SAFETY MANUAL

for use in the

FUNDAMENTALS OF CHEMICAL ENGINEERING LABORATORY CM3215

Department of Chemical Engineering
Michigan Technological University
Houghton, Michigan 49931

Edited August, 2005 by D.W. Caspary
Revised September, 2007; 2010, 2011 by F. A. Morrison

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PREFACE

This safety manual describes the safety program in the Fundamentals of ChE Laboratory at Michigan Technological University. The main objective of this safety program is to protect students 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 Fundamentals of ChE 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 Fundamentals of ChE 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 Fundamentals of ChE Laboratory!

C. Safety Team

The Safety Team – Starting with experiment #2 of of the Fundamentals of ChE 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 a bulletin board inside the lab. The Safety Team must submit a Safety Report along with their laboratory report (counts as a quiz). 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 Fundamentals of ChE 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 MSDS 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 Material Safety Data Sheet (MSDS) must be available to the employees for each hazardous chemical in the workplace. The MSDS 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. MSDS 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 MSDS'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 MSDS 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 blue manometer fluid 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) 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) After closing main steam valves, wait 15 minutes and then re-close the valve.

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

-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.

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 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.

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.

11. The laboratory floor must be kept dry, clean, and uncluttered at all times. Any spills should be cleaned up immediately. Book bags, backpacks, should be placed on a chair, or on a counter. coats and hats should be placed on the coat rack.

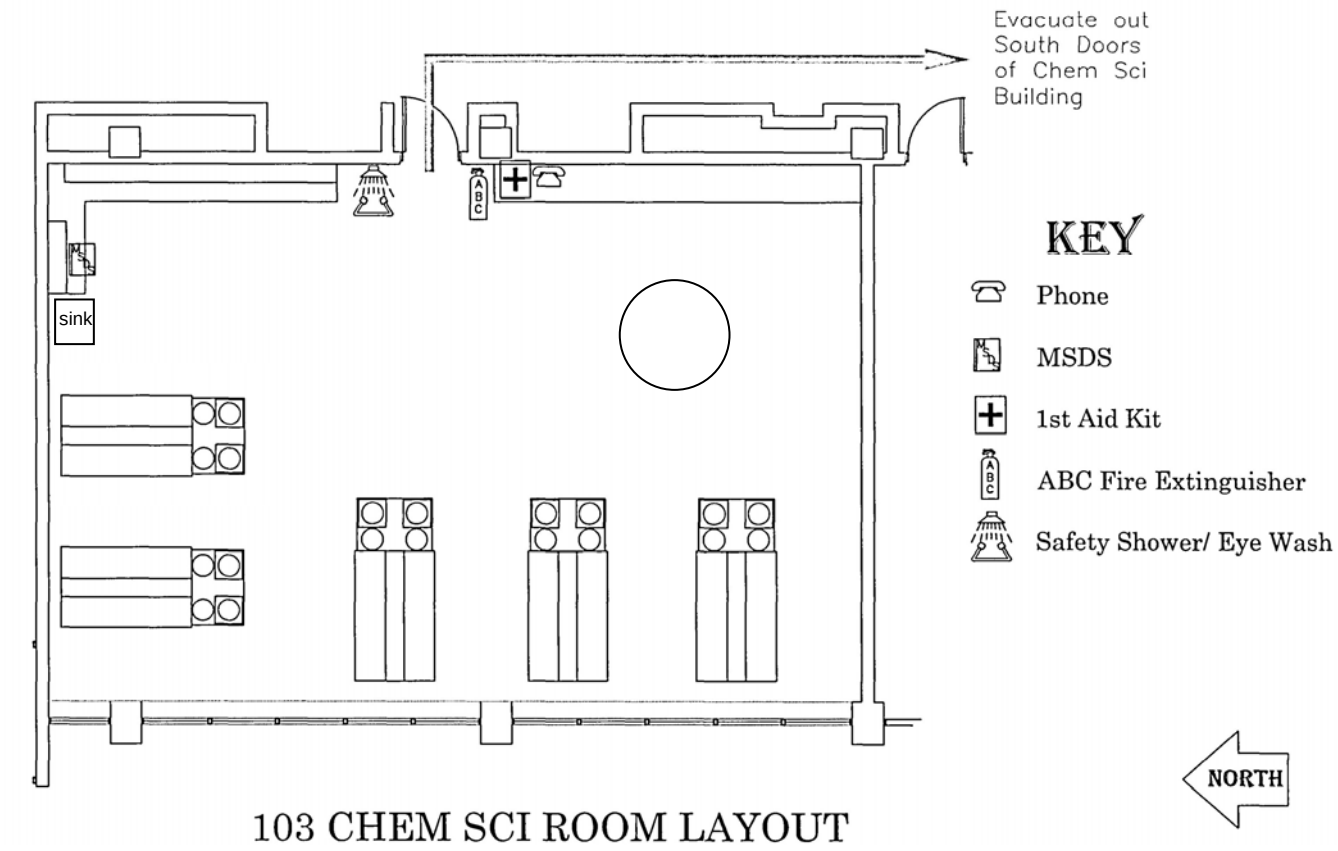
12. The students are expected to be familiar with the safety aspects of all the chemicals used in the laboratory and with the coding system used to label containers and pipelines.

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



103 CHEM SCI ROOM LAYOUT

I. Individual Experiments

1. Pressure Measurement and Calibration of the DP Meter

Safety
Review safety aspects of manometer.
Review MSDS 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.

Emergency Shutdown
a) Shut off DP cell using DC power switch on grey box – located on south side wall. Use left-hand rule.
b) Unplug DP cell from manometer.

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) Drain 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) Drain Tanks T01 and T02
d) Disconnect DP cell cables 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) Drain Tanks T01 and T02
d) Disconnect DP cell cables 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 –

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

J. Chemicals Used

1. 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 MSDS for further information.

Chemical	Where Used & Comments
Blue Fluid	Pressure measurement
Sucrose	Viscosity measurement
Acetone	Pressure measurement Viscosity measurement

K. Safety References

1. Occupational Safety and Health Administration, *Code of Federal Regulations, 29 CFR 1910*, U.S. Government Printing Office, Washington, DC.

2. 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*

3. 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

MICHIGAN TECH UNIVERSITY
DEPARTMENT OF CHEMICAL ENGINEERING
FUNDAMENTALS OF CHEMICAL ENGINEERING LABORATORY

PAWS

Prevent **A**ccidents **W**ith **S**afety

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

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

Health Hazard	
4	Very short exposure could cause death or serious residual injury even though prompt medical attention was given.
3	Short exposure could cause serious temporary or residual injury even though prompt medical attention was given.
2	Intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical attention is given.
1	Exposure could cause irritation but only minor residual injury even if no treatment is given.
0	Exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials.

Flammability	
4	Will rapidly or completely vaporize at normal pressure and temperature, or is readily dispersed in air and will burn readily.
3	Liquids and solids that can be ignited under almost all ambient conditions.
2	Must be moderately heated or exposed to relatively high temperature before ignition can occur.
1	Must be preheated before ignition can occur.
0	Materials that will not burn.

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

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

This section is used to denote special hazards. There are only two NFPA 704 **approved** symbols:

OX This denotes an oxidizer, a chemical which can greatly increase the rate of combustion/fire.

W Unusual reactivity with water. This indicates a potential hazard using water to fight a fire involving this material.