies Or Equipment

CLEANROOM SUPPORT EQUIPMENT TRAINING.....29

- I. Wet Bench Training
- II. Specialty Gas Hook-ups And Gas Manifolds
- III. Chillers
- IV. Infrastructure

CLEANROOM EMERGENCY PROTOCOL.....35

- I. Cleanroom Emergency Shut-offs And Evacuations
- II. Emergency Evacuations
- III. Emergency Equipment
- IV. Safety Equipment
- V. Spill Response Procedures
 - I. Introduction
 - II. Spill Response Cart Items
 - III. “I’ve Spilled A Bottle of ----”
 - IV. “I’ve Found A Chemical Spill”
 - V. First aid

FINAL NOTE.....44

CLEANROOM BASIC INFORMATION

The cleanroom has many parts that allow it to function correctly. It is important that the cleanroom users properly understand how a cleanroom operates in order to ensure cleanroom quality.

I. WHAT IS A CLEANROOM DEFINITION AND ITS PURPOSE?

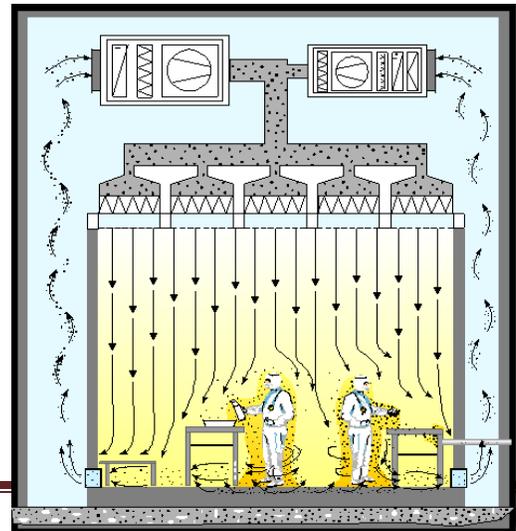
A cleanroom is a controlled environment that allows essential components to be manufactured. Cleanrooms are necessary in the pharmaceutical industry, nanotechnology, and biotechnology; which in many cases require an **unpolluted** environment to assure that potentially harmful contaminants, such as dust particles, are not present in products that are constructed.

A cleanroom is a room in which the concentration of airborne particles is controlled to specified limits. Eliminating sub-micron airborne contamination is really a process of control. These contaminants are generated by people, process, facilities and equipment. They must be continually removed from the air. The level to which particles must be held to a minimum depends upon the standards required by the facility and the processes undertaken within the facility.

II. HOW DOES A CLEANROOM STAY CLEAN?

The only way to control contamination is to control the total environment. Air flow rates and direction, pressurization, temperature, humidity, and specialized filtration all need to be tightly regulated. All sources of particles need to be contained or eliminated whenever possible. The cleanroom has HEPA (High Efficiency Particulate Air Filter) within the ceiling. These filters are extremely important for maintaining contamination control. They filter particles as small as 0.3 microns with a 99.97% minimum particle-collective efficiency.

Figure 1 – Movement of Air Flow throughout a side wall return cleanroom



III. CLEANLINESS CLASSES

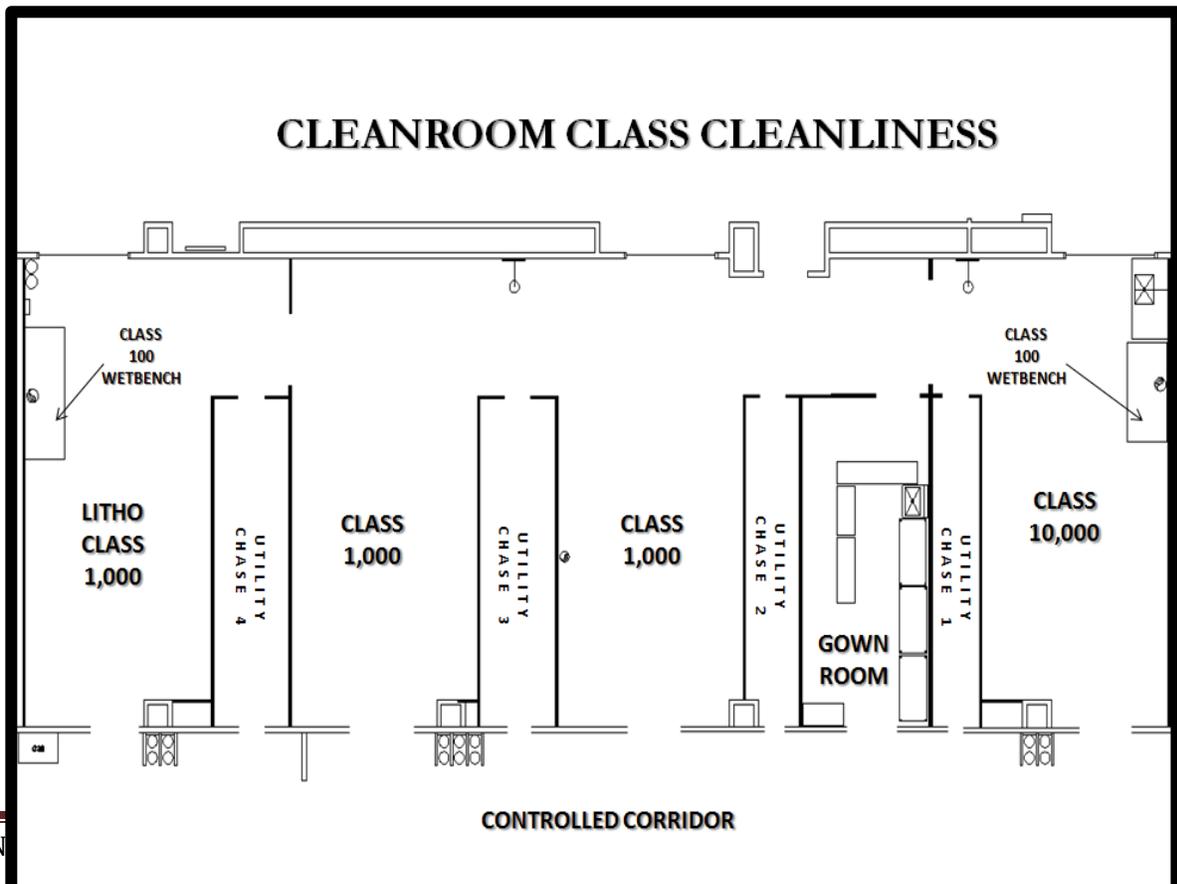
It only takes a quick monitor of the air in a cleanroom compared to a typical office building to see the difference. Typical office building air contains from 500,000 to 1,000,000 particles (0.5 microns or larger) per cubic foot of air. An ISO 6 cleanroom is designed to never allow more than 1,000 particles (0.5 microns or larger) per cubic foot of air. An ISO 7 and an ISO 8 cleanrooms are designed to limit 0.5 micron particles to 10,000 and 100,000 respectively.

A human hair is about 75-100 microns in diameter. A particle 200 times smaller (0.5 micron) than the human hair can cause problems in a cleanroom. Contamination can lead to downtime. In fact, the billion dollar NASA Hubble Space Telescope was damaged and did not perform as designed because of a particle smaller than 0.5 microns. Cleanliness is crucial to maintain the reproducibility of newly developed state-of-the-art electronic device processes

There are three cleanliness classes in our cleanroom:

1. Class 10,000 (ISO 7)– East portion of cleanroom
2. Class 1,000 (ISO 6)– West and central portions of cleanroom
3. Class 100 (ISO 5)– Wet benches located in east and west portions of cleanroom

Figure 2 – Cleanliness Classes in the SEB Cleanroom



IV. TYPES OF CONTAMINATION

Contamination is a process or act that causes materials or surfaces to be soiled with contaminating substances. Contaminants can produce a “killer defect” in a miniature circuit. Film contaminants of only 10 nm (nanometers) can drastically reduce coating adhesion on a wafer or chip. It is widely accepted that particles of 0.5 microns or larger are the target. However, some industries are now targeting smaller particles.

A list of contaminants is found below. Any of these can be the source for killing a circuit. Preventing these contaminants from entering the cleanroom environment is the objective. It requires a commitment by everyone entering the cleanroom to make it happen. Personnel need to be aware of the importance of controlling contaminants. Strict procedures should be followed whenever entering or cleaning a cleanroom. Compromise is not acceptable when working in a cleanroom.

1. Particle contamination

- A. Dust
- B. Corrugated containers/paper
- C. Skin and dandruff
- D. Footborne dirt from shoes
- E. Equipment-generated



2. Chemical contamination

- a. Ions and non-volatile residues
 - i. Sodium from hands
 - ii. Ions from rust
 - iii. Off gassing from welding residue
 - iv. Out gassing from hydrocarbon residues



3. Biological contamination

- a. Bacteria
- b. Viruses
- c. Spores
- d. The smallest is 1-2 microns in size

4. Human contamination

- a. Normal talking (saliva) 2 to 3 feet



- b. Coughing (saliva/lung tissue) 4 to 6 feet
- c. Sneezing (200 mph) 10 to 15 feet

CLEANROOM PROTOCOL NOTIFICATION

WARNING

DO NOT ENTER THE CLEANROOM OR USE ANY EQUIPMENT UNTIL YOU HAVE FOLLOWED ALL THE PROCEDURES OUTLINED BELOW. IF YOU NEED HELP IN UNDERSTANDING THESE INSTRUCTIONS, PLEASE ASK THE SEB ASSISTANT DIRECTOR.

THE PENALTY FOR NON-COMPLIANCE IS **SUSPENSION OF CLEANROOM PRIVILEGES.**

I. PURPOSE OF THE CLEANROOM USERS PROTOCOL

Working in a cleanroom environment presents many hazards and it is imperative that users fully understand the rules and regulations in place to protect them. It is important that users come to the lab manager or the SEB Assistant Director with any questions and fully read and understand the safety manual before beginning work in the cleanroom.

The procedures and precautions outlined in this manual are for the purpose of protecting Cleanroom users, equipment, and infrastructure. Anyone found in violation of the aforementioned procedures will suffer the consequences, which may include a loss of privileges or even a complete loss of access to the Cleanroom. In order to prevent such consequences, it is the responsibility of the user to review this procedures manual frequently and attentively. If users see others in violation of any protocol in the manual, users should inform them of their mistake, or confer with cleanroom staff and the SEB Assistant Director, in order to prevent minor or catastrophic accidents from occurring.

II. HOW TO BECOME A CLEANROOM USER

A user must be fully trained before he/she is allowed to operate in the SEB cleanroom. For a newcomer to gain access into the Cleanroom and become a certified user one must follow the basic procedures:

1. Participate and complete the Cleanroom Orientation
2. Be able to properly demonstrate the proper gowning procedure
3. Applicants must sign a form acknowledging that they have read and understood the contents of the Cleanroom Users Protocol.

After you become a cleanroom user, you will be granted cleanroom access and added to the Cleanroom user mailing list. All cleanroom-related information is circulated through this

mailing list.

CLEANROOM PROTOCOL: OPERATING POLICIES AND PROCEDURES

I. INTRODUCTION

An ISO 6 cleanroom is defined as having less than 1000 particles more than 0.5 micron in size within a cubic foot of air. Similarly, an ISO 7 cleanroom has less than 10,000 particles more than 0.5 micron in size within a cubic foot of air. This level of cleanliness is necessary to maintain the reproducibility of newly developed state-of-the art electronic device processes. To reach and maintain this level of cleanliness, the transfer of particle and chemical contaminations must be eliminated wherever they are found.

One's attitude towards cleanliness will ultimately determine the success or failure of any cleanroom policy. All the elaborate equipment installed to provide a microscopically clean or controlled atmosphere would be to no avail if the users do not believe in and help enforce these policies. It is also recognized that technology is continually changing and that cleanroom users are a tremendous resource for new ideas. With this in mind, one is strongly encouraged to recommend changes that may make the facility safer, cleaner, easier to use, and less expensive to maintain.

When in the cleanroom, be aware of your knowledge limitations. It is extremely important that you ask someone for help if you are unsure about the operation of these facilities.

II. ACCESS INTO THE CLEANROOM

The cleanroom is equipped with a Marlok card system, which limits access to authorized users.

Users must have their Marlok card in order to enter the first floor service corridor and the gown room, where the main entrance to the cleanroom is located. A Marlok is also required for exit of the gownroom.

The gownroom is the **ONLY** entrance and exit into and out of the cleanroom under normal conditions. Users are not to enter, open, or exit the large wooden emergency exit doors. These are only to be in use in case of emergency evacuations.

Users are required to use their Marlok cards in order to enter and exit the cleanroom, even if they are following a colleague. The card system will record the times of entry/exit for each user.

The cleanroom is open 24/7/365. Authorized users are able to come in at any time when open, however, it is strongly encouraged to follow the Buddy System.

III. BUDDY SYSTEM

The buddy system is advised in the cleanroom. The buddy system requires that a minimum of two people be inside the cleanroom at all times, both of whom should be authorized users. This is to ensure the safety of the users.

IV. VISITORS

PERMISSION IS NECESSARY. Whenever possible, visitors should remain outside the cleanroom where they may view the entire facility through the windows in the public hallway. If a visitor must enter the cleanroom he/she must first request permission from either the Lab Manager, Principal Investigator, or SEB Assistant Director.

Once permission is granted, they must follow the same policies and procedures as authorized users. Visitors must be escorted by a cleanroom qualified faculty/staff member

While inside the cleanroom, visitors must always be escorted by an authorized user. The escort, (Cleanroom user who has access into the Cleanroom), will be responsible for ensuring that the visitor follows the facility policies and procedures.

V. BRINGING ITEMS INTO THE CLEANROOM

Users may need to bring items in and out of the cleanroom such as tools, equipment, stationary, etc. Due to the nature of the cleanroom, you need to be very careful of what items are brought in and how clean they are. Certain items are not allowed into the cleanroom, such as non-cleanroom paper, cardboard, wood, etc. If you are not sure whether an item is allowed inside, please consult the SEB Assistant Director. Remember, it is better to be safe than sorry. After knowing an item can be brought into the cleanroom, it is imperative to ensure its cleanliness.

A. For ALL Items NOT Pre-Packaged:

1. A coarse-cleaning of ALL items going into the gown room must go through the following procedure:
 - i. Once in service corridor, the item must undergo a rough cleaning using the compressed air hose to blow clean any excess particles.
 - ii. Obtain a 70% Isopropyl alcohol (IPA) wipe and wipe down each item. Only after the item has been wiped down, may it be brought into the gownroom.
 - iii. Once inside the cleanroom, an ultra-cleaning of each item using a 30% Isopropyl alcohol (IPA) wipe. It must be done at either the work

bench or the area immediately inside the gown room. Make sure to get all the nooks and crannies where dust and dirt may hide.

B. Packaged Items Specific for the Cleanroom

1. Only open packaged items in cleanroom or gownroom by cutting the package open with cleanroom scissors.

C. Carts

1. A stainless steel cart will be provided in the service corridor outside the gown room. Carts from other areas of the building or campus CANNOT enter the cleanroom. Transfer items from the original cart onto the cleanroom cart.
2. Complete a coarse-cleaning of the transferred items that are on the cleanroom cart in the service corridor by using the compressed air and 70% IPA wipes.
3. Once in the cleanroom, at either your work bench or immediately inside the cleanroom, complete an ultra-cleaning on your transferred items on the cleanroom cart using 30% Isopropyl alcohol (IPA) wipes.

D. Bringing Large Tools and Equipment Into the Cleanroom

1. For large tools and equipment that cannot easily fit through the gown area, please see the SEB Assistant Director for proper cleanroom installation.

VI. PRE-GOWNING PROCEDURE

The following items and activities are required to begin the process of entering/using the cleanroom. These activities are known to affect the level of particulate contamination created in the cleanroom environment and adhering to these pre-gowning requirements is tantamount to maintaining proper cleanroom cleanliness.

- A. Personnel with colds, temporary sneezing and coughing, and severe sunburns should not enter the cleanroom until they have recovered. The majority of particles come from the users of the cleanroom.
- B. A daily bath/shower is recommended for all users as well as the wearing of clean, freshly laundered under garments and outer clothing.
- C. Shampoo regularly and take action to control dandruff.

- D. Users must abide by the following dress code:
- 1) No sleeveless shirts
 - 2) No shorts or skirts, full length pants must be worn
 - 3) No slippers, sandals, open-toed shoes, or worn out/dirty shoes
 - 4) No jewelry that can puncture garments or gloves
 - 5) Avoid clothing that sheds, such as wool, etc.
- E. The use of cosmetics and make-up, hair spray and gel, colognes and perfumes, body lotions, as well as other personal skin care products should be kept to a minimum as these products have the potential to affect the rate at which the human body sloughs particulates or contaminate cleanroom attire and equipment that is re-usable.
- F. Users must not smoke within 45 minutes of use of the cleanroom. This is strictly prohibited because personnel, who smoke, shed sub-micron sized particles for well over a half-hour after smoking a cigarette. This can be a severe source of contamination within the cleanroom.
- G. Users should plan out their work prior to entry into the cleanroom so that traffic going in and out of the facility is minimized. This includes making a list of all materials, solvents, tools, etc. that the user will need to successfully complete their cleanroom session as well as preparing these items for entry into the cleanroom according to the procedure for bringing items into the cleanroom. Please see section V, page 9 for information on bringing specific items into the cleanroom.

The user will need to:

1. Ensure all items being carried into the cleanroom are cleanroom-approved (i.e. stationary, tools, equipment, etc.)
2. Ensure that approved items are wiped down prior to entry with a solution of 70% IPA and 30% DI H₂O
3. Ensure that larger approved items are transferred onto a cleanroom cart

Users must also turn on the N₂ tanks outside in the service corridor if the wet benches will be used while working in the cleanroom.

- H. Prior to entering the gownroom, remove extraneous street clothing that is not easily covered by the cleanroom jumpsuit and attire, i.e. hats, jackets, or sunglasses, and leave these elsewhere or in the lockers provided in the service corridor.

VII. ENTRANCE COURTESIES

- A. The buddy system is recommended in the cleanroom
- B. Only authorized users may enter the cleanroom unescorted
- C. Users must be trained and properly gowned before entering the cleanroom
- D. If special equipment set-up is required, consult the SEB Assistant Director.
- E. Remove cartons and packaging material *before* taking materials into the cleanroom area
- F. Do not bring in tools or boxes with rust, oil, or peeling paint
- G. Only cleanroom paper or plastic-laminated paper will be allowed in the cleanroom. Cleanroom paper taken out of the cleanroom may be brought back into the cleanroom.
- H. If you are not sure if it belongs in the cleanroom, ask before you bring it in
- I. Clean equipment and materials before entering the cleanroom
- J. Do not use cosmetics, colognes, and perfumes in the cleanroom and gowning areas
- K. Keep all hair and ears covered with hood or cap
- L. Keep personally clean – particularly hands, face, hair
- M. NO ONE who is physically ill, especially with respiratory or stomach disorders, may enter. This is a good practice in any cleanroom environment.

VIII. THE NEED FOR GOWNING

The primary reason for gowning in clean room attire before entering the facility is to maintain the cleanliness of the facility. Humans are major sources of both contaminants and particulates (dust). The contamination of the facility by exposure to human skin, hair and street clothes must be minimized to promote a reasonable research environment. People shed both particles and chemical contaminants (skin oils, sodium, saliva etc.) that can destroy the ability of researchers to fabricate good devices if not properly contained.

IX. CLEANROOM GARMENTS

Required attire includes:

- ✓ **Coverall:** Used to cover body from ankles to neck
- ✓ **Shoe covers:** Used to prevent excessive dirt contamination coming off of street shoes
- ✓ **Bouffant:** Contains hair and minimizes shedding of particles
- ✓ **Hood:** Used to cover body from head to neck
- ✓ **Face-mask:** Used to minimize particle contamination from breathe and breathing
- ✓ **Booties:** Used to contain particles from shoes within the booties and serves as “clean shoes”
- ✓ **Cleanroom gloves:** Used to prevent oils and skin particles from contaminating the surface of the work benches and equipment
- ✓ **Safety eyewear:** Used to protect against particles from entering inside the eyes

X. CLEANROOM GOWNING PROCEDURE

Introduction

By far the dirtiest thing in our cleanroom will be the people who use it. Even the most carefully manicured person generates a shroud of particles from their skin, hair, clothing, and breath. Consequently, all cleanroom users must wear cleanroom garments which trap and hold the particles emitted by their bodies and clothing.

The SEB Cleanroom has adopted the following gowning procedure for use in the Cleanroom. It is important that each person who enters the cleanroom carefully follow this procedure.

Frequent cleanroom users should tag a garment hanger with their name using cleanroom tape. Their gown, hood and booties must be disposed of approximately after two weeks of use.

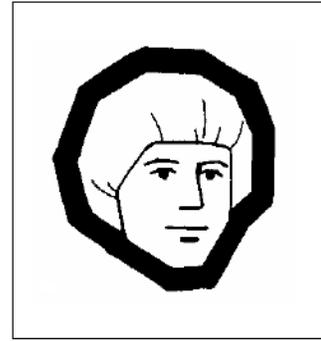
- A. Remove unnecessary items and place hat, coat, and any other street garments in a locker:** Enter into service corridor. Remove street garments not needed for modesty and warmth along with valuables; secure in designated locker. The individual will need to provide his/her own lock.



- B. Swipe into the gown room using your Marlok card:** All users are required to use their Marlok card even if they are entering behind someone else. Before entering the door, be sure to step **THREE** times on the sticky mat.

- C. Put on shoe covers located just inside the entrance of the gowning room.** Only flat or very low-heeled shoes may be worn. No sandals or open-toed shoes. Upon entering the gown room, immediately step to the bench on the left and have a seat. Grab a set of shoe covers from the bin next to the bench and place over shoes. Shoe covers must be worn at all times while in the gown room.

D. Put on face mask and bouffant: Bouffant is required to extend the life of the hood, help to contain the hair within, and reduce contaminants while gowning.



Bouffant Cap

E. If you are a new user, you will need to assemble your gown then label the coverall, hood, and shoe covers with the date it was assembled and last name.

The labeling of these items should only be with a cleanroom pen.

The gown should be labeled inside on the back, at the collar.

The hood should also be labeled inside on the back side.

The shoe covers should be labeled on the side inside both the left and right portions.



Hood and Face Mask

If gown was already assembled, retrieve your gown from the hanger.

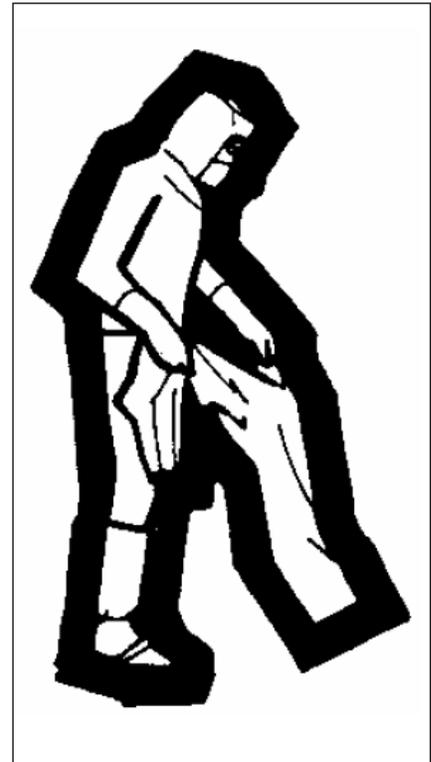
Only keep gown for two weeks of use (14 working days).

F. Carefully put on a hood: The hood must completely cover your hair and ears.



G. Inspect the coverall of your gown. Take care to keep the garment completely off of the floor at all times. Inspect your garment each time before donning, look for tears or soiling. If damaged, do not wear and dispose.

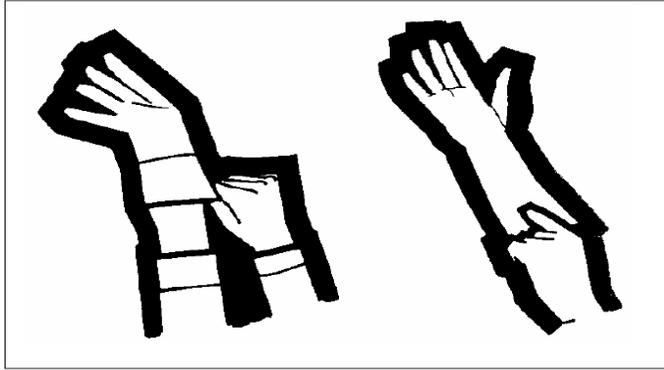
H. Put on your cleanroom gown. First, step into the gown legs, taking care not to let the garment touch the ground at any time. Then pull on the upper half of the gown and zip it all of the way up. While wearing a hood, be sure the “skirt” of the hood is completely inside the collar of the jumpsuit.



I. Put on Shoe Covers: To put on cleanroom shoe covers, sit on the gowning bench with your feet on the dirty side of the bench. Put on one bootie and swing the “clean” foot to the clean side of the gown room. Then put on second cleanroom shoe cover and swing fully to the clean side and stand up. Be sure the top of the boot is over the bottom of the jumpsuit leg so that any particles falling down the gown leg will be trapped in the shoe cover.
Note: Shoe covers should never be worn on the dirty side of the gowning room. Only booties are allowed on the dirty side.
Shoe covers should only be worn on clean side of the gowning room or in the cleanroom



- J. Put on Cleanroom Gloves:** Carefully put on the first glove, touching the outside of this glove as little as possible. Put on the second glove using the previously gloved hand, taking care not to touch your skin with the gloved hand. Pull the cuff of the gloves over the sleeve of the jumpsuit so that any particles falling from your sleeves are trapped in the glove. worn at all hands or



Gloves should be times, no bare fingers.

- K. Put on Goggles/Safety Eyewear:** Before putting on your safety glasses, make sure to wipe them down with an IPA wipe provided in gown room. This will ensure that the glasses are free of any particles and clear.

- L. Step on sticky mat THREE times upon entrance into the cleanroom:** Stepping on the sticky mat THREE times just within the cleanroom area is required in order to begin work.

M. Notes

- Use mirror to verify proper closure of garments: ensure all hair and clothing is covered.
- Cleanroom garments shall be worn only within the cleanroom complex, except under emergency conditions.
- Do not wear soiled, dirty or lint-producing street clothes under cleanroom garments.
- Do not hang street clothes or lab coats in the gown room. Use lockers located outside the gowning room in the service corridor.
- Facemasks are to be worn over the top of the nose.
- Never open your gown in the cleanroom.
- Change cleanroom garments completely, once after two weeks of use (14 working days)

- If garment is ripped during use, replace immediately
- Gloves are to be disposed of upon leaving the cleanroom. Booties and bouffant are to be disposed upon leaving the work area.

XI. PROPER BEHAVIOR IN THE CLEANROOM

- Use special care to keep fume-hoods and wet benches in ultra-clean conditions.
- **IMPORTANT** – Hot plates (one of the main causes of cleanroom fires):
 1. Never leave on when unattended
 2. Make sure that the temperature is: 20°C below the flash point of its contents and 20°C below the melting point of beaker materials.
- Minimize the amount of materials stored. Excess storage in the cleanroom is not permitted. Only items relevant to cleanroom work should be in the cleanroom
- Users will make proper entry each time a piece of equipment is used that has a logbook.
- At no time will paper in any form be torn or mutilated within the cleanroom. Corrugated cardboard, Styrofoam, or foam rubber of any type **WILL NOT** be allowed in the cleanroom without plastic containment and prior approval.
- Be aware of supplies. If quantities of stock appear to be low, report it to the Cleanroom Manager.
- If you are not sure how a piece of equipment works, ask before you use it
- Use only cleanroom materials present in the cleanroom
- Minimize traffic through the gown room and service corridor
- Use knife or scissors to open bags
- Use cleanroom approved paper, notebooks, ball-point pens, and tape. Pencils, erasers, and retractable pens shall not be used within the cleanroom. Non-retractable ballpoint pens are approved for writing purposes.
- Obey signs in the cleanroom and on equipment.

- When working with acids or solvents, wear chemical resistant nitrile/neoprene gloves available on the storage rack. Before using the gloves, be sure they are in good shape. Replace them if they are not.
- Do not dump solvents down the drains. Use the solvent waste bins located at the fume-hoods.
- Be considerate by not touching or messing up someone else's work
- When disposing of acid mixtures, dilute with lots of water.
- Personal items such as combs, cigarettes, matches, tissues, and similar particle-shedding products **SHALL NOT** be exposed in the cleanroom. Such items may be carried into service areas in street clothes pockets, provided they are not removed from the pockets within the clean area.
 - a. Cell phones are allowed and may be used in the cleanroom but must never be put under your gown. It must always be attached on the outside of the gown, or must be kept in the gown pocket.
- Do not wear jewelry (except plain wedding bands), watches, and pierced ear studs.
- Report adverse changes in environmental conditions (particle generation or accumulation, marked changes in humidity or temperature) and/or changes in your physical condition (profuse nasal discharge, skin conditions, etc.) to the SEB Assistant Director.
- Emergency exit doors are **ONLY** for **EMERGENCIES**, such as fire or explosion in the lab. In case of an alarm, exit immediately, **DO NOT** take time to remove your gown until you are clear of the building.

XII. HABITS TO AVOID WHILE IN THE CLEANROOM

- A. Avoid scratching exposed skin areas, touching face or skin with gloves, if you do, replace gloves immediately with clean gloves. The oils on your face can be transferred to the gloves and subsequently to the cleanroom equipment or your samples.
- B. Never comb or brush hair within the cleanroom or gowning area.

- C. Walking rapidly, or moving unnecessarily, including running or horseplay, or any other fast motions is prohibited. Try to minimize air disturbance.
- D. Never chew gum or use tobacco, smoke, eat, or drink in cleanroom or clean areas
- E. Never wear torn or soiled cleanroom garments
- F. Avoid wearing cleanroom garments outside of the cleanroom
- G. Never unfastening cleanroom garments in cleanroom
- H. Never remove items from beneath the cleanroom garments
- I. Do not allow any tool to rest on the surface of a bench or table, as it should be placed on a cleanroom wipe
- J. Use of hydrocarbon-based aerosol cans is strictly prohibited
- K. Coughing or sneezing persistently should be avoided
- L. Never bringing wooden tool boxes, wooden-handled tools into cleanroom

XIII. TOOLS AND REPAIRS

- A. Vacuum or blow clean all equipment followed by an IPA wipe before taking it into the cleanroom. No equipment will be modified without prior approval of the cleanroom manager. No new equipment will be moved into the cleanroom without prior approval of the SEB Assistant Director.
- B. Keep parts and tools at the workstation as clean and orderly as possible. Use toolboxes where possible.
- C. Any work or tools dropped on the floor shall be considered contaminated, and must be cleaned with an IPA wipe.
- D. Never leave exposed critical parts on the workbench.
- E. Work on a clean surface.
- F. Operations such as lapping, filing, deburring, and heavy soldering are prohibited in the cleanroom, except where contamination is isolated and exhausted from the clean areas.

XIV. CLEANROOM ETIQUETTE 1001

1. How to Handle Broken and Un-cleanable Glassware, Razors, and Other Sharp Objects

With glassware used in the cleanroom, obviously breakage will occur, or things will get contaminated beyond the point of being cleanable. If you find glassware meeting this description, please be sure to throw it into the container marked “Sharp Objects Only.” This also applies to the following materials: wafers, razor blades, needles, microscope slides and cover slips, and anything else that is questionable. Please be careful about this in order to prevent others from being stabbed by sharp things carelessly thrown into the regular garbage.

2. Disposal of Solvent-and Photoresist-Soaked Materials

Many people think of the solvents we commonly use as “safe, but the fact of the matter is that they all can be dangerous if you get exposed to them enough. There are several containers in the cleanroom built specifically for the disposal of solvent-soaked materials, and require that they be used for the disposal of all such materials. While it may seem like a couple of TexWipes with photoresist on them is not that bad, just remember that the air in the cleanroom is constantly being recirculated, so all those vapors will eventually find their way back in for everyone to breathe. The following materials should be put in the solvent cans:

- Any alcohols (ethanol, methanol, isopropanol, etc.)
- Acetone
- TCE (Trichloroethylene)
- Chlorobenzene (this stuff is particularly dangerous)
- Photoresist and related products

3. How to Store Things

There is a rack with clear totes available in the Class 1,000 room, just outside the gown room for users to keep their items that should stay in the cleanroom. Just be sure users label their tote.

4. What If I See Someone Else Doing Something Wrong?

From time to time, people will have other things on their mind and unintentionally do something they really should not do. Most people don't mind a friendly reminder now and then. It's up to the users to keep the cleanroom operating smoothly, and as long as everyone cooperated then the chances of ruined projects, injuries, and problems in general are greatly reduced. If anyone has a problem with being politely told about something that may endanger somebody or negatively affect a clean environment, tell the SEB Assistant Director about it and the problem will be taken care of.

XV. EXIT COURTESIES AND CLEAN UP PROCEDURES

- A. If you turn it **ON**, remember to turn it **OFF**.
Examples: Vacuum valves, fume hood DI rinse and drains, Specialty Gases, Hot Plates, etc.
Exceptions: Pieces of equipment that must be left on all day for practical reasons
- B. Do not remove dedicated items from the cleanroom without the Cleanroom Manager's permission.
- C. Any materials you plan on taking out of the lab with you should be bagged to prevent contamination.
- D. If you think you may have accidentally messed up someone's work or equipment, please try to find whose it is and what to do about it.
- E. If you make a mess, you are responsible for cleaning it up. Return everything to its original condition, or leave conditions better than you found them. This includes your entire set-up for experiments or projects.
- F. All cleanroom users should put away all tools, throw away all wipers and disposable items, and thoroughly clean all glassware. Make it look as though you were never there, or better yet, make it look better than it was before you were there.

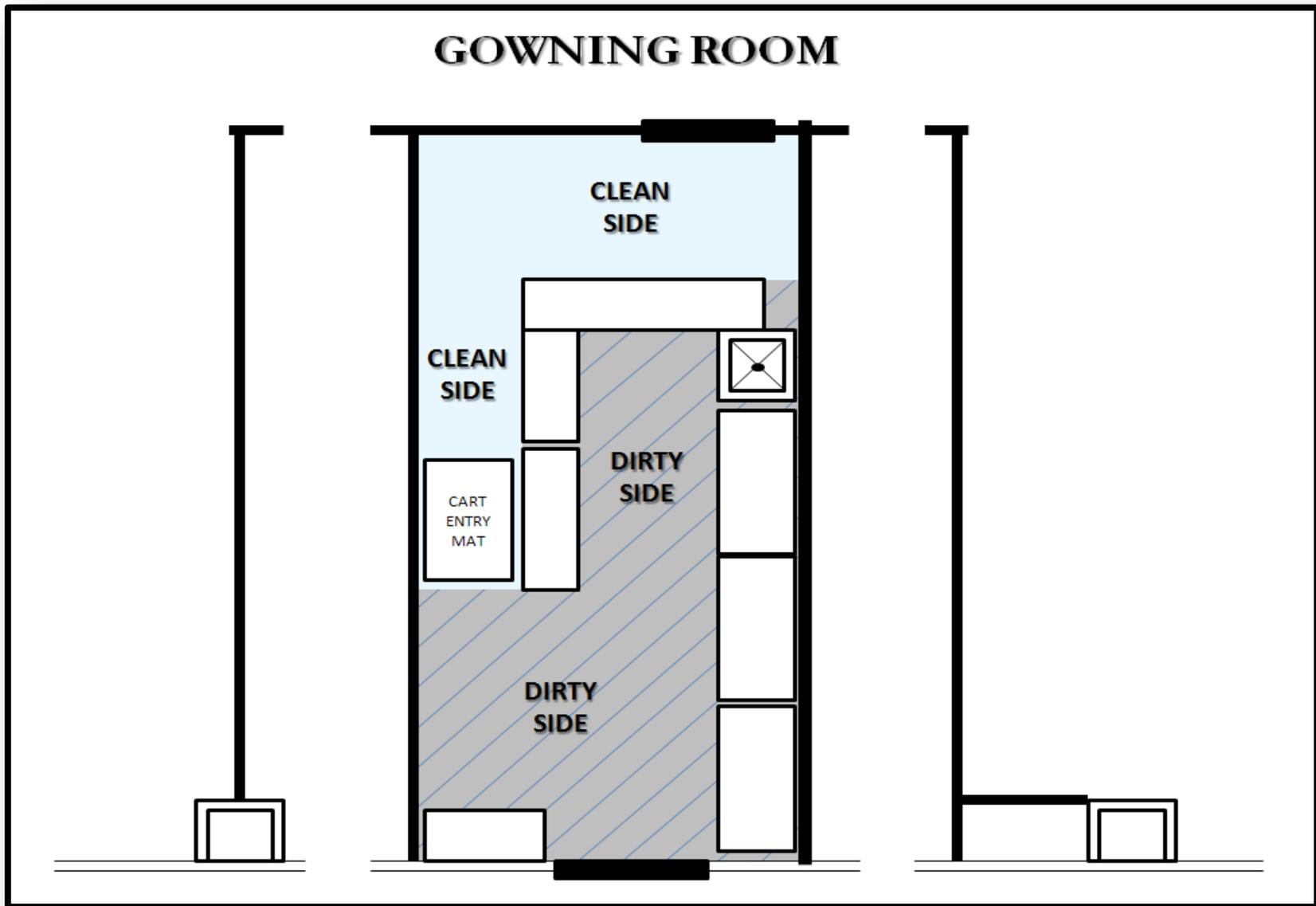
XVI. CLEANROOM EXIT PROTOCOL: DE-GOWNING PROCEDURE

1. **Enter gown room** from the cleanroom area
2. **Remove safety glasses:** Take safety glasses off and return them back to the safety glasses rack.
3. **Remove gloves:** Take off gloves and dispose of them in garbage can by the sink.

4. **Remove shoe covers:** While on the clean side, sit down on the L-shaped bench. Taking one shoe bootie off at a time (without touching the ground) and swinging that foot over to the dirty side. Repeat the same procedure for the other leg and shoe bootie.
5. **Remove additional garment items.** Take off hood, facemask, and bouffant. Discard facemask and bouffant in garbage can by the sink. Do not throw away hood.
6. **Remove coverall.** While on the dirty side, take off coverall without allowing it to touch the ground
7. **Hang up garment items:** Assemble items on a hanger (gown, hood, and shoe booties) and hang on rack.
 - a. Booties and hood should be contained inside the gown and the gown should then be zipped up.
8. **Exit cleanroom** removing shoe covers and dispose of them outside the gown room in the service corridor garbage can.

Note: In case of an emergency, do not remove cleanroom garments until after leaving the cleanroom work area or the building. Upon returning, discard them completely and assemble a new suit.

Figure 3 – Gown Room Clean Side and Dirty Side



XVII. UTILITY CHASE ENTRY PROCEDURE

A. FOR ENTRY OUTSIDE OF THE CLEANROOM

Entrance into the utility chases from outside of the cleanroom should only be used by SEB Staff or the cleanroom staff.

Entry procedure is as follows: Enter from the service corridor and step on the sticky mat three times, immediately sit on the provided stool and don booties. You may now work within the utility chase. When you are finished with your work, you must exit the same way you came in—through the utility chase door that leads into the service corridor, then dispose of your booties.

B. FOR ENTRY FROM INSIDE THE CLEANROOM

Entry from inside the cleanroom is permitted. Users may enter in full gowning to turn on or adjust equipment. A gowned individual should never be in the utility chase with a un-gowned individual. When returning to the cleanroom, step THREE times on the sticky mat before reentry.

XVIII. POLICIES AND PROCEDURES ENFORCEMENT

The policies and procedures described in this manual are intended to ensure the safety of our users, protect the equipment in the cleanroom and to create an environment in which many different research groups can co-exist peacefully. It is expected that the cleanroom users will police themselves by encouraging and assisting one another in adhering to these policies. Flagrant or repeat offenders will be penalized, typically through suspension or expulsion from the cleanroom. The penalties are defined in the Cleanroom Rules, the next section of the manual, starting on page 27.

XIX. CLEANROOM RULES

The following describes proper cleanroom policies that users must follow at all times. Failure to do so is a violation, and the penalty for the violation is also listed below.

Violation & Penalty	Proper Cleanroom Policy
<p>1. Unlawful use of any cleanroom equipment without being an authorized user for the equipment.</p> <p><u>Penalty:</u> Suspension from the cleanroom for two weeks.</p>	<ul style="list-style-type: none">• Every user operating any equipment must be authorized to use that equipment. In order to obtain an authorization to use equipment, a user requires going through cleanroom orientation, training on the equipment, and a subsequent check off. This means, following the orientation, and being included in the list of authorized cleanroom users, a user needs to attend a training session on that equipment.
<p>2. Allowing a user to enter the cleanroom behind you when he/she has not swiped his/her Marlok card.</p> <p><u>Penalty:</u> Reprimand and reminder of this policy.</p>	<ul style="list-style-type: none">• Be careful that no one follows you into the cleanroom without swiping his/her own Marlok card. Each user should swipe his/her Marlok card to enter the cleanroom level, and get in the gowning area. No one should follow another user into the cleanroom. This is to prevent the entrance of unauthorized users into the clean room.

Violation & Penalty

Proper Cleanroom Policy

3. Not wearing proper safety equipment at the fume-hood.

Penalty:

First Offense: Verbal reminder to don proper safety equipment.

Second Offense: Written warning.

Third Offense: One week suspension from the cleanroom.

Fourth Offense: One month suspension from cleanroom.

Subsequent Offense: One semester suspension from cleanroom.

- Safety equipment must always be used when handling chemicals at the fume-hood, or any other situation where you face the risk of injury.

- Normal cleanroom garment consists of a gown, hood, shoe covers, booties, mask, gloves, safety glasses and a bouffant cap (optional).

- In addition, when dealing with chemicals, a face shield and an apron must be worn at the fume hood.

- When handling acids, acid gloves should also be worn.

4. Not following proper gowning and de-gowning procedures.

Penalty:

First Offense: Demonstration of proper gowning and de-gowning procedures.

Second Offense: Written warning.

Subsequent Offense: Two week suspension from the cleanroom each time.

- Normal cleanroom garment consists of a gown, hood, shoe covers, booties, gloves, safety glasses, mask, and a bouffant cap (optional). They should be methodically worn.

- You should not put your feet (with/without shoe covers/booties) on the bench in the gowning room at any time while gowning/de-gowning.

- NOTE: Safety glasses are mandatory.

Violation & Penalty	Proper Cleanroom Policy
<p>5. Removing supplies and/or equipment from cleanroom without permission.</p> <p><u>Penalty:</u> Suspension from the cleanroom for three weeks.</p>	<ul style="list-style-type: none"> • All the supplies of the cleanroom, such as the solvent squirt bottles, 4-inch boxes, and hotplates are for use only within the cleanroom. These supplies and equipment are exclusive for cleanroom-related research. • Nothing should be removed from the cleanroom and taken for use in any other lab or department. • The lack of supplies and equipment hinders other users from making progress in their research.
<p>6. Choosing not to follow any of the procedures and courtesies stated in the Cleanroom Users Protocol</p> <p><u>Penalty:</u> Suspension from cleanroom.</p>	

CLEANROOM SUPPORT EQUIPMENT TRAINING

The cleanroom contains equipment specifically designed for cleanroom use only. It is very important that these instruments and machines are used properly and handled with care. Consult with your advisor and get his/her approval on the equipment for which you should be trained.

Remember: You are allowed to operate the equipment only after your supervisor qualifies you. Unauthorized operation may cause equipment downtime and delay many research projects. If you have any equipment training-related questions, please contact the cleanroom manager.

Please review the following training information regarding each piece of equipment before use.

I. WET BENCHES

A. The Class 10,000 and Class 1,000 wet benches are used to create a cleaner environment to work in. With the HEPA filter and fans within the wet bench, it can become a Class 100 working environment or better. The open front area allows for clean laminar air to flow evenly across the work surface while offering full access for operation. This laminar flow excludes particles and directs fumes through the exhausted slots at the rear of the station's work surface and out through the facility exhausts. NOTE: Fume protection is only behind the acrylic flashing, or in the back half of the work surface.

B. Class 10,000 Wet Bench Components:

- i. Turn on wet bench: To turn on the Class 10,000 wet bench, you must press the POWER ON button, which will then turn green. Pressing this button will enable the polished water, utility sink, the HEPA light, and HEPA fan. Though the wet bench is on and enabled, you must turn on each individual component:
 - a. Gooseneck Switch: Flip the toggle switch labeled "Gooseneck Switch ON" in the up direction. This enables the gooseneck on the sink and allows the water to flow when operating the bench.
 - b. Utility Sink Drain Switch: Flip the toggle switch labeled "Utility Sink Drain Switch ON" in the up direction. This opens the sink drain and allows any contents within the sink to drain. By closing the sink drain, you will be able to fill up the sink with water, for example, to dilute any acids before sending down the drain.
 - c. HEPA Light Switch: To turn on the light switch, you must press the black switch labeled "HEPA Filter/Light." This will enable the HEPA light and turn it on.

- d. HEPA Fan Speed knob: The HEPA Fan Speed knob is used to change the strength of the air flow coming out of the HEPA filters and will improve the ISO Class within the wet bench environment even more with varying speeds
 - To turn ON the HEPA Fan, turn the knob labeled “HEPA Fan Speed Knob.” When this knob is turned from its off position, air from the top of the wet bench will come out of secondary HEPA filters and will improve air flow creating a cleaner working environment. When the HEPA Fan is OFF, the wet bench is still exhausting air through the back slots and out of the building.
 - If you do not need a cleaner environment to work in, keep HEPA fan knob in the off position.
- e. N₂ Control Area Purge:. This should only be used when handling highly flammable solutions or volatile vapors at the wet bench. You must turn on the N₂ valve to allow N₂ to be consumed. You will then have to adjust the black knob until it is at a minimum of 50 SCFH (standard cubic foot hours).
- f. Emergency Power Off (EPO) switch: In the event of an emergency, push the large red button with the palm of your hand. This action will power off the entire wet bench.
- g. Exhaust Monitor gauge: Monitors exhaust suction from the building system.
- h. If any Alarm lights are on, please contact the SEB Assistant Director.

C. Class 1,000 Wet Bench Components:

- i. The Class 1,000 wet bench is best used when working with strong acids or solvents, but has the same components and functions as the Class 10,000 wet bench. Its few differences include, a larger bench accommodating two users; two HEPA filter zones, one on the right side and one on the left side; a necessity for a constant flow of N₂ and a CO₂ Fire Suppressor System. NOTE: Fume protection is only behind the acrylic flashing, or in the back half of the work surface.
 - a. CO₂ Fire Control System.
 - The Class 1,000 wet bench has a manual release agent in front. Please be conscious of this manual release agent so you do not

accidentally trigger the release of CO₂. Doing so will create an expansive service call.

- The manual release agent should only be activated in the event of a fire while working at the bench. There is also an auto sensor on the right hand side and below the work surface of the wet bench that will activate in the event of fire. Once activated, CO₂ will come out of the nozzles.
- After activation, whether manually or automatic, all cleanroom users **MUST** exit the cleanroom through the emergency exits **IMMEDIATELY**.
- This label will be located on the front panel of the wet bench. The label provides a warning to the user that tool is protected by a fire control system.



D. Personal Protective Equipment (PPE)

- i. PPE must be worn at all times when using the wet benches for hazardous work. This attire includes:
 - a. Cleanroom gloves (must be worn underneath chemical resistant gloves)
 - b. Chemical Resistant gloves
 - c. Safety Glasses
 - d. Face Shield
 - e. Long-Sleeved Aprons

E. Safety

- i. The wet benches and equipment are to be operated by trained personnel only.
- ii. Always operate the workstation within the proper limits as per plumbing and electrical services required.
- iii. Safety interlocks are not to be bypasses electrically or pneumatically
- iv. Observe all warning labels and do not remove them.
- v. Operation of the workstation should be terminated upon detection of leaking or damaged components
- vi. For maintenance or repairs please contact the SEB Assistant Director.

F. Class 10,000 and Class 1,000 Wet Bench Shut Down

- i. Please remember to put the DI and chemical guns back inside their compartments.
- ii. Spills must be cleaned from surfaces.
- iii. The sinks should be emptied and clear of beakers, etc.
- iv. The PPE for that specific bench must be cleaned and put back in its place.
- v. All components turned on at the bench **MUST** be turned off once you are finished working at the wet bench.
 - a. To turn off gooseneck, press toggle switch down
 - b. To turn off and close utility sink drain, press toggle switch down.
 - c. When you are finished using the HEPA Fan you must turn it off by turning the knob all the way to the left until in the off position.
 - d. Don't forget to turn off the N₂ valve to stop the flow of N₂ into the wet bench.
- vi. Press the "POWER OFF" button located on the main panel of the wet bench to power off the wet bench and disable all the components. Once pressed, the button will turn red.
- vii. Once you are finished working in the cleanroom, you must turn off the N₂ tanks out in the service corridor.

II. SPECIALTY GAS HOOK UPS AND GAS MANIFOLDS

- A. Specialty gas tanks are not allowed in the Cleanroom. There are tank stalls for specific gases outside of the Cleanroom in the service corridor. There are gas manifolds that carry the gas from the tanks into the cleanroom to adjustable valves on the Cleanroom walls.
- B. Manifold Safety Instructions
 - i. All personnel working in the vicinity of this system must read the Material Safety Data Sheet for all gases being used
 - ii. Open all valves, cylinder, and header **SLOWLY**, especially high-pressure cylinder isolation valves. Heat recompression may ignite combustible materials.
 - iii. Never permit oil, grease, or any other combustible material to come in contact with cylinders, manifold, and connections. Oil and grease may react and ignite while in contact with some gases-particularly oxygen and nitrous oxide.

III. CHILLERS

- A. Non-refrigerated, water-to-water (WW) systems are designed to remove process heat and discharge it to centrally-chilled building water. These WW systems are ideal where water temperature to the application can be maintained within 3°C (5°F) of the auxiliary water-supply temperature.

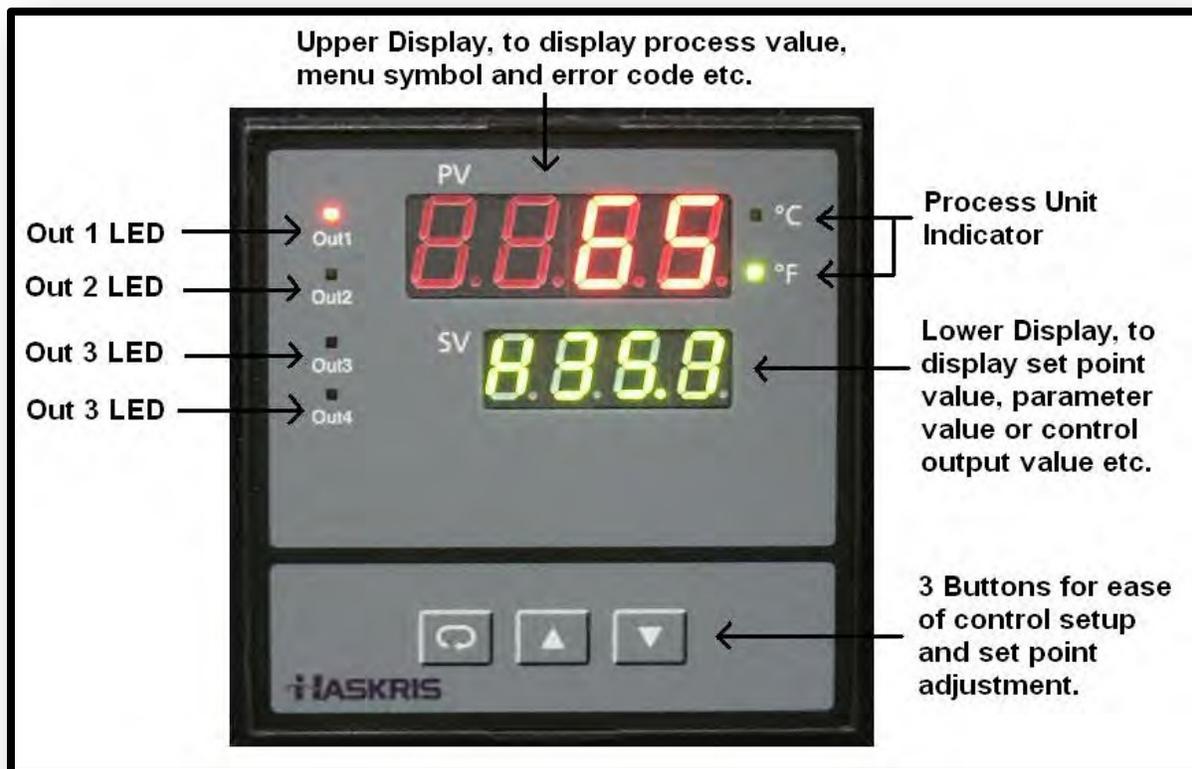
B. Fill Tank With Water

- i. The water level should remain below the links (bulkhead fittings) at the top of the tank. Do not use water purer than 1 megohm.

C. How to Adjust Supply Water Temperature

- i. Our chillers' temperature controller is the Electronic (PID) Controller
 - a. To Operate: Press the UP and DOWN arrow button to adjust the temperature set-point. Set-point (SV) will be displayed on the lower display.
 - b. Temperature is Pre-set
 - c. Adjust temperature while system with the actual heat load
 - d. Permissible Temperature Settings: Permissible supply water temperature range is 55 to 70°F (13 to 21°C.) If a temperature setting outside of this range is required, please se SEB Assistant Director
 - e. Response Time for Adjustments:
 - f. Condensation Reminder

Figure 5 – Electronic PID Controller



D. Water Level “Full” Pilot Light

- i. The pilot light is installed on the control panel.

- ii. When the pilot light is on, the storage tank is sufficiently filled. When the pilot light is out, the storage tank water is below the recommended operating level and you will need to contact the SEB Assistant Director to refill.

E. Water Storage Tank

- i. Tank Inspection: Periodically inspect the tank to make sure that the water is clear, that it has a neutral pH level, and that there had been no accumulation of debris.
- ii. Frequency of Water Changes: Change the water in the tank once or twice per year at minimum.
- iii. Biological Growth: If you notice biological growth in the hoses, please notify the SEB Assistant Director as soon as possible.

IV. INFRASTRUCTURE

A. Door Interlocks

The sliding glass doors are interlocked such that the hallway to gownroom and gownroom to cleanroom cannot open at the same time. Respectively the gownroom to class 1,000 and class 1,000 to class 10,000 cannot be open at the same time

B. Differential Pressure Sensors

The cleanroom has four differential pressure sensors monitoring the pressure between classes, cleaner to dirtier. Please contact the SEB Assistant Director if these are ever in alarm.



C. Humidifiers

The cleanroom has its own make up humidity system designed to maintain the relative humidity at 45% +/- 5%

D. Filters

The cleanroom contains a series of course merv-13 filters and HEPA filters. This critical contamination control component is a consumable which can cost up to \$50,000 to do a replacement when saturated. It is therefore imperative protocols are strictly followed so particulates are not introduced into the space prematurely suturing the expensive filters.

E. Modular Walls/ Epoxy Coatings

The cleanroom envelope and bay and chase modular walls are constructed such that repair is very difficult or impossible without major renovation and disruption. Therefore great care must be taken not to strike the walls in any way.

CLEANROOM EMERGENCY PROTOCOL

I. CLEANROOM EMERGENCY SHUT-OFFS AND EVACUATIONS

- A. All other labs in SEB are under negative pressure. Therefore any fumes from a hazardous spill or smoke will automatically be contained within. This will not occur in our cleanroom environment because it is a positively pressurized space. Any spill which generates noxious fumes or fire will migrate to the public areas of the building and must be mitigated.

Emergency shut-off procedures can only be performed by the SEB Assistant Director, Facilities Maintenance, or Risk Management and Safety. Request for an Emergency shutdown should be initiated in the following situations:

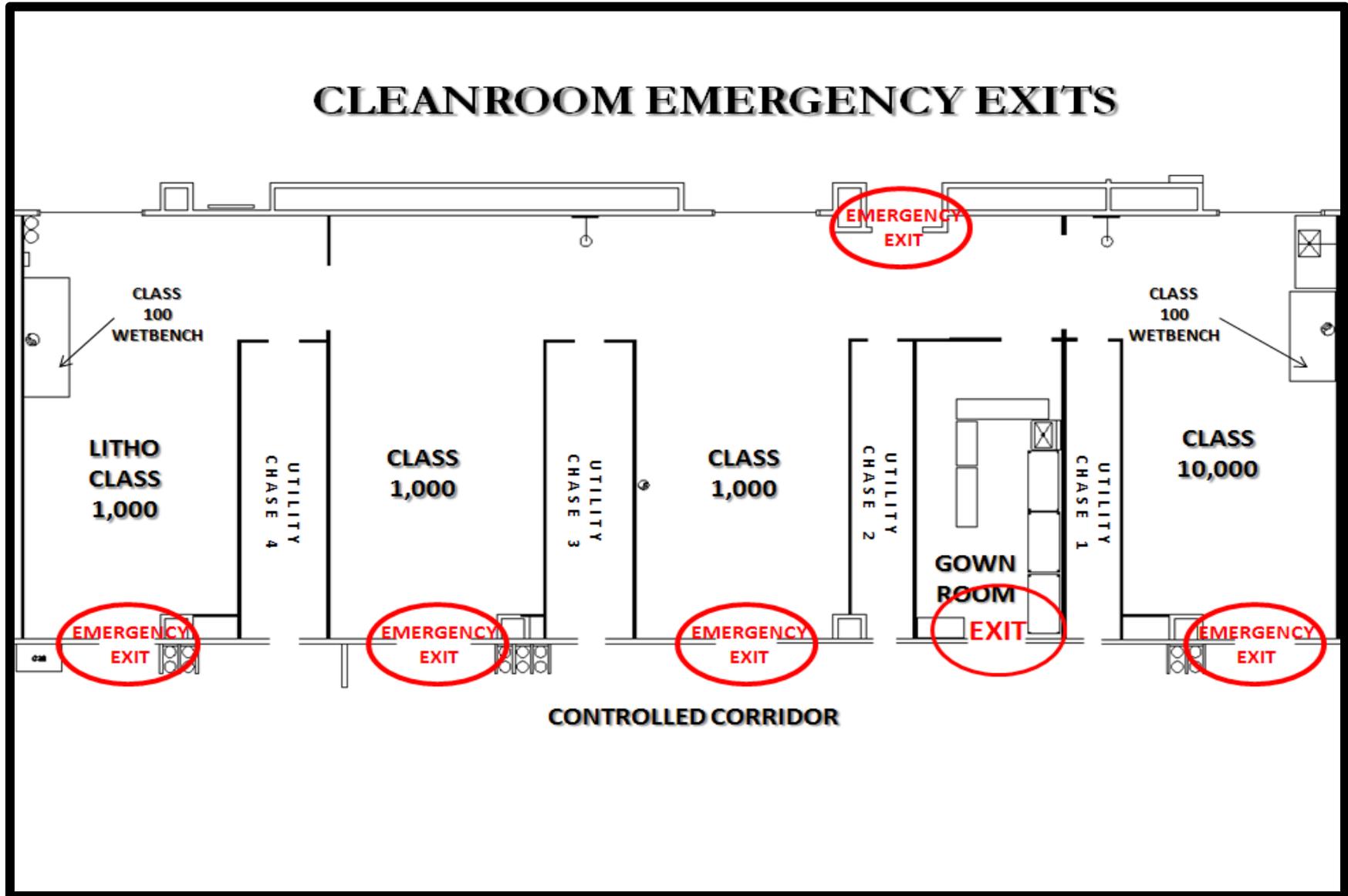
1. A large chemical spill
2. Electrical fire
3. Chemical fire
4. Smoke

Contact immediately the SEB Assistant Director, RMS, or the Help Desk if this emergency situation is required.

II. EMERGENCY EVACUATIONS

- A. If the building fire alarm sounds within the cleanroom, set your work in its place and make your way to the nearest cleanroom wooden emergency exit door in a quick but orderly manner. Do not take the time to go into the gownroom to de-gown; immediately exit to outside of the cleanroom with cleanroom attire on, and proceed to the outside of the building to a safe place. Please refer to the map on the next page to become familiar with the location of all the emergency exit doors in the cleanroom

Figure 5 – Cleanroom Emergency Exit Map



III. EMERGENCY EQUIPMENT

It is important to familiarize yourself with the emergency and safety equipment as well as its location in the cleanroom. Users must know how to properly use the equipment described below.

A. Safety Showers

Purpose: For chemical decontamination of a person and their clothing.

How it Functions: The lever must be pulled and the victim should use the shower for at least 15 minutes to mitigate and dilute the chemical. Those assisting the victim should use the phone to call for emergency assistance.



Location:

#1 - In the East Class 10,000 cleanroom along the North wall

#2 - In the West Class 1,000 cleanroom along the North wall

#3 - In the Litho Class 1,000 cleanroom along the North wall

B. Eye Wash Station

Purpose: For mitigating a chemical splash in the eye.

How it Functions: The handle must be pulled down and the victim should use the shower for at least 15 minutes to mitigate and dilute the chemical. Those assisting the victim should use the phone to call for emergency assistance.



Location:

#1 - In the East Class 10,000 cleanroom along the North wall

#2 - In the West Class 1,000 cleanroom along the North wall

#3 - In the Litho Class 1,000 cleanroom along the North wall

C. **Phone:**

Purpose: Use to contact during emergency situations. Refer to the emergency phone number list for any emergencies.

Location: Class 1,000 center bay.

D. **Fire Extinguishers**

a) Halotron extinguishers contain a non-flammable gas and are highly pressurized. They are used for fires smaller than a waste paper basket by those who are trained to use them.

b) Operation of the extinguisher requires four steps:

- 1, **P**ull the pin.
2. **A**im at base of flames
3. **S**queeze the trigger to release the vapor
4. **S**weep the nozzle horizontally back and forth to smother the flames.



The memory key is “**P A S S**”: **P**ull, **A**im, **S**queeze, **S**weep

c) Location: Wall mounted in each cleanroom bay.

E. **First Aid Kit:**

Purpose: Contains band-aids as well as standard first aid bandages for small abrasions or burns

Location: Service Hall Emergency Cabinet



F. **Spill response kits:** (see Section V)

G. **Automatic Sprinkler System:** The entire building including the cleanroom has automatic fire sprinkler system that is heat-activated.

IV. SAFETY EQUIPMENT

- A. **Safety glasses:** Users must have safety glasses already on from following the proper gowning procedure in the gown room. These must be worn to protect eyes.
- B. **Face Shields:** Face shields are located at the wet benches
- C. **Chemical Resistant Gloves:** These gloves will be located at the wet benches.
- D. **Heat Resistant Gloves:** These gloves are located at the wet benches.
- E. **Apron:** Chemically-resistant, aprons are available in the wet processing bay, and are to be worn when working with hot and/or strong acids, bases, or HF.

V. SPILL RESPONSE PROCEDURES

A. Introduction

There are many potentially dangerous chemicals in the cleanroom and the possibility of a major spill always exists. It is necessary to know how to react quickly and properly to any chemical spill to avoid injury, death or major equipment damage. A large acid spill, HF for instance, might cause serious injury or even death if handled improperly. These procedures are intended only to provide guidelines. Common sense should always be used when dealing with any chemical spill. Safe practices should be foremost on your mind whenever you are in the cleanroom.

Be advised: It is strongly recommended that you should NEVER work alone in the cleanroom. You should have at least one other person in the cleanroom with you at all times for your safety.

B. Spill Response Box Items

The cleanroom spill response box is located in the Class 1000 center utility chase. It is plainly marked and contains the items you will need to combat a spill.

These items are included:

- absorbent spill dam
- absorbent pillows
- acid neutralizer
- caustic neutralizer
- Hydrofluoric ointment (calcium gluconate 2.5%)
- pH paper
- two pair of acid gloves
- two respirators with acid gas cartridges
- two pair of vapor-resistant goggles

If you have any other suggestions, please contact the SEB staff.

C. “I’ve Spilled a Bottle of ----”

If you are the person responsible for the spilled chemical, clean up should be straightforward.

1. Did the chemical spill on you?

- If the chemical is a strong acid or base, remove contaminated clothing and run the affected area under water for 10 to 20 minutes. This should relieve some of the pain and reduce the danger of severe burns.
- If the chemical is HF, remove contaminated clothing and run the affected area under water for 15 to 20 minutes. Apply a liberal amount of calcium gluconate gel to the area, following the directions on the package. Seek medical attention as soon as possible.

2. Is the chemical hazardous?

- If the chemical is hazardous and you feel you cannot handle it, alert others to its presence and evacuate the cleanroom.
- During the workday, notify SEB staff (at ext 4-4732) or Risk Management and Safety. After hours, call the help desk (at ext 5-HELP)
- If the chemical is a solvent or possesses a strong odor, evacuate the cleanroom and don a respirator and goggles before returning to clean up the spill.

3. Retrieve the spill response box:

- If the chemical is acidic or basic, don acid gloves, respirator and goggles before attempting to clean up the spill.
- Isolate the area around the spill.
- Select the proper equipment for the spill. For large spills, those from a half gallon bottle or larger, an absorbent dam will be necessary to prevent spreading. For small spills, only absorbent pillows are necessary. Select the proper neutralizer for the chemical (note: solvents do not require a neutralizer).

4. Attack the spill:

- If you are using an absorbent dam, place the dam around the spill, approximately 4 inches from the liquid.
- Place the neutralizer bottle on the floor. Release the clamp and spray neutralizer, pushing the chemical into the spill dam. Be sure to cover the entire spill.
- For the strong acids (HF and Sulfuric), you will need approximately an 8:1 ratio of neutralizer to chemical to completely neutralize the spill.
- The acid neutralizer will turn from purple to yellow to red when finished. Check pH, it should be around 7. If still acidic, continue adding neutralizer until pH=7.

- For the strong bases (metal and ammonium hydroxides), you will need approximately a 6:1 ratio of neutralizer to chemical. The base neutralizer will turn from red to blue to yellow when finished. Check pH, it should be around 7. If still basic, continue adding neutralizer until pH=7.
- Once the reaction has ceased, allow liquid to cool. Check pH, it should be around 7. When cool, vacuum with the wet-vac cleaner.
- If you are dealing with a solvent spill, do not attempt to neutralize it.
- Soak up the chemical as soon as possible to avoid damage to the floor.
- Do not use water on the spill until after the chemical is soaked up.

5. Clean up:

- Do not remove your safety equipment until you have finished cleaning up. There may still be some active chemical on the floor.
- When the liquid has been completely absorbed, place the absorbent dam and pillows in a double trash bag.
- If any glass is involved, place the glass in a separate Haz-Mat bucket and label it as “SHARPS” along with the chemical the glass contained.
- Wipe down the spill area with the mop and DI water. When finished, place the mop head in a fume hood sink and rinse it thoroughly with DI water. Be sure to use the wet-vac inside the cleanroom to vacuum up the liquid. Do not use any other vacuum.
- Place the bag in a Haz-Mat bucket and apply an NFPA diamond label, writing the chemical on the label.
- Put the lid on the bucket and bring the bucket to the SEB Stockroom for disposal.

D. “I’ve Found a Chemical Spill”

Finding a chemical spill can be more dangerous than spilling the chemical yourself if the proper precautions are not taken. In most cases, the spill will be of a small amount of unknown chemical. In this situation, we assume that you do not know the identity of the chemical.

1. Assess any immediate hazards:

- Is there a strong odor? If so, evacuate the bay and don a respirator before continuing.
- Is a violent reaction taking place? If so, it may be wise to wait until the reaction has finished.

2. Attempt to identify the chemical:

- Look for clues to the chemical’s identity: labels, tipped containers, etc.
- Wearing an acid glove, use the pH paper to identify whether the chemical is an acid, base or solvent and its strength.
- If the chemical can be classified as an acid or base with the paper but not identified, assume it is a very strong acid (HF) or a very strong base (Sodium Hydroxide).

3. Is the chemical hazardous?
 - If the chemical is suspected of being hazardous and you feel you cannot handle it, alert others to its presence and evacuate the cleanroom. During the workday, notify SEB staff (at ext 44732) or Risk Management and Safety. After hours, call the help desk (at ext 5HELP)
4. Retrieve the spill response cart:
 - Don acid gloves and goggles before attempting to clean up the spill.
 - Select the proper equipment for the spill. For large spills, those from a half gallon bottle or larger, an absorbent dam will be necessary to prevent spreading. For small spills, only absorbent pillows are necessary. Select the proper neutralizer for the chemical. (note: solvents do not require a neutralizer)
5. Attack the spill:
 - If you are using an absorbent dam, place the dam around the spill, approximately 4 inches from the liquid.
 - Place the neutralizer bottle on the ground. Release the clamp and spray neutralizer, pushing the chemical into the spill dam. Be sure to cover the entire spill.
 - For the strong acids (HF and Sulfuric), you will need approximately an 8:1 ratio of neutralizer to chemical to completely neutralize the spill.
 - The acid neutralizer will turn from purple to yellow to red when finished. For the strong bases (metal and ammonium hydroxides), you will need approximately a 6:1 ratio of neutralizer to chemical. The base neutralizer will turn from red to blue to yellow.
 - Once the reaction has ceased, allow liquid to cool. When cool, place absorbent pillows over the spill and allow them to soak up the liquid.
 - If you are dealing with a solvent spill, do not attempt to neutralize it.
 - Soak up the chemical as soon as possible to avoid damage to the floor.
 - Do not use water on the spill until after the chemical is soaked up.
6. Clean up:
 - Do not remove your safety equipment until you have finished cleaning up. There may still be some active chemical on the floor.
 - When the liquid has been completely absorbed, place the absorbent dam and pillows in a double trash bag.
 - If any glass is involved, place the glass in a separate Haz-Mat bucket and label it as "SHARPS" along with the chemical the glass contained.
 - Wipe down the spill area with the mop and DI water. When finished, place the mop head in a fume hood sink and rinse it thoroughly with DI water. Be sure to use the wet-vac inside the cleanroom to vacuum up the liquid. Do not use any other vacuum.
 - Place the bag in a Haz-Mat bucket and apply an NFPA diamond label, writing the chemical on the label.

- Put the lid on the bucket and bring the bucket to the SEB Stockroom for disposal.

E. First Aid

First aid is an important element of cleanroom knowledge. The Microelectronics Cleanroom environment contains many potential hazards, especially the chemicals we use. This section presents only a simplified first aid procedure for a hazardous chemical spill.

Did the chemical spill on you?

- If the chemical is a strong acid or base, run the affected area under water for 10 to 20 minutes. This should relieve some pain and reduce the danger of severe burns.
- If the chemical is HF, run the affected area under water for 15 to 20 minutes and then apply a liberal amount of calcium gluconate gel following the directions on the package. Seek medical attention as soon as possible.
- If the chemical is a solvent, rinse the affected area for 10-15 minutes to reduce any irritation.

The chemical spilled on someone else:

- If the person is coherent, find out what chemical they were using.
- If they are unable to tell you, call 911, then have someone place them under a safety shower and remove contaminated clothing while you attempt to identify the chemical:
 - ❖ Look for clues to the chemical's identity: labels, tipped containers, etc.
 - ❖ Wearing an acid glove, use the litmus paper to identify whether the chemical is an acid, base or solvent and its strength.
- If the chemical can be classified as an acid or base with the paper but not identified, assume it is HF or Sodium Hydroxide.
- Take necessary first aid action, including the use of HF ointment.
- Notify Risk Management and Safety at 5-4226 as soon as possible.

Final Note

The intent of these policies and procedures are to ensure an environment where researchers can work together safely and productively while maintaining the integrity of the cleanroom environment and equipment. These policies and procedures will change with time so please make sure your copy is up to date. Users are strongly encouraged to make suggestions on how we can more effectively meet our expectations and goals.

Last Updated:
July 17th 2013
Eric Knight

UNLV

Science and Engineering Building

University of Nevada, Las Vegas

*4505 S. Maryland Parkway
Las Vegas, NV 89154*

SCIENCE & ENGINEERING BUILDING CLEANROOM POLICY AND PROCEDURE ACCEPTANCE STATEMENT

- I have received a copy of the **UNLV SEB Cleanroom Users Protocol** document and I have attended the **Cleanroom Orientation** training.
- I understand and agree to practice all the policies and operating procedures set forth now and in the future.
- I agree to abide by the conditions, provisions, and obligations imposed on me, as a user of the Science & Engineering Building Cleanroom.

Name (Please Print)

Department

Email

Phone

Signature

Date