

## ECE 444 Theory and Fabrication of Integrated Circuits 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 nearly 35 years of operation of the 444 lab. This handout is intended as a supplement to the information contained in the Lab Manual (ECE 444 Lab Safety, Laboratory Health and Safety: Be Aware, Be prepared, Be protected, The Sinks and Fume Hoods, Etching, Furnaces and A Word of Caution) and the web pages on safety. 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 latex gloves (ask for vinyl if you are allergic to latex) 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. The MSDS for the ECE444 are located on the safety pages of the web page. 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 inside the wet lab (You may take it off when using the microscopes, just remember to put the face shield back on when finished).
- Whenever working with chemicals, work under the appropriate fume hood. Most of the chemicals in the lab are noxious or volatile.
- Always wear the 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 LATEX will N O T 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 40° C) you will reach (at least locally) the boiling point of the DI/H<sub>2</sub>SO<sub>4</sub> (Sulfuric Acid) mixture. 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 40° 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 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 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 on the furnaces a local high-pitched alarm will sound. If this happens:
  1. Turn the hydrogen off
  2. Turn the alarm off by pressing the AUTO IGNITION button.
  3. Check that the furnace is at the right temperature and that oxygen is flowing
  4. Try turning the hydrogen on again, if the LOCAL alarm goes off again repeat steps 1 and 2 and contact your TA.

### **The Evaporators**

You should always wear a face shield in the vicinity of any vacuum system using a glass bell jar. An implosion of the chamber will result if thousands of glass pieces flying in the vicinity of the machine.

### **Emergencies**

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

Your name

Location -

Integrated Circuit Fabrication Laboratory  
 Room 50Q, Basement of Everitt Lab  
 1406 W. Green St.  
 Specific information about the emergency

## Fire Alarms

In case of a fire students should evacuate (see evacuation routes) the lab as soon as possible and always in an orderly fashion. Activate one of the REGULAR fire alarms in your way out. REGULAR fire alarms require you to break a small glass to access the handle. The special CO<sub>2</sub> fire alarms are smaller and they don't have glass covers.

- **Special CO<sub>2</sub> fire alarms:**

There are two handles for these alarms. The first one is outside the Wet Lab on the door by the shower. The second one is on the north wall inside the Wet Lab, by the emergency hatch. These alarms should only be activated in case of a fire in one of the fume hoods. (This is a fire on either the solvent, acid, or RCA hoods). This alarm will flood the Wet Lab with CO<sub>2</sub>.

**The last person leaving the Wet lab should activate this alarm.** If you are using the alarm by the emergency hatch, make sure you do it once you have at least one foot out of the hatch. If this alarm is activated while someone is still inside the Wet Lab the CO<sub>2</sub> will asphyxiate him or her.

## Hydrogen Alarms

*Hydrogen is a highly flammable and explosive gas, therefore a hydrogen alarm should be considered just as a fire alarm. There are 3 levels of hydrogen alarms in the Lab.*

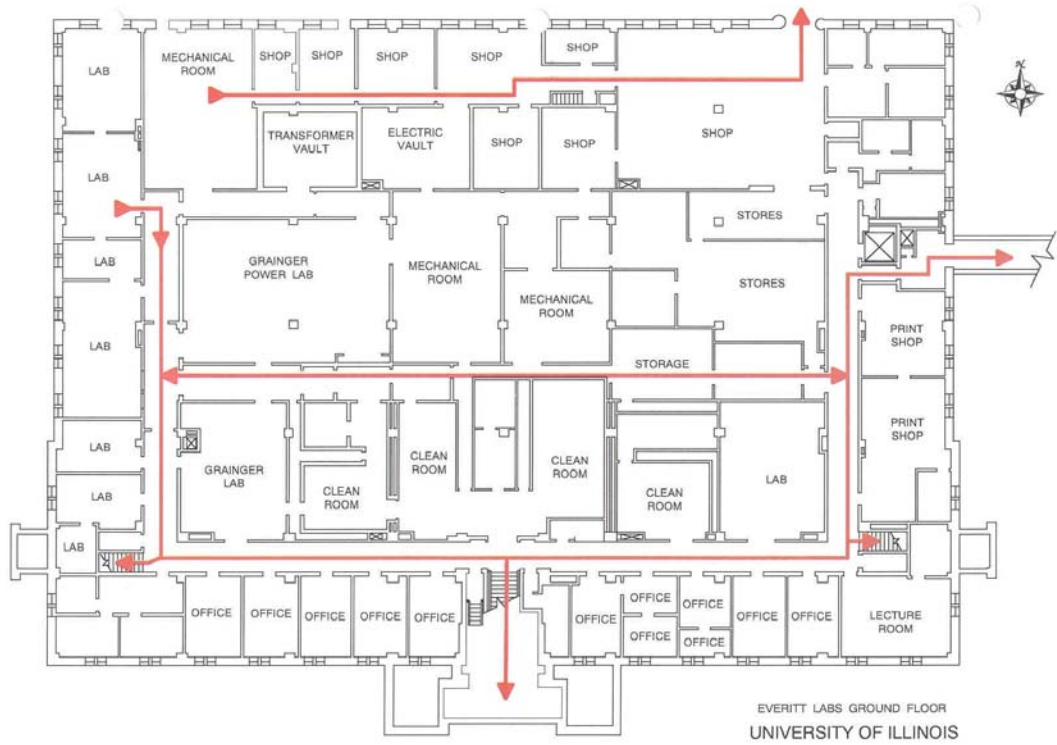
- The main H<sub>2</sub> alarm is located outside of the Wet Lab just to the east of the door. You will notice 3 gauges and a sound alarm. This alarm has 2 levels of security. If hydrogen concentration reaches 5%LEL it will sound a local alarm. This is a warning that will give your TA a few minutes to fix the problem. At this point students should get ready to evacuate the Lab. You will hear the siren coming out of the Alarm. If H<sub>2</sub> levels reach 10%LEL in any of the sensors, then the main alarm of the Lab will fire. **You will notice this**, evacuate the building immediately.
- The second level of security is a local alarm in the furnaces. See the "safety equipment and procedure section: furnaces" of this document. There is no need to evacuate the building due to this alarm, unless your TA indicates otherwise.

## Evacuation Routes

We have 3 evacuation routes in case of an accident in the ECE444 lab. (See figure 1)

All of these routes should end up in front of the Everitt lab. Exit the building and wait for your TA outside the building by the bike path located south of the Everitt Lab. It's important that TAs account for everybody, so don't take your suit off, it makes it easy for them to get a fast count of students.

- **Main evacuation Route. Route 1.** This route should be used in case of an emergency, if access of this route is impossible due to fire, chemicals, electrical hazard or smoke use either of the other 2 evacuation routes.  
Go to the main glass door of the lab (in front of the Wet Lab's door), exit the lab, use the stairs to get to the south door of the Everitt Lab, and exit the building.
- **Evacuation Route 2.** This route should be used when access to the Main evacuation route is not possible.  
You can access this evacuation route from the Test area, from the furnace area and from the Wet lab. If you are on the Wet lab or on the Furnace area use the emergency hatches located in the north wall. Pull the red handle and exit to the service corridors. **TURN LEFT** and you will end up in the gown room again. **IF YOU TURN TO THE RIGHT YOU WILL FIND AN EMERGENCY EXIT DOOR THAT IS USUALLY LOCKED, YOU CAN NOT EXIT THROUGH THAT DOOR.** If you are in the test area, exit to the gown room, then leave the lab through the same path you usually follow. Exit the building and wait for your TA outside the south door of the building.
- **Evacuation Route 3.** This route is used only for the Steppers room and the storage room. Use the door in the south wall of the Stepper room to exit to the hallway. Exit the building and wait for your TA outside the south door of Everitt Lab



February, 1999. Carlos Manzanedo  
Revised August 19, 2004, Dane Sievers