

SAFETY MANUAL

for use in the

CHEMICAL ENGINEERING JUNIOR LABORATORY CM3215



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PREFACE

This safety manual describes the safety program in the ChE Junior Laboratory at Michigan Technological University. The main objective of this safety program is to protect students and the community against adverse health effects or injury. The key to doing this is accident prevention. If the students follow the safety rules and operating procedures presented in this manual, the possibility of an accident will be greatly reduced. In the event of an accident, any harmful effects will be minimized by knowledge of the emergency and first-aid procedures presented.

The program is modeled after the Unit Operations (UO) Laboratory safety program and serves as an introduction to the UO Lab PAWS program. The PAWS safety program (Prevent Accidents With Safety) was initiated during the spring quarter 1989. The name of the program was suggested by Elizabeth A. Vary, a 1988-89 student in the Unit Operations Laboratory; various aspects of the program were suggested by other students of the Class of 1989. The program is a combination of features used in the SOAR (Stop, Observe, Act and Report) program at the BASF Corporation and the Praise Positive Program at the Dow Chemical Company.

This manual contains information on: policies, procedures, rules and regulations that must be followed; the safety precautions for each of the experiments in the laboratory; the potential hazards of the chemicals used; proper procedures for operating equipment in the laboratory; proper use of the safety equipment; and emergency procedures.

In case of Emergency
DIAL 911
on the Laboratory
telephone or on a cell
phone

A. Introduction

The objective of this safety program is to provide sufficient information to the students in the ChE Junior Laboratory so that they will follow safe procedures for operating equipment, use proper procedures in handling chemicals, and be prepared to deal with any emergency situations that may arise. It is absolutely essential that the students be thoroughly familiar with the material in this safety manual before starting any experimental work in the laboratory.

B. The “PAWS” Program – Prevent Accidents With Safety

The PAWS program helps to develop a safety community or culture within the laboratory. The key to the PAWS program is that the students in the laboratory bear the responsibility for their own safety and for the safety of those around them. In the ChE Junior Laboratory we use a scaled-down version of the Unit Operations PAWS program.

A student observing an unsafe act or condition is expected to correct the situation before an accident occurs. A PAWS Safety Report Form is to be filled out and submitted to the Laboratory Supervisor. (Blank PAWS Safety Report Forms are available in the appendix of this manual and on the web at www.chem.mtu.edu/~fmorriso/cm3215/WebPAWSform9%2710.pdf). The identity of the “perpetrator” of the unsafe act is not important and remains anonymous on the PAWS Safety Report Form. A PAWS Form is also submitted for accidents and “near misses,” for major spills, for laboratory evacuations, and for safety suggestions.

REMEMBER: The goal of the PAWS program is accident prevention. We will work diligently to protect the health and safety of all those involved in the ChE Junior Laboratory!

C. Safety Team

The Safety Team – Starting with experiment #2 of of the ChE Junior Laboratory, each laboratory period will have a two-person safety team (see the web for the assignments). The team has two jobs:

Safety Presenters – The team will be responsible for presenting a 3-5 minute summary of the key safety points associated with the current assignment. This presentation will take place in the laboratory before work commences on lab day.

Safety Coordination – The team will take a special interest in hazards identification/evaluation and in the safe operation of all the teams’ laboratory experiments. The Safety Team will be the last ones out of the lab, will close any open windows, and will verify that all equipment has been properly shut down and stored.

The Safety Team along with the TA will review any new PAWS reports, follow up on any open PAWS reports from previous experiment cycles, and post copies of any PAWS forms on the bulletin board inside the lab. The Safety Team must submit a Safety Report along with their laboratory report. These reports will be passed on to the subsequent Safety Team. An example safety team report is at this link:

www.chem.mtu.edu/~fmorriso/cm3215/SafetyReports/SafetyReportsFall2009/L02-4.pdf

The last week of the semester there will be a general safety review debriefing to discuss overall class/laboratory safety. An archive of the notes from previous years is on the web at this link: www.chem.mtu.edu/~fmorriso/cm3215/SafetyReviewNotes.html.

D. The Michigan Right-To-Know Law

As applied to the ChE Junior Laboratory, the Michigan Right to Know Law requires:

1. Identification of both containers and pipelines holding hazardous chemicals. Unlabeled and unknown containers of chemicals and chemicals without an SDS must be considered to be a hazardous chemical. (Note that this is equivalent to requiring that all containers and pipelines holding even innocuous chemicals be labeled).
2. A Safety Data Sheet (SDS) must be available to the employees for each hazardous chemical in the workplace. The SDS contains information on the health and safety hazards (health effects, fire hazards, and reactivity) of the chemical, proper handling procedures, protective equipment required for safe handling of the chemical, and first aid and spill procedures. SDS for the laboratory are located in the drawer next to the safety shower and eyewash station.
3. An employee training program. This must include information on the Michigan Right-To-Know Law and on an employee's rights under the law, a list of the hazardous chemicals used in the workplace, the location of the SDS's, and training in proper procedures and in the use of proper equipment for handling hazardous chemicals. Enrolled students will be treated as employees for the sake of compliance with the Michigan Right To Know Law.
4. This safety manual is a part of both the training program and the Written Hazards Communications Program required by the Right-To-Know Law. Information on hazardous chemicals, including their adverse effects and location in the laboratory, is included in this safety manual.
5. The coding system used on containers and pipelines will also be explained at the beginning of the semester. Students are expected to be familiar with the labeling system.

E. General Laboratory and Equipment Safety

1. Chemical Safety (See also J. Chemicals Used)
 - a) Use a Class B Fire Extinguisher for chemical fires (See F. Safety Equipment).
 - b) All containers must be labeled as to their contents and must have an NFPA diamond attached (see Appendix). Any chemical in an unlabelled container must be reported to the Laboratory Supervisor and be treated as a hazardous substance until identified.
2. Chemical Storage
 - a) No flammable, volatile chemicals are to be stored in laboratory.
 - b) ALL chemicals must be properly labeled.
 - c) Only chemicals listed on the door of the cabinet may be stored in the cabinet.
 - d) The teaching assistant (TA) must be notified of any new chemical placed in the chemical storage cabinet so that the SDS can be obtained and the chemical list updated.

3. Electrical Safety

- a) Power must be off before making electrical connections.
- b) Avoid splashing or spraying water on electrical connections, wall sockets, lights, and junction or power boxes.
- c) Keep extension cords away from traffic and water.
- d) Use 3-pronged plugs with a ground connection.
- e) Use a Class C Fire Extinguisher for fires involving electrical equipment.
(See J. Safety Equipment).

4. Glassware

- a) Always wear eye protection when using glassware.
- b) Take care in storing and in handling glassware.
- c) Discard or replace damaged glassware.
- d) Dispose of broken glass in the broken-glass container.
- e) For disposal of unbroken glassware, rinse clean with tap water, destroy label, and placed near the wastebasket for pickup.

5. Manometers

- a) Always wear eye protection when using the manometer.
- b) When connecting to pressure taps into the manometer, make sure the connection is secure.
- c) Prevent fluid from reaching the very top of the manometer.
- d) If the manometer fluid, Blue Fluid 175, is released, immediately notify the TA.
- e) When rolling the manometer into place or back to its storage position, use two hands to avoid tipping.

6. Personal Hygiene Practices

- a) Wash hands with soap before and after running an experiment.
- b) Wear gloves appropriate for the experiment. Clean reusable gloves after using them; dispose of disposable gloves.
- c) Cover any cuts or open wounds with clean, suitable material.
- d) Do not apply cosmetics while in the laboratory.
- e) Do not touch your eyes, mouth, nose, or face while in the laboratory.
- f) Use a pipette bulb; do not use your mouth to pipette.

7. Radios, Media Players, and Computer Games

- a) Listening to radios, MP3 players, etc., or wearing headphones is prohibited in the laboratory.
- b) Playing computer games or viewing DVDs is prohibited in the laboratory.
- c) Surfing the internet other than for laboratory-related purposes is prohibited in the laboratory.

8. Steam Lines and Condensate Lines

- a) Use insulated gloves for operating steam valves.
- b) Use a hard hat when working under the lab bench.
- c) Open valves slowly and only to the desired amount.
- d) Keep hands and clothing away from steam lines.
- e) Lines from steam traps should extend into the drain.

- f) Stay clear of condensate/steam discharge lines, especially during initial start up.
- g) At the end of lab day in which steam is used, follow this procedure: After closing all station main steam valves (SV-1), wait 15 minutes and then re-close each station's condensate gate valve (SV-2).¹

F. Safety Equipment

1. Eye-Wash Fountains

Use

- When there has been chemical contact with the eyes.

Operation

- Depress lever on right hand side of fountain (water pressure should pop the caps off).
- Place eyes in contact with water stream for 15-20 minutes.
- Important that eye lids are kept open. A second person should assist in holding the eye lids open.
- Contact lenses must be removed.

Maintenance

- Test weekly. Allow water to run until clear to flush out piping.
- The person performing the test should initial and date the tag. When the tag is full, replace it with a new one from the UO lab office.

Location: North side of door.

2. Safety Showers

Use

- When chemicals have splashed or spilled onto someone.
- Clothing fires.

Operation

- Pull chain suspended beside the shower.
- The quick-acting valve will deluge the victim with water.
- Clothing should be removed for a major spill.

Maintenance

- Test weekly. Allow water to run until clear to flush out piping.
- The person performing the test should initial and date the tag. When the tag is full, replace it with a new one from the UO lab office.

Location: North side of door.

3. Fire Extinguishers

Use

¹ When a steam valve is closed it is hot. As it cools it will shrink and the valve seat will start to leak steam. The seat will erode if this is left like that for long periods. If you wait about 15 minutes until after it cools down some, then tighten the valve handle, it will stop the steam leak and prevent seat erosion. This does not apply to ball valves where they are used in a steam shut-off application (D. Caspary, 5Sept2013).

-Small fires

Operation

- Remove from wall.
- Pull pin.
- Point at base of flames.
- Squeeze handle.
- Sweep extinguisher back and forth and advance toward the flames.

Types

- All fire extinguishers in the Laboratory are Class ABC.
- Class A - Wood, cloth, paper, and/or rubber fires.
- Class B - Gas, liquid, and grease fires.
- Class C - Fires involving energized electrical systems.

Location: South side of door.

Maintenance: Annual inspection by University Safety workers (see tag)

4. First-Aid Kits

The first-aid kit contains a variety of supplies to treat injuries that might be expected in the lab.

Use

- To treat minor laboratory injuries. Report all injuries to the TA.

Location: South side of door.

5. Fire Alarms

Use

- Sound an alarm throughout the building in the case of a fire, chemical release, or other emergency requiring building-wide evacuation.

Operation

- Pull the red handle.

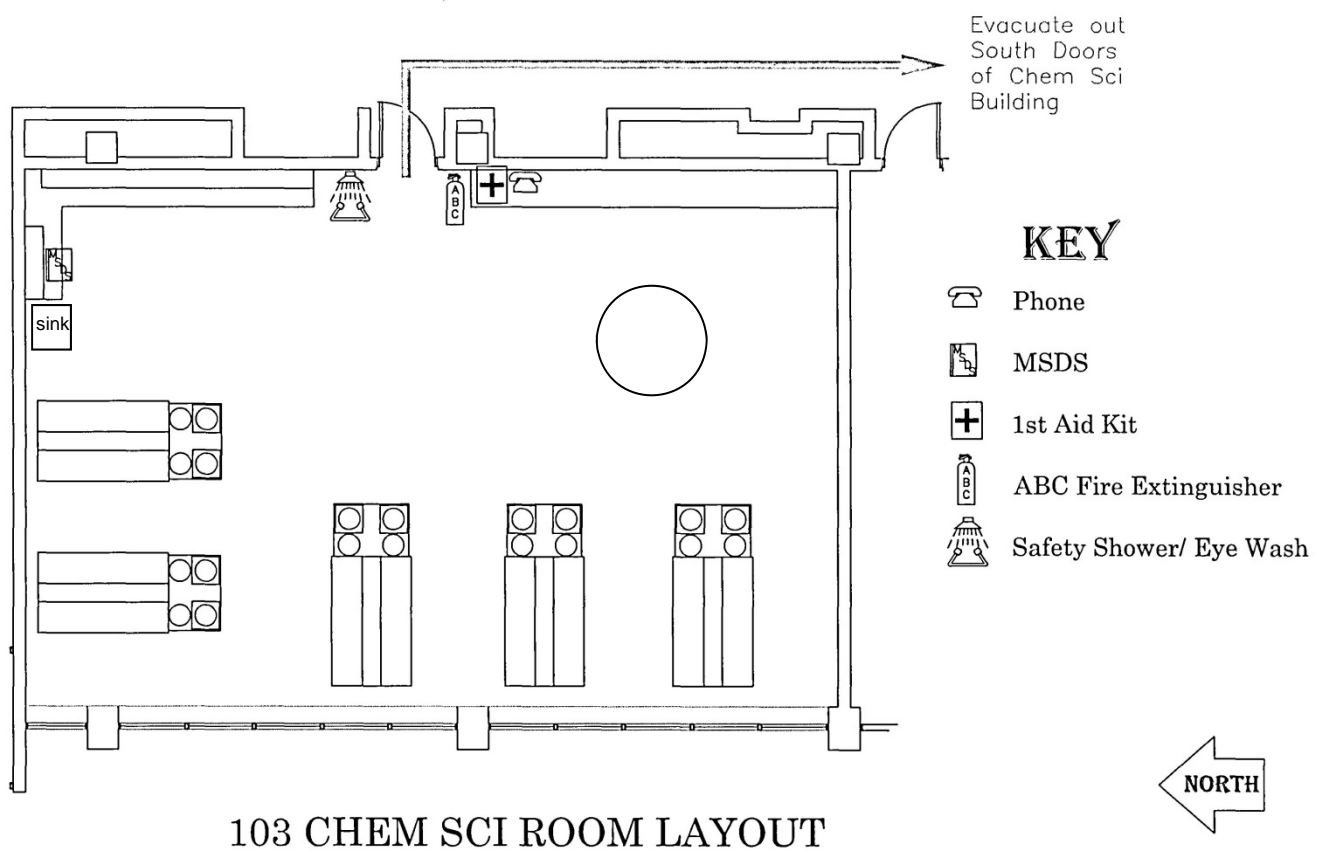
Location

- On the wall in the *hallways* on every floor near every building exit.

G. Laboratory Safety Rules

1. The lab is open during scheduled lab hours. Equipment may only be operated during scheduled lab times.
2. No equipment is to be operated without the approval and supervision of the instructor or the TA. Only the equipment pertaining to the assigned experiment is to be operated.
3. The appropriate personal protective equipment (PPE) must be worn at all times. PPE for the laboratory when in session includes safety glasses with side shields or safety goggles, closed-toe shoes, a shirt that covers the entire torso, and long pants. Neckties, dangling clothing or jewelry, and other unsafe items are prohibited. Long sleeved shirts are recommended. Hard hats are required for portions of the heat exchanger laboratory.
4. Keep cabinet doors and drawers closed when not actively in use to avoid accidental bumping.
5. Sleeping is prohibited in the laboratory. Violation of this rule will result in dismissal from the laboratory for that day and an unexcused absence.
6. Horseplay of any sort is absolutely prohibited in the laboratory.
7. Eating, drinking, and chewing gum are prohibited in the laboratory. Water bottles and food in backpacks must not be accessed while in the laboratory.
8. Smoking and open flames are prohibited in the laboratory.
9. All safety precautions must be followed at all times.
10. Equipment must always be attended when it is operating. On the rare occasion when equipment is to be operated unattended, an "Unattended Equipment/Experiment Operation Notice" must be posted on the outside door.
11. The laboratory floor must be kept dry, clean, and uncluttered at all times. Any spills should be cleaned up immediately. Book bags and backpacks, should be placed on a chair, or on a counter. coats and hats should be placed on the coat rack.
12. The students are expected to be familiar with the safety aspects of all the chemicals used in the laboratory and with the coding system used to label containers and pipelines.
13. Any accident or hazardous situation must be reported to the TA immediately and a PAWS form should be filled out.
14. Any "serious" violation of any of these safety rules may lead to immediate dismissal from the course. A person who repeatedly disregards the safety rules will be called in for consultation with the course instructor. A penalty that suits the violations may be imposed and, at the discretion of the course instructor, the student's grade may be lowered.
15. Windows to the laboratory may be opened but must be closed at the end of the lab period; this is to be verified by the Safety Team.

H. Laboratory Layout



I. Individual Experiments

1. Pressure Measurement and Calibration of the DP Meter

Safety

Review safety aspects of manometer.

Review SDS for Blue Fluid 175.

Review safety aspects of using glassware; dispose of broken glassware in the broken-glass box.

Follow three-point rule for ladder safety.

Additional PPE Required – Use proper gloves when measuring the density of Blue Fluid 175.

Emergency Shutdown

- a) Shut off DP cell using DC power switch on grey box – located on south side wall. Use left-hand rule.
- b) Disconnect DP cell tubing.

2. Measure Viscosity

Safety

Electrical hazard: outlet near the constant temperature-controlled water baths.

Review safety aspects of using glassware; dispose of broken glassware in the broken-glass box.

Additional PPE Required – N/A

Emergency Shutdown – N/A

3. Calibrate Rotameter and Explore Re

Safety

Check for water leaks (slip hazard). Report any leaks/spills to the TA immediately.

Additional PPE Required – N/A

Emergency Shutdown

- a) Turn off pump P-01; grey switch next to AC outlet
- b) Close main water valve, WV-10
- c) Open the drain valves for tanks T01 and T02

4. Frictional Losses in a Straight Pipe

Safety –

Check for water leaks (slip hazard). Report any leaks/spills to the TA immediately. Follow three-point rule for ladder safety.

Additional PPE Required – N/A

Emergency Shutdown

- a) Turn off pump P-01; grey switch next to AC outlet
- b) Close main water valve, WV-10
- c) Open the drain valves for Tanks T01 and T02
- d) Disconnect DP cell tubing and multimeter

5. Characterization of a Pneumatic Control Valve

Safety –

Check for water leaks (slip hazard). Report any leaks/spills to the TA immediately. Ensure that the needle valve, WV-5 is closed. If it is open, damage to the rotameter can occur. Follow three-point rule for ladder safety.

Additional PPE Required – N/A

Emergency Shutdown

- a) Turn off pump, P-01; grey switch next to AC outlet
- b) Close main water valve, WV-10

6. Analysis of a Centrifugal Pump

Safety –

Check for water leaks (slip hazard). Report any leaks/spills to the TA immediately.

Additional PPE Required – N/A

Emergency Shutdown

- a) Turn off pump P-01; grey switch next to AC outlet
- b) Close main water valve, WV-10
- c) Open the drain valves for Tanks T01 and T02
- d) Disconnect DP cell tubes and multimeter

7. Heat Transfer Coefficient for Heat Exchanger

Safety –

- Ensure water is flowing through the heat exchanger before running the experiment.
- Outlet water temperature should not exceed 120°F (50°C)
- Follow three-point rule for ladder safety.

Additional PPE Required –

Insulated Gloves: Always wear insulated gloves when adjusting the steam valve, when touching uninsulated piping, or when handling condensate. Hard hats are required due to need to crawl under the lab bench.

Emergency Shutdown –

- Close regulator to the steam valve
- Close main steam valve, SV-1
- Turn off pump, P-01; grey switch next to AC outlet
- Close main water valve, WV-10

J. Chemicals Used

- Non-Hazardous Chemicals – The following chemicals can be considered to be non-hazardous because of their characteristics or because the volumes used are very small. However, the normal precautions used in handling any chemical should be taken and good personal hygiene practices should be followed. The general first-aid procedures for skin and eye contact, for ingestion, and for inhalation should be applied. Consult the SDS for further information.

Chemical	Where Used & Comments
Blue Fluid 175	Pressure measurement
Sucrose	Viscosity measurement
Acetone	For classware drying; Pressure measurement, Viscosity measurement

K. Safety References

- Occupational Safety and Health Administration, *Code of Federal Regulations, 29 CFR 1910*, U.S. Government Printing Office, Washington, DC.
- Safety Manual for use in the Chemical Engineering Unit Operation Laboratory CM 4110 and Plant Operations Laboratory.
http://www.chem.mtu.edu/chem_eng/resources/safety/images/SafetyManual2008.pdf
- Crowl, Daniel A. and Joseph F. Louvar, “*Chemical Process Safety: Fundamentals with Applications*,” (Prentice Hall: Englewood Cliffs, NJ, 1999).

APPENDICES

- A. PAWS Safety Form
- B. NFPA Diamond
- C. Unattended Equipment/Experiment Operation Notice

MICHIGAN TECH UNIVERSITY
DEPARTMENT OF CHEMICAL ENGINEERING
CHEMICAL ENGINEERING JUNIOR LABORATORY



PAWS
Prevent Accidents With Safety



Unsafe Acts:

- Chemical Safety problem
- Improper PPE
- Unsafe Act in Lab or Improper Use of Equipment
- Other: _____

Equipment or Facility Problems:

- Violation of Hazard Communication Standard
- Leaks
- Safety Equipment problem
- Electrical problem
- Faulty Equipment
- Hot Surfaces
- Odors
- Missing Guards

Safety Suggestion (describe below)

Explanation (where, when, how, what, experiment name, etc.):

Action Taken:

Your Name: _____

Date: _____

NFPA Diamond

NFPA = National Fire Protection Agency



“The mission of the international nonprofit NFPA is to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating consensus codes and standards, research, training, and education. NFPA membership totals more than 81,000 individuals from around the world and more than 80 national trade and professional organizations.”

www.nfpa.org


CM3215 Fundamentals of Chemical Engineering Laboratory

<http://www.ilpi.com/msds/ref/nfpa.html>


	<p style="text-align: center;">Health Hazard</p> <p>4 Very short exposure could cause death or serious residual injury even though prompt medical attention was given.</p> <p>3 Short exposure could cause serious temporary or residual injury even though prompt medical attention was given.</p> <p>2 Intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical attention is given.</p> <p>1 Exposure could cause <u>irritation</u> but only minor residual injury even if no treatment is given.</p> <p>0 Exposure under fire conditions would offer no hazard beyond that of ordinary <u>combustible</u> materials.</p>
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	<p style="text-align: center;">Flammability</p> <p>4 Will rapidly or completely vaporize at <u>normal pressure and temperature</u>, or is readily dispersed in <u>air</u> and will burn readily.</p> <p>3 Liquids and solids that can be ignited under almost all ambient conditions.</p> <p>2 Must be moderately heated or exposed to relatively high temperature before ignition can occur.</p> <p>1 Must be preheated before ignition can occur.</p> <p>0 Materials that will not burn.</p>
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<http://www.ilpi.com/msds/ref/nfpa.html>

	Instability¹
4	Readily capable of detonation or of <u>explosive decomposition</u> or reaction at <u>normal temperatures and pressures</u> .
3	Capable of detonation or <u>explosive</u> reaction, but requires a strong initiating source or must be heated under confinement before initiation, or <u>reacts explosively with water</u> .
2	Normally unstable and readily undergo violent <u>decomposition</u> but do not detonate. Also: may <u>react violently with water</u> or may form potentially <u>explosive mixtures</u> with water.
1	Normally stable, but can become unstable at elevated temperatures and pressures or may <u>react with water with some release of energy</u> , but not violently.
0	Normally stable, even under fire exposure conditions, and are not reactive with water.

¹ Prior to 1996, this section was titled "Reactivity". The name was changed because many people did not understand the distinction between a "reactive hazard" and the "chemical reactivity" of the material. The numeric ratings and their meanings remain unchanged.

	Special Hazards
<p>This section is used to denote special hazards. There are only two NFPA 704 approved symbols:</p>	
OX	This denotes an <u>oxidizer</u> , a <u>chemical</u> which can greatly increase the rate of <u>combustion</u> /fire.
W	<u>Unusual reactivity with water</u> . This indicates a potential hazard using water to fight a fire involving this material.

Unattended Operation (from the Chemical Engineering Department Safety Manual)

Unattended operation of equipment in the laboratory is discouraged since hazardous situations might develop that would normally not present a significant problem if someone were in the laboratory to correct the problem. This includes equipment leaks, failed bearings, overheated equipment, hose failures, and so forth. Furthermore, power or water failures might initiate hazardous situations.

Some equipment may operate with minimal hazard in unattended mode. A form is provided on the following page that must be completed and posted on the laboratory door for unattended operation. This form provides emergency response information, utility information, and contact information in the event of a problem.

*Michigan Technological University
Department of Chemical Engineering*

Unattended Equipment/Experiment Operation Notice

This form is to be filled out and posted on the outside of the laboratory door whenever an experiment is left running at night or over the weekend if that experiment could become hazardous during unattended operation.

Room Number _____

Building _____

Start Date _____

End Date _____

(This notice will automatically terminate one week from start date unless and end date is specified.)

IN CASE OF EMERGENCY, PLEASE CALL:

Name _____

Name _____

Phone _____

Phone _____

If possible, THE UTILITIES CHECKED BELOW SHOULD BE SHUT OFF IF AN EMERGENCY OCCURS:

_____ Electricity

_____ Water

_____ Bottled Gas

_____ Steam

_____ Natural Gas

Type _____

_____ Vacuum

_____ Air

Location _____

The electrical breakers for this equipment are located in _____

And labeled _____

THE FOLLOWING UTILITIES SHOULD NOT BE SHUT DOWN: _____

The following special precautions should be taken:

Signature