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Version 1

I-1

UCSB Chemical Hygiene Plan

Rev. 03-12
THERMO LAB INFORMATION

GENERAL LAB INFORMATION

Laboratory Supervisor (PI):

    Prof. John Bowers  
    Email: bowers@ece.ucsb.edu  
    Office: ESB 2221C  
    Phone: (805) 893-8447 (x8447)

Laboratory Location(s) (Building /Rooms):

    ESB 1111

DEPARTMENT INFORMATION

Department Safety Representative:

    Paul Gritt  
    Email: paulg@ece.ucsb.edu  
    Office: Harold Frank Hall 1157  
    Phone: (805) 893-5775 (x5775)

Location of Department Safety Bulletin Board:

    2nd and 3rd floors in the middle of the lab corridors by the restrooms

Location of Building Emergency Assembly Points:

    - Primary location: Southwest of building, south of Chemistry Lecture Halls  
    - Secondary location: Northwest of building in Lot 11

EMERGENCY INFORMATION

Evacuation procedures

    - Leave the lab immediately.

First-aid kit

    - Located on the floor between the fume hood and the door.
Fire extinguisher

- Located on the wall between the fume hood and the door.

Per campus policy, all significant injuries must be documented via the UCSB Report of Injury to Employee/Student form as soon as possible – form available in your departmental office. This is necessary for potential reimbursement for personal medical costs, or Worker’s Compensation Claims.

Per SB County Fire and campus policy, all fires must be reported to 9-911 immediately – even if the fire is out. This is particularly true if there is use of an extinguisher (must be replaced); an injury; or property damage.

**HEALTH & SAFETY REFERENCES**

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<td>1. UCSB Campus Emergency Flip Chart</td>
<td>Filing cabinet near door</td>
</tr>
<tr>
<td>2. Laboratory Personal Protective Equipment (PPE) Policy</td>
<td>On the door</td>
</tr>
</tbody>
</table>

Material Safety Data Sheets (MSDS):

Per OSHA, all lab chemical users must know: a) what an MSDS is, b) MSDS relevance to their health and safety, c) how to readily access them. These issues are all covered in the EH&S lab safety orientation program.
THERMO LAB ACCESS AND RULES

LAB ACCESS

1. Contact Ben Curtin (bcurtin@ece.ucsb.edu) to request lab training.

2. Print the following documents and bring them with you to lab training:
   a. THERMO Lab Information form:
   b. UCSB Lab Safety Training program certificate of completion:
      http://ehs.ucsb.edu/training/lsvideo.html

3. Complete the THERMO Lab Information form and obtain a signature from your PI/employer to acknowledge lab access and fees.

4. Request key card access for ESB 1111.

5. Contact users for training on specific tools that you will need to use.

LAB FEES

Hourly rate:
- On-campus User: $30.59/hour
- Off-campus User: $46.35/hour

Failure to use Exit Reader fees: (Maximum per instance)
- On-campus User: $91.77
- Off-campus Use: $139.0

GENERAL LAB POLICIES/PROCEDURES

- Always use card readers when entering and exiting the lab.
- The lab door is to remain closed, but in the event that it is open or you are following another individual into the lab, you must pass your key card over the readers.
- You must stay in the lab until completion of an experiment. If you need to take a short break, the exit and entry process must be used each time.
- Preference goes to Bowers group members for all equipment usage.
- Removal of equipment is only allowed with written permission. Send requests to bcurtin@ece.ucsb.edu.
- E-mail any equipment or general lab issues to bcurtin@ece.ucsb.edu.
• Lab information will be distributed via email. Forward email address updates to bowers.admin@ece.ucsb.edu and bcurtin@ece.ucsb.edu.

• Smoking is not allowed in or near any building on campus.

• Pathways and all lab doors must be accessible at all time.

• Lab furniture is braced for safety; do not attempt to move it.

• Should the fire alarms sound, quickly and calmly leave the building and assemble outside, on the other side of the bike path, near the Chemistry Building.

• A First Aid kit is available for small injuries and located near the front door.

• Emergencies related to personal injury or structural issues require a call to 9-911. Follow-up with a call to the ECE Department Safety Representative Paul Gritt at 805-893-5775.

**THERMO LAB RULES AND ETIQUETTE**

• You must be trained by users at the end of this document before using the following equipment:
  - o High temperature testing bell jar
  - o Logitech abrasive wire saw

• Please notify the lab manager when general supplies are running low or missing. General supplies include, but are not limited to: Batteries, Kim-wipes, and soldering station supplies.

• Please be respectful of other measurement setups and do not disturb measurements in progress without contacting the user.

• Please clean up when you are finished by:
  - o Removing your sample
  - o Cleaning the stage of excess thermal paste and vacuuming the surrounding area if necessary
  - o Returning cables and equipment that are unnecessary for general use

• Preference is given to reservations booked through our scheduling calendar. Plan ahead and reserve time according the your measurements and equipment you plan to use:
  - a. High temperature calendar – measurements involving the high temperature bell jar, probes contained inside the bell jar, and equipment on the right hand side of the thermoelectrics bench
  - b. Room temperature calendar – measurements involving the water cooled stage, dual TECs, probes located outside the bell jar, and equipment on the left side of the thermoelectrics bench

• If you need to occupy a measurement setup for an extended period of time, please work with others who may also need the setup and leave a note with your name, phone number, and e-mail address.

• Fill out the log book when you are finished.
GENERAL CHEMICAL SAFETY INFORMATION

FUME HOOD USE

Rules:

- The following solvents may be used in the fume hood:
  - Acetone
  - Ethyl alcohol
  - Isopropyl alcohol
  - Methanol

- None of these may be heated. Care should be taken around hot plates.

- No other chemicals may be used in the fume hood (except DI water) without permission from the lab manager and consultation with the chemical safety officer.

- Beakers left out without supervision should be labeled with the user, date, and chemical.

- Liquid waste should be disposed of in appropriately labeled waste bottles. Each bottle should have an EH&S hazardous waste label and be capped when not in use. Do not pour solvents down the drain. Request a pickup from EH&S when bottles become full or if they have been in use for more than 9 months.

- Do not block air flow by storing large objects in the fume hood. Do not lift the sash past the red arrow.

- Take appropriate (gloves, lab coat, and eyewear) safety precautions according to the chemical you are working with, as specified below.
NON-HALOGENATED SOLVENTS

Examples: Acetone, isopropyl and ethyl alcohol, and methanol

Hazard Properties:

- Repeated contact can cause the skin’s protective fats and oils to dissolve, resulting in reddening, itching and blistering.

- Can be readily absorbed through skin, producing systemic toxic effects.

- In addition to irritation of the respiratory tract and mucous membranes, inhalation can cause dizziness, drowsiness, headache, lack of coordination and nausea.

- Exposure over a prolonged period of time may result in damage to the liver, kidneys, lungs, blood, nervous system, and other organs. Carcinogenic, mutagenic and teratogenic effects are not uncommon.

- Unlike most halogenated solvents, most non-halogenated solvents are flammable or combustible (see the subsequent section on Flammable Materials).

Practices:

- Use fume hoods to prevent inhalation of solvent and build-up of flammable levels of vapor. Minimize solvent vaporization by avoiding unnecessary open containers.

- Allow space for thermal expansion in containers; overfilling can cause rupture if they are filled nearly to the top with cold liquid and then stored in a warm area.

- Wear eye protection for all operations in which accidental splashing might occur.

- Substitute a less toxic solvent whenever possible.

- Avoid direct skin contact by using lab coat and solvent-resistant gloves. Appropriate gloves are kept in the gray cabinet near the back of the lab. If supplies are running low, contact the lab member in charge of the fume hood.

- Dispose of solvent waste in a sealable container with an EH&S hazardous waste label. The container must be sealed when not in use.

- Store solvent bottles in the “flammable” cabinet below the fume hood. Do not store them in the fume hood, as this blocks air flow.
Ketones and Aldehydes (Examples: acetone, methyl ethyl ketone, cyclohexanone)

- These chemicals are generally highly flammable.
- Typical effects are those of respiratory tract irritation, anesthesia, and dermatitis.

Aromatic Hydrocarbons  (Examples: benzene, toluene, xylenes, styrene; none in lab)

- Chronic exposure to a low concentration of benzene may damage the bone marrow, with resultant changes in blood cells. Benzene is considered carcinogenic, and has a relatively short latency period. Substitutes for benzene should be used.
- Aromatics defat the skin, and prolonged use causes drying, scaling and cracking. Readily absorbed through intact skin and may produce systemic toxic effects.
- The most commonly used aromatic solvents are flammable

Aliphatic Hydrocarbons (Examples: hexanes, pentanes; none in lab)

- Typically lighter aliphatics are highly volatile and flammable with low flash points.
- Although not typically very toxic, the aliphatic hydrocarbons do cause many of the common symptoms related to organic solvent overexposure.
- N-hexane is unusual among aliphatic hydrocarbons as it is particularly toxic to the peripheral nervous system.

Ethers  (Examples: ethyl ether, dioxane, glycol ethers; none in lab)

- Many cause anesthetic effects and may be potent irritants and cause dermatitis.
- Glycol ethers may, in addition to the typical symptoms of organic solvent exposure, cause anemia (low red blood cell count) and have deleterious reproductive effects.
- The lower molecular weight ethers (e.g., diethyl ether) are highly volatile and are particularly hazardous flammable liquids.
- Can form explosive peroxides upon exposure to air.
FLAMMABLE MATERIALS

Flammable and combustible materials are a common laboratory hazard. To minimize the risk of fire, all laboratory personnel should know the properties of the chemicals they are handling. MSDSs or other sources of information should be consulted for information such as vapor pressure, flash point, and explosive limit in air. In addition to fuel, an ignition source and an oxidizer are required for a fire to start. Users should be aware of any potential ignition sources in the immediate area including electrical equipment such as mechanical stirrers. A blanket of inert gas can be used to remove oxidizer (air) from the system. Some basic precautions for the safe handling of flammable materials include the following:

General Safety:

- Cap bottles and vessels when not in use. Use narrow-necked bottles and flasks for transferring to help reduce the release of flammable vapors.

- Never heat flammable substances with an open flame. Preferred heat sources include steam and water baths, oil baths, and heating mantles.

- Provide ventilation adequate enough to dilute the vapor concentration to below flammable levels rapidly. Working in a fume hood is an excellent way to achieve this.

- Use only refrigeration equipment that is certified for the storage of flammable materials.

- Metal containers and lines should be grounded to disperse static charges.

- Note that most flammable vapors are heavier than air and can travel long distances along bench tops and floors. Be aware of ALL potential ignition sources in the area, including those at a lower level than the work area.

- Know the location and proper use of laboratory fire extinguishers.

Flammable gases can rapidly produce an explosive atmosphere in the lab upon leakage or escape. Acetylene, hydrogen, ammonia, hydrogen sulfide, propane, and carbon monoxide are especially hazardous in this regard. Great care should be used when handling flammable gases. Precautions include working in a fume hood and enclosing larger cylinders in a ventilated gas cabinet. Installation of flash arresters on hydrogen cylinders is recommended. A reaction vessel should be triple flushed and purged with an inert gas prior to introduction of a flammable gas.
PHYSICAL HAZARDS

VACUUM SYSTEMS

Vacuum systems have a variety of hazards associated with their operation. There are risks associated with implosion, as well as the release of toxic materials. The systems are typically complicated and require extensive training prior to use.

General Safety:

- Understand the type of vacuum pumps being used and their limitations. Always check with the manufacturer for the appropriate application.
- Prepare for power outages whether you are present or not. Some valves close upon loss of power, some open. Understand the effects that a series of valve openings and closings will have upon the system’s integrity.
- Always replace the pump belt guard to prevent catching fingers or clothing in the mechanism.
- Be aware of the hot surface in oil diffusion pumps.
- If a glass vacuum line is ever used above ambient pressure, it should be shielded from personnel to prevent glass shards from flying if the line were to shatter.
- Glass vessels that are evacuated should be round-bottomed and/or thick-walled and designed for low-pressure work. They should be regularly checked for star cracks and scratches.
- The use of safety glasses is mandatory.

Traps and Venting:

- Use of house vacuum systems must employ appropriate traps to prevent chemical, radioactive or biohazardous material from contaminating the building lines. Likewise, use of an aspirator should also employ a suitable trap to avoid contaminating the water stream.
- Mechanical vacuum pumps should be protected by cold traps – generally liquid nitrogen based.
- If hazardous materials are used with the vacuum system they should be located in, and vented to, a fume hood.
- Pump oil from vacuum system exhaust has been known to accumulate in building ductwork systems increasing the likelihood of fire spread. Pump exhaust should only be done into the fume hood proper, or if exhausted directly into building ductwork, an oil trap must be installed.
- Operation of low temperature traps must be thoroughly understood. Both the cooling and warming phases deserve undivided attention. For example, when using liquid nitrogen, the
condensation of air due to an open valve may cause a serious explosion when the air vaporizes upon warming.

- Dewar flasks are under high vacuum and are therefore subject to implosion. They should be wrapped in tape or plastic sheathing.

Chemical Hazards:

- Mechanical pump oil can become contaminated with hazardous materials that were being pumped on. Upon maintenance, proper protective equipment must be employed. A ventilated area should be used for changing pump oil, as harmful vapors may be released. Clean or contaminated pump oil must be disposed of as hazardous waste via EH&S.

- Mechanical pump exhaust may require suitable scrubbing for volatile highly toxic materials. This may involve a relatively simple filter or liquid bubbler.

General Practices:

Turning ON a High Vacuum System:

- Make sure all valves are closed.
- Turn on vacuum pump.
- Place Dewar around trap flask
- Submerge trap flask in liquid nitrogen. Make sure system is under vacuum before cooling trap to avoid condensation of liquid oxygen.

Turning OFF a High Vacuum System

- Remove all samples and experiments from vacuum line.
- Remove trap flask from Dewar. Allow to warm to room temperature
- Open vacuum system to atmosphere. Do not do this while trap is cold to avoid condensation of liquid oxygen.
- Turn off pump.
ULTRAVIOLET LIGHT SOURCES

The solar simulator is an arc lamp based system where a light source produces high intensity light output in UV, visible and infrared range. Risks associated with the light source are radiation, heat, ozone, electrical shock and lamp explosion. The lamp enclosure is designed to protect against the risk described above; however, proper training and knowledge is required before operating the system.

UV spectrum is divided into three sub bands, UV-A radiation (315nm to 400nm), UV-B radiation (280nm to 315nm) and UV-C (100nm to 280nm). UV-A radiation is the least photo biologically-active but exposure can produce tanning, burning of skin and can lead to the formation of cataracts. UV-B radiation can cause tanning, sunburn, photokeratitis, photoconjunctivities and cataracts. UV-C radiation also causes photokeratitis and photoconjunctivitis. Exposed persons often do not realize the hazard associated with exposure to UV radiation until the damage has occurred (sensation or pain do not occur initially).

Toxic gas can also be generated during lamp operation; UV radiation at wavelengths below 250nm can produce ozone, nitrogen oxide and convert chlorinated hydrocarbons, if present, into phosgene and hydrogen chloride. A ventilation system is installed to minimize this risk.

General Safety:

- Do not stare directly at the output and reflections from the light source.
- Wear proper eye protection against UV radiation and warn other users when the light source is not contained.
- Wear a long sleeve shirt and pants and warn other users when the light source is not contained.
- Due to the heat generated under normal operation, proper ventilation is installed in the enclosure to prevent overheating. Do not block the system venting fan and avoid direct contact.
- Due to the high intensity of the UV light, it is possible that oxygen converts into ozone. Proper ventilation is installed in the enclosure to prevent ozone build up; however ozone-sensitive persons should be aware of this.

Arc Lamp Replacement:

- In normal operation, users are protected from contact with any energized electrical connections. However, when repairing the light bulb or when the enclosure is open, please wear protective eyewear and clothing. Do not touch any electrical connection and unplug the system before replacing the lamp or servicing the power supply section.
- Arc lamp used in the system contains high pressure gas and may explode if not handled properly. Wear gloves when replacing the lamp and avoid touching the glass section of the lamp. If touched, use isopropyl alcohol and soft tissue to wipe off any fingerprints as they will weaken the lamp envelope. Avoid scratching the glass and do not use a lamp with a scratched envelope. Install the lamp with proper polarity and do not stress the glass parts when tightening electrical connections. Make sure all plastic packaging has been removed from the lamp before installation. Replace the lamp before it reaches its lifetime limit, a build-in timer meter helps you keep track of lamp operating hours. Wear proper eye protection and protective clothing when
replacing a lamp. Do not attempt to replace lamp if you are not trained so. An operational manual is available for further information on replacing the lamp.
ABRASIVE WIRE SAW

There are several risks associated with the abrasive wire saw, including physical harm from the rotating blade/cutting wheel and exposed electrical wiring. Before using the saw, training is required and users are encouraged to read through the manual which is located beneath the saw assembly.

General Safety:

- The operator should be fully aware of the use of the machine according to the Operation Manual, and be fully instructed in the use of cut-off wheels.
- The machine must be placed in an adequate working position, providing stable support and adequate ventilation.
- Be sure that the supply voltage corresponds to the voltage stated on the back of the machine. The machine must be connected to earth ground.
- Establish efficient exhaust from the working area if cutting materials and/or consumables which give off harmful dust or vapors are used.
- Ensure that the blade is correctly located between clean securing flanges.
- Before loading or unloading your sample, ensure that the blade/cutting wheel has completely stopped rotating.
- Keep clear of the rotating blade/cutting wire and sample holder during operation.
- Ensure that all splash guards and safety screens are in place before using the cutter.
- Use protective goggles for protection against splashing/debris as appropriate.
- Use only the recommended coolants and observe the current safety regulations for handling, emptying, and disposal of waste materials and fluids.
- Do not apply external effort to increase the cutting speed.
- Always turn off the power and remove the plug or cable before opening the machine or working on any terminal connections.
EQUIPMENT-SPECIFIC STANDARD OPERATING PROCEDURES

HIGH TEMPERATURE TESTING BELL JAR

Initial Check:

1. Determine if Bell Jar is Under Vacuum: Open PfeifferRS485 and read pressure AND manually check whether roughing pump in on or off. If under vacuum, follow venting procedure before opening.

Pumping Down:

1. After loading sample and verifying connections lower bell jar until it is resting on the base. Check that the o-ring is in contact all the way around the bell jar. Do not over-lower after contact is made.
   
   a. If o-ring is not in contact all the way around and vacuum cannot be drawn contact the person in charge of the system to have the chamber re-aligned.

2. Open PfeifferRS485 program.

3. Hit “Start Pump”, wait for pump to start (up to 30 seconds).

4. Verify that pressure is decreasing.

5. Wait for Pressure to fall below 1e-5 Torr to start measurement. (~20 minutes)

Venting to Atmosphere:

1. Open PfeifferRS485 program.

2. Verify that heater temperatures are below 160 C on both Digi-Sense Temperature Controllers before venting.

3. Check that Nitrogen Valve above system is open, if it is not then open it.

4. Hit “Stop Pump”, wait for pump to stop (1-2 seconds).

5. Wait for pressure to read 7.5E+02 Torr (10-20 minutes).

6. Raise bell jar 2-3 inches using hoist control, remove pin on hoist arm, swing aside

7. Remove sample if present and fill out log book.

8. If there are no users after you please close the Nitrogen valve.
Other Notes:

1. Verify that heaters are off before leaving for the day. If heaters are accidentally left on at high temperatures damage can occur to the probes and bell jar. Do not trust the computer to turn off heaters as computer freezes and programming glitches can occur. If in doubt whether the heaters are off turn Digi-Sense controllers off from the switch in the back. This will ensure the heaters are off.

2. It is OK to leave system pumping overnight to allow copper blocks to cool, but make sure that samples are removed before next the next user’s time slot.

3. Maximum heater temperature is 600 C, but you must be present to monitor probe temperature when above 500 C. If probe temperature is greater than 50 C, you must turn off the heaters to prevent damage. If you wish to go above 600 C contact person in charge of tool.

4. Pressure must be below 1e-5 Torr when above 160 C to prevent oxidation of copper blocks.

For Questions or Problems Contact:

Alex Sztein
asztein@umail.ucsb.edu

Peter Burke
peterburke@umail.ucsb.edu
PHOTOVOLTAIC MEASUREMENTS

Standard operating procedures are currently under development.

For Questions or Problems Contact:

Chieh-Ting (Tony) Lin
clin01@umail.ucsb.edu

Emmett Perl
emmettperl@ece.ucsb.edu