Safety at a Glance

The University of Illinois, and especially the ECE444 laboratory, has a long standing tradition of safety awareness. There have been no serious accidents in over 40 years of operation of the 444 lab. It's your responsibility to be familiar with this material: you will be tested on it!

The first and most important tool for safety available to you is common sense. Be aware that you are working in a potentially dangerous environment where you cannot afford to be careless. Never horse around in the lab or engage in any activity that may be risky to you or other people working in the lab.

Be conscious of the safety hazards of the lab: You are working with strong chemicals, with high temperatures, with vacuum pumps and with lasers.

Safety Equipment and procedures

Safety in the lab begins before you get into the lab. Always wear covered shoes (no sandals) and pants (shorts and skirts only mean that you have 1 layer less of clothing between you and the lab). Never wear contact lenses; they may trap chemicals against your eyes.

Before you come into the Lab make sure you are properly wearing your Tyvek® suit, cap, boots and safety glasses. If you are processing, you must wear gloves (nitrile gloves are provided). This will provide you with the basic safety equipment, and will also protect the equipment, lab and experiments from contamination you may bring into the lab. You should wear these items at all times inside the Lab.

Be familiar with MSDS (Material safety data sheets). These are the specifications for all the chemicals we use in the ECE444 lab. In case of an emergency, medical personnel will NEED this information. You are responsible for reading and understanding the MSDSs for all the chemicals in the lab.

The Wet Lab

The Wet Lab deserves special attention due to the potentially dangerous chemicals that are stored there.

- Always wear a closed face shield inside the wet lab.
- When working with chemicals, work under the appropriate fume hood. Most of the chemicals in the lab are volatile.

Always wear the heavy nitrile gloves (thick green gloves) when working in the acid or RCA hoods.

**BE ESPECIALLY CAREFUL WITH THESE GLOVES:**

- **Remember: never touch the outside of the gloves.**
- **Students are usually careful when getting in and out of the gloves; however some students tend to be careless while using the gloves.**
- **Never touch your face with the gloves.** If your face / nose itches don’t use your gloved hands to scratch
- **Always be aware of BOTH hands.** Always keep hands above the counter. Don’t let your left hand (if you are right handed for example) out of your sight; you will tend to get it by your left hip. Remember: TYVEK and LATEX will NOT PROTECT YOU FROM CHEMICALS.
- **If you see or feel anything wet inside the gloves let one of the TAs know.** We have plenty of new gloves.
- **When handling chemicals for the RCA clean be careful when you get them in and out of the cabinets underneath the hoods.** When you are done with the bottles and other equipment, remember to rinse them before returning them to their storage place. Always open the containers underneath the hood, some of them will give off fumes as you open them.
- **If using sulfuric acid in SC-2, remember the jingle “Always do as you oughta, add ACID to WATER”.** When working with acids and water, water always goes first. When you add the sulfuric acid to the solution you will notice a sharp increase in temperature. If you pour too fast, or to a solution that is already too hot (above 60° C) you will reach (at least locally) the boiling point of H₂SO₄ (sulfuric acid). This will cause bubbling and splashing of acid outside the quartz boat. If this happens, stop pouring acid immediately, turn the temperature controller off and wait for the temperature to go below 60° C before continuing to pour the acid.

The Furnaces

- When working with the furnaces make sure you are wearing the appropriate gloves
- Make sure there is only 1 person in the furnace area (marked by yellow and black tape on the floor) when someone is loading / unloading a boat.
- Whenever you turn in any of the gases make sure you check the flow and pressure settings. You want to make sure that the ball in the flow meter is floating, and that the pressure gauges read ~ 15 psi AFTER you turn the gas on.
- Hydrogen is used to produce pyrogenic steam – H₂ and oxygen (O₂) is injected into the chamber where combustion occurs, producing steam (H₂O(v)).

Under the appropriate conditions, this is a safe and controlled reaction. However, if there is an excess of H₂ (leading to H₂ gas leaving the chamber), or the temperature is <800°C (the temperature is too low to spontaneously combust), the potential for an explosion are present. To prevent this from occurring, the gas control panel monitors the H₂/O₂ ratio and temperature at the point of injection. If it is unsafe, the control panel will turn off the hydrogen and sound an alert. If this occurs, contact your TA. Note that the control panel will leave the system in a safe state (i.e. no H₂ flow into the chamber). The hydrogen flow rate will need to be adjusted or the furnace will need time to reach the auto-ignition temperature.

Emergencies

In case of emergency always call 9-911 and give the following information:

- Your name
- Location - Integrated Circuit Fabrication Lab Room 50Q, Basement of Everitt Lab 1406 W. Green St., Urbana
- Specific information about the emergency

Fire

In case of a fire, students should evacuate (see evacuation routes) the lab as soon as possible in an orderly fashion. Activate one of the fire alarms on your way out.
Fire Suppression

The lab is equipped with multiple fire suppression systems.

Sprinklers

Due to the high cost and difficulty in procuring processing equipment, a wet sprinkler system would not be a prudent system to extinguish fires. Therefore, a ‘dry’ sprinkler system is employed in the lab.

Specifically, the system is a single interlock pre-action dry pipe system. This system minimizes the potential for damage to the equipment in the lab due to accidental damage to sprinkler heads or false alarms.

In normal operation, the sprinkler lines are sealed by a valve and pressurized with air. Before water is released into the lab, two actions must occur:

- A detecting device must sense the presence of fire – this will open the main valve to the system, filling the line with water. The lab uses smoke detectors located throughout the area.
- A sprinkler head must be activated to release the water in the charged line. The sprinkler head must reach a specified temperature before opening – the sprinkler heads in the lab contain blue bulbs, requiring a temperature of 286°F before activating.

The requirement of meeting two conditions lowers the probability of accidental release of water onto the equipment in the case of a faulty detector, a controller fault, or the accidental breakage of a sprinkler bulb.

In addition to the features above, the sprinkler system in the photolithography lab is fitted with dry pendant sprinkler heads. This provides additional protection by minimizing the chance of water dripping onto equipment, even if the line is charged with water.

HFC-125 Fire Suppression System – Photolithography Lab

The photolithography lab contains equipment that is difficult and expensive to repair or replace. To prevent damage, a clean agent fire suppression system is used to extinguish a fire in this area. If a fire is detected, pentafluoroethane (HFC-125) is released into the room from a pressurized storage vessel. The HFC-125 suppresses fire by absorbing heat energy at a higher rate than the amount of heat generated by the fire, preventing the fire from sustaining itself. The area to be protected must be air-tight to maintain a sufficient quantity of HFC-125 for suppression.

The HFC-125 system is automatic. In the event a detector senses the presence of fire, a warning alarm will sound 30 seconds prior to the release of the suppression agent. During this 30 second warning, release of the agent can be halted by pressing the bypass button (in the case of a false alarm). Otherwise, after the 30 second warning the main fire alarm for building will be activated and the HFC-125 will be released into the room.

Evacuate the lab as described in ‘Evacuation Routes’, making sure that all doors to the photolithography lab are shut tight.

The photolithography area also contains a single interlock pre-action dry pipe system, with the additional protection of dry pendant sprinkler heads. This type of sprinkler head provides additional protection by minimizing the chance of water dripping onto equipment, even if the line is charged with water.

CO2 Fire Suppression System – Wet Lab

The wet lab houses multiple fume hoods, which poses a particular hazard in the case of a fire.

A fume hood, by design, draws air into the working area and exhausts the air outside of the lab at a velocity of 80-120 feet per second. This high flow of air will cause a fire located inside the hood to grow quickly.

In order to reduce the potential for an uncontrollable fire, the fume hoods contain nozzles connected to a pressurized vessel containing CO2. In the event of a fire in a fume hood, the CO2 cylinder may be manually released into the hoods. The CO2 suppresses the fire by displacing oxygen.

However, people need oxygen as well in order to live. Therefore, the system should not be released until everyone has evacuated the area.

This is a legacy system and should only be activated by lab personnel.

Hydrogen Alarms

Hydrogen is a highly flammable gas, with the potential of being explosive at certain concentrations in air. The lab contains two systems which monitor hydrogen levels.

Furnace Gas Control Panel

Gases are injected into the furnace chambers through the gas control panel located in the cabinet at the end of the furnace.

The control panel monitors chamber temperature and the H2/O2 ratio (as explained previously). If either parameter is outside the limits of safe operation, the panel will turn off the hydrogen and sound an alarm. The alarm is local to the gas cabinet, and does not tie into the lab fire alarm system.

When in alarm, the system defaults to a safe condition. Therefore, there is no need to evacuate the building due to this alarm, unless your TA indicates otherwise.

Lab Area Hydrogen Detection System

The Hydrogen Detection System continuously monitors various points in the lab and reports hydrogen levels as a percentage of the lower explosive limit (LEL).

The reporting unit is located to the right of the wet lab door (looking into the wet lab). It consists of the interface panel (state indicators, bypass switch, and silence button) and three LCD displays.

The sensor heads are located at three key positions around the furnace:
- Gas cabinet
- Chamber exhaust
- Above the false ceiling

This system has been programmed to respond to two levels of detection:

5% LEL Alarm
- Local alarm sounds and strobe light activated.
- Warning to personnel that hydrogen is being released, allowing the opportunity for the cause to be found and fixed before going into full alarm.
- Students should prepare for potential evacuation

10% LEL Alarm
- Local alarm sounds, strobe light activated, and building-wide fire alarm activated.
- Building evacuation (see ‘Evacuation Routes’ below).

Evacuation Routes

The ece444 laboratory has multiple emergency exits due to its size. Safe exits can be identified by illuminated signage adjacent to the exit. The exit route used in an emergency should be based on the immediate situation. Do not de-gown.

After evacuation, students must meet on the sidewalk on the south side of the building (by Green Street) at a safe distance from Everitt Lab. Keep your lab garments on. It is essential to regroup so that lab personnel can account for everyone and notify the responders of anyone that is missing.
The illustration below identifies the egress routes from the lab. Green arrows indicate direction of travel. Red crossed-circles indicate doors located in the lab that should not be used for evacuation.