

# Safety Handout

## Introduction

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 of the fact 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, booties and lenses. As you come into the lab always get a pair of nitrile gloves 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 MSDSs (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. The MSDS for the ECE444 are located online. Ask your TA to show you one and explain the basics of an MSDS.

## 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 past the yellow/black lines inside the wet lab.

Whenever working with chemicals work under the appropriate fume hood. Most of the chemicals in the lab are volatile.

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

BE ESPECIALLY CAREFUL WITH THESE GLOVES:

Remember never to 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 both 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 put it by your left hip. Remember: TYVEK and THIN NITRILE gloves 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.

When using the sulfuric acid on SC-2 remember your 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 H<sub>2</sub>SO<sub>4</sub> (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 you continue to pour the acid.

## The Furnaces

When working with the furnaces make sure you are wearing the appropriate gloves.

Make sure there is only one (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 on 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 above 15 psi AFTER you turn the gas on.

Hydrogen is explosive in high concentrations or below 800°C. If any of these conditions is present within the furnaces, a local 0.5% LEL alarm will sound (high-pitch tone).

If this happens:

1. Turn the hydrogen off
2. The alarm will automatically reset.
3. Check that the furnace is at the right temperature and that enough oxygen is flowing
4. Try turning the hydrogen on again, if the LOCAL alarm goes off again repeat steps 1-3 and contact your TA.

If the 2.5% LEL BUILDING alarm goes off, evacuate immediately. The TA will turn off the Hydrogen before leaving the lab.

### **The Evaporators**

You should always be aware of the extreme negative pressures within the chamber. Never turn off the pumps or try to open the chamber while at a low pressure, as this will result in damage to the tool. Cold Cathode gauge should ALWAYS be turned off before venting the system.

### **Emergencies**

In case of emergency, always call 911 (that is 9-911 if calling from a campus phone) and give the following information:

Your name

Location -

ECE444 Fabrication Laboratory  
Room 260, 2nd Floor MNTL  
208 N. Wright St.

Specific information about the emergency

### **Fires and Fire Suppression Systems**

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.

*Each lab area is equipped with fire suppression systems.*

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 a sprinkler head dripping water onto the equipment, even if the line is charged with water.

### **Furnace/Photolithography Lab**

The Furnace/Photolithography lab shares a common window with the MNTL atrium. Therefore, an additional high-pressure suppression system is applied to the windows to improve cooling.

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.

### **Hydrogen Alarms**

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

### **Furnace Gas Control Panel**

Gasses 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 H<sub>2</sub>/O<sub>2</sub> ratio (as explained previously). If either parameter is outside the limits of safe operation, the panel will sound an alarm. The 0.5% LEL alarm is local to the gas cabinet, and does not tie into the lab fire alarm system. However the 2.5% LEL alarm is tied into the building fire alarm system.

During the 0.5% LEL alarm, turn off the Hydrogen and monitor the level. 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 gas cabinet (looking into the Furnace room). It consists of the interface panel (state indicators, bypass switch, and silence button) and an LCD display.

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:

**0.5% 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

**2.5% LEL Alarm**

- Local alarm sounds, strobe light activated, and building-wide fire alarm activated.
- Building evacuation (see 'Evacuation Routes' below).

**Evacuation Routes**

There are 4 evacuation routes in case of an accident in the ECE444 lab. 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 at a safe distance from MNTL. 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.