Safety Orientation

for

Faculty, Staff, and Students

Includes Hazard Communication Program

Contains Portions of MTU Safety Manual

First class education and research, done safely, in an environmentally conscientious manner

Department of
Mechanical Engineering – Engineering Mechanics

Michigan Technological University

Last Update Aug 2007

Turn Page For Emergency Information

WHAT TO DO IN AN EMERGENCY

If an MTU employee, student, or visitor becomes seriously ill or injured on campus:

- If life threatening, or if you are in doubt, call MTU PUBLIC SAFETY at 911 using any campus phone.
- Dialing 911 directly links MTU Public Safety. By going outside the MTU system (8-911), the call will be answered by Michigan State Police in Negaunee and the communications will be routed back to Houghton / MTU Public Safety.
- If an office or lab phone is not available, call 911 from any red emergency phone located near most MEEM elevators, or a "blue-ligthted" phone located around the campus.
- Request an ambulance and provide any additional information about the nature of the emergency, remain calm. If an ambulance is requested, inform the dispatcher that the ambulance must arrive at the FRONT of the MEEM building. The back gates may be closed.
- In the event of a major chemical spill, notify the dispatcher who will also notify MTU Occupational Safety and Health Services.

Other Important Phone Numbers

	Campus Phone	Off Campus
Emergency	**911**	**911**
MTU Occupational Safety	7-2118	487-2118
MTU Public Safety (NON-Emergency)	7-2216	487-2216
MTU Central Heating Plant	7-2707	487-2707
Poison Control Center	8-1-800-222-1222	1-800-222-1222
Poison Crisis Line	8-1-800-356-3232	1-800-356-3232

EMERGENCY RESPONSE
(Every Situation is Unique)

FIRE

- Eliminate the source of the fire (shut down equipment, for example) only if this can be done without endangering yourself.
- Extinguish the fire only if this can be done without endangering yourself.
- If not, evacuate the area immediately and PULL THE FIRE ALARM and DIAL 911 on any campus phone. Help any other person in need of evacuating the area.
- Evacuate the building by stairs but remain in the vicinity to provide information to emergency responders.

SMOKE

- If smoke is visible in the hallway or laboratory, and it is not obvious where it is coming from, DO NOT INVESTIGATE.
- PULL THE FIRE ALARM and DIAL 911 on any campus phone.
- Evacuate the area and the building by stairs but remain in the vicinity to provide information to emergency responders.
- If you only smell smoke, attempt to find the source and report it or pull the alarm if in doubt, but never allow yourself to be trapped in an area without an immediate exit. When in doubt, evacuate and pull the alarm.

EVACUATION

- All personnel are REQUIRED to evacuate the building via stairs if the fire alarm sounds. Emergency exit stairs are at each end (east and west) of the MEEM building. DO NOT USE THE ELEVATOR.
- After leaving the building, remain in the area outside the building (at least 100 feet away) and attempt to account for those who you know were in the building. The meeting area is between the MEEM building and the Memorial Union Building in the vicinity of the clock.
- Faculty are responsible for ensuring that students under their direct control are evacuated, such as during a class.
- Those who need assistance are to wait until others have evacuated so as not to cause delays at exits and stairs. Persons in wheel chairs or who are unable to use stairs are to be assisted to a safe refuge area, a landing of an emergency stairway. A designated person will direct emergency personnel to the location of anyone needing assistance in a safe refuge area.
- Do not re-enter the building until notified by a Public Safety Officer.

HAZARD COMMUNICATION PROGRAM

(29 CFR 1910.1200)

It is the obligation of every employer to provide a safe work environment for their employees, and safe tools with which to conduct that work. It is also the employer's responsibility to make employees aware of hazards in the workplace and how to avoid or minimize the risk from those hazards.

It is the obligation of every employee to conduct themselves and their work in a safe manner and in such a way that they are not a hazard to themselves, co-workers, or property. It is the responsibility of employees to bring to the attention of their supervisors conduct or situations that present increased risk.

Therefore, the burden of providing a safe work environment lies upon the faculty, lab support staff, and supervisor (employers) of a laboratory or area, whether it is a research lab, a teaching lab, or a public area. Students are considered employees of their advisors and/or instructors. Office or computer staff may be both employers and employees depending on their supervisory role.

Summary of Requirements

- Those portions of 29 CFR 1910.1200 (OSHA) that form the basis of this Hazard Communication Program (HCP) are provided in ***Appendix A***. The following is a condensation of that information, and should not be regarded as the CFR in its entirety.

- For the purpose of this HCP, the term employer includes faculty, staff, administration, or anybody in a supervisory role.

- For the purpose of this HCP, the term employee includes staff, paid or unpaid students, or anybody in a supervised role.

- A chemical hazard means any chemical that presents a health hazard (such as acetone or sulfuric acid).

- A physical hazard means any material, tool, or apparatus that presents a physical injury hazard (such as an unprotected razor knife or a hot exhaust pipe).

- An energy hazard means a material or apparatus that through the uncontrolled release of energy presents a hazard (such as rotating machinery, elevated weight, or pressurized gas).

- Items encountered in MEEM labs may be a combination of the three types of hazards summarized above and must be accorded the safety measures for each hazard type.

Hazard Determination

- The determination whether a chemical presents a health hazard is based on Material Safety Data Sheets (MSDS) shipped with the chemical. Definitions of some of the terms used in the MSDS are located in ***Appendix B.***

- Physical hazards will be determined through sound judgment by anticipating reasonably foreseeable circumstances.

- Energy hazards will be determined through sound judgment by anticipating reasonably foreseeable circumstances.

- It is not possible to list all possible hazards, therefore employers and employees must be diligent, must plan out activities, and must have the reasonable foresight to determine possible risks under normal, abnormal, and emergency conditions. They must then eliminate or reduce those hazards to an acceptable or manageable level.

Employee Information and Training

- The MEEM Chair will be responsible for ensuring that initial and refresher training is performed by the Chair's designee.

- Training will be performed by immediate supervisors. The Chair, Safety Committee, or designee will train faculty and staff on the elements of this Hazard Communication Program. Faculty or staff will perform training of students under their supervision. Records of all training will be maintained by the MEEM Department.

- Each hazardous procedure or situation should be evaluated using the Risk Assessment Matrix on the following page. This is particularly applicable for procedures that have not been previously performed or evaluated.

MEEM Safety Committee

MEEM Charter Safety Committee Charge – *To institute responsible safety practices for the MEEM department.*

The MEEM Safety Committee does not police the MEEM labs and work areas. It is the responsibility of supervisors to police their respective areas. The MEEM Safety Committee will make general safety suggestions through safety audits and general training.

The MEEM Safety Committee does not provide technical guidance to supervisors concerning safety in their respective areas. It is the responsibility of supervisors to obtain current information on safe and legal safety practices. The MEEM Safety Committee will make general safety suggestions through safety audits and general training.

The MEEM Safety Committee does not enforce safety policies. It is the responsibility of the Chair to enforce safety practices and procedures. The MEEM Safety Committee will make general safety suggestions through safety audits and general training.

Risk Assessment Matrix

Severity of Injury

SEVERITY FREQUENCY	CATASTROPHIC Death or permanent total disability	CRITICAL Disability in excess of 3 months	MARGINAL Minor injury, lost workday	NEGLIGIBLE First aid or minor treatment
FREQUENT Likely to occur	HIGH	HIGH	SERIOUS	MEDIUM
PROBABLE Likely to occur several times	HIGH	HIGH	SERIOUS	MEDIUM
OCCASIONAL Likely to occur sometime	HIGH	SERIOUS	MEDIUM	LOW
REMOTE Not likely to occur	SERIOUS	MEDIUM	MEDIUM	LOW
IMPROBABLE Very unlikely; may assume exposure will not happen	MEDIUM	LOW	LOW	LOW

HIGH	OPERATION NOT PERMISSIBLE
SERIOUS	HIGH PRIORITY – REMEDIAL ACTION REQUIRED
MEDIUM	TAKE REMEDIAL ACTION AT APPROPRIATE TIME
LOW	RISK ACCEPTABLE – REMEDIAL ACTION DISCRETIONARY

GENERAL PROCEDURES AND PRACTICES

It is well established that there is a basic three-tier hierarchy to preventing accidents.

Step 1: Eliminate the hazardous nature of the situation. Redesign the experimental setup or use safer materials, for example.

Step 2: If the hazard can not be eliminated, then guard against the hazard by means of engineering controls, personal protection equipment, interlocks and guards, for example.

Step 3: If you guard against the hazard, you must also warn users (employees) that a hazard is present and users must be trained on the proper use of the controls, guards, and procedures.

GENERAL PROCEDURES

Engineering Controls

Engineering controls are the first and best defense against hazardous situations. Engineering controls are physical devices (not procedures) that help ensure that chemical, physical, and energy hazards are controlled. The greater is the consequence of a hazard, the greater is the need for engineering controls.

Examples of engineering controls include:

- Mechanical and/or electrical interlocks on a machine and/or its guards that render the machine inoperable unless the guard(s) are in place and/or closed;
- Mechanical and/or electrical interlocks that require one or more procedures to be completed, or one or more systems to be operating before the next step is allowed to take place (such as an engine exhaust system operating prior to starting the engine);
- Mechanical guards over/around rotating machinery or components;
- Solid or finely perforated metal shields placed around glass containers that operate at pressure other than ambient;
- Braided wire reinforcing around high pressure hydraulic hoses, leak deflection shields;
- Use of a fume hood;
- Door interlocks on acoustic chambers;
- Two-hands-required controls on powered presses and shears.

Training

Training that is not properly documented never took place. Agree or disagree, it is the law.

Supervisors will record the type of training, the training instrument used, the names of those trained, and the date of the training. **All employees will undergo training appropriate for the labs and areas in which they work.** A training form is in ***Appendix C.*** A copy of the training form will be sent to the MEEM Safety Committee for inclusion in the MEEM safety training records and a copy will be retained by the lab supervisor and placed in the Lab Safety Manual.

In the event of an incident or accident, the nature of the incident or accident will be recorded on the MTU OSHS Supervisor's Incident Report. A copy is in ***Appendix D***. All personnel involved will also be interviewed by one or more members of the MEEM Safety Committee. The purpose of the interview is to learn the circumstances of the incident or accident and to develop methods to mitigate it being repeated, not to lay blame. All students in the same or similar work, whether they were involved or not, will undergo re-training or formal notification by their immediate supervisor about the incident or accident. The purpose of this is to ensure that the incident or accident is not repeated by a different student.

Sole Occupancy

When working in a lab, leave the door open if possible so those passing by can see you. Should you become incapacitated and you are hidden behind a closed door, needed help may not arrive in a timely manner. The determination whether it is permissible to work alone in a lab is the responsibility of your supervisor. However, working in a lab where you must come into contact with personally hazardous chemicals (strong acid and bases, noxious gases, highly flammable materials, etc) you are prohibited from working alone. The other person is not required to be technically competent in your work but must be there, in visual or direct audible proximity, to help you should you become incapacitated. When in doubt, do not work alone.

Children in Laboratories

It is the policy of Michigan Technological University that children under the age of 12 are not permitted in work areas (e.g., offices, classrooms, shops), except those spaces specifically intended for public use, without the written permission of the department Chair or director. Children under the age of 12 who are not enrolled in a Michigan Tech class or program are not permitted in laboratories at any time. Children under the age of 16 must be under the direct supervision of the laboratory supervisor while visiting or participating in MTU sponsored activities in laboratories containing hazardous chemicals or equipment.

Laboratory Audits

In lieu of (or in addition to) safety audits conducted by OSHS personnel, the MTU Safety Committee will conduct periodic audits of MEEM laboratories. The audit will be preceded by notification of the lab supervisor and an invitation for the lab supervisor to accompany the audit team. The purpose of the audits is to help maintain safety in the laboratories and work areas of the department. It is not expected that an audit will identify all safety problems that may be present. The lab supervisor will be provided with a copy of the Safety Audit Checklist and a copy will be maintained as a part of the MEEM safety records. The lab supervisor is expected to

correct, or have corrected, the identified safety issues in a timely manner. Issues that are an immediate safety risk must be immediately corrected before the lab is used further. The Safety Audit Checklist is in ***Appendix E.***

Graduate Student Laboratory Exit Form

Upon completion of graduate degree requirements, an exit form shown in ***Appendix F*** must be completed and signed first by the MEEM Safety Officer or designee and then by the MEEM Chair. This form must be submitted at the time the oral examination scheduling form (M5 or D7) is submitted. The purpose of this form is to ensure that all chemicals and materials have been disposed of or are properly labeled and stored and that no known or unknown hazards remain from the research.

CHEMICAL HAZARDS

Chemical MSDS (Material Safety Data Sheet)

Regardless of how or from where a chemical is obtained, a MSDS copy must be forwarded to Chemical Stores including the location and quantity of the chemical, a copy must be forwarded to Jerry Dion in MEEM including the location and quantity of the chemical, and a copy must reside in the Lab Safety Manual in the laboratory(s) where the chemical is used and stored. MSDS placed in the Safety Manual must be easily and quickly retrieved in their entirety in the event of an emergency so they must be appropriately organized.

If a hazardous chemical is ordered through Chemical Stores or by a purchase order placed through the MTU Purchasing Department, then the MSDS will automatically be placed with Chemical Stores. Copies then must be placed with Jerry Dion and in the Lab Safety Manual.

Users of chemicals must be knowledgeable of the symptoms of exposure, limits of exposure, and measures to be taken in case of exposure. This information is found in the MSDS and it is the responsibility of the lab supervisor to ensure that employees understand this information.

During an emergency reading through MSDS takes valuable time. It is recommended that for particularly hazardous chemicals, the personal protection equipment (PPE), exposure symptoms, and first aid information be extracted from the MSDS and posted where the chemical is normally used or stored.

Container Labeling

The requirement for proper container labeling extends beyond the needs of the individual user since that user may not be present in the event of a fire, explosion, or spill. Container labels must be durable, legible, and informative.

The supervisor of each work area is responsible for ensuring that all containers received, stored, or used are properly labeled. Labels on incoming containers of hazardous chemicals may not be removed or defaced.

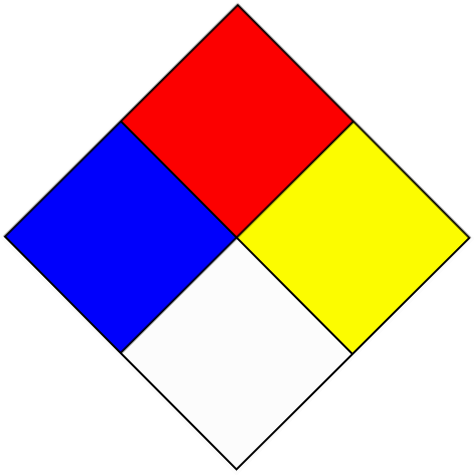
Container labels must include the chemical identity (name used in the chemistry lab) of the hazardous chemical, if known. If the chemical(s) identity is not known, the label must include the nature and use of the chemical (Hydraulic Oil – Petroleum Based) for example. Non-descript manufacturer's trade or marketing names are not acceptable.

The container must also display the date the chemical was obtained, the name of the student who uses the chemical, and the name of the lab supervisor responsible for the chemical. This applies to the original container as well as subsequent transfer and use-containers, and for water containers as well.

Labeled commercial bottled water will not be used as a source of water or other chemicals for any laboratory work.

Chemical Shipments and Containers

It is against federal law to ship or receive hazardous chemicals without proper training and handling. All hazardous chemicals must be ordered by and received by Chemical Stores. All shipments of hazardous materials must go through the MTU OSHS. Many chemicals and materials are shipped directly to the MEEM office. As appropriate, the outside of the box will be labeled with the NFPA (National Fire Protection Association) diamond. The printed box may not have the colors shown, but the information remains the same.



The top (red) section informs on the flammability hazard. The left (blue) section informs on the health or toxicity hazard. The right (yellow) section informs on the reactivity or corrosiveness hazard. The bottom (white) section informs on any other special hazard. Each section will contain a number from 0 to 4. The numbers signify: (0) very low; (1) slight; (2) moderate; (3) severe; (4) extreme. While no container should be mishandled, numbers 0-2 signify a relatively benign material.

Chemical Safety

While nearly all MEEM labs are not considered chemical laboratories, chemical hazards may be present.

See ***Appendix G*** for general guidelines on incompatible chemicals, particularly for storage.

Skin contact with all chemicals is to be avoided. Gloves suitable for the chemicals handled will be worn. Not all gloves are equal.

Employees will wash exposed skin immediately after handling hazardous chemicals.

Do not smell, taste, or touch any unknown chemical in an attempt to identify it. If the requirements for labels are followed, this should never present itself. Never use a mouth-siphon to initiate a transfer of a chemical.

Chemical and Hazardous Waste Disposal

There are strict environmental federal laws on the proper disposal of chemicals and materials. Just because you might discard of a substance in a particular manner off-campus does not mean it can be disposed in the same way on-campus. There are harsh penalties imposed for the improper disposal of chemicals and hazardous materials and these penalties may be imposed on the institution *and the individual.* The Chemical Disposal Form is located in ***Appendix H.***

Prior to the onset of projects that might generate waste, the following should be addressed:

- What is the waste composed of;
- Quantity of waste and frequency at which it will be generated;
- Location of generation and must it be transported to another on-campus site;
- Disposal method and cost of disposal.

All persons involved with handling hazardous wastes must be trained in safe handling, proper accumulation and storage procedures, and emergency and spill response procedures.

Hazardous waste must be properly labeled and safely stored at the general location where it was generated. In addition to the required content label, a hazardous waste label must be affixed and include the accumulation start date, and the EPA waste code. A sample label is in ***Appendix I.***

It is the responsibility of every MTU employee generating laboratory or other hazardous wastes, to dispose of them in compliance with all federal, state, local, and MTU regulations. Any MTU employee generating laboratory or other wastes should contact the office of Occupational Safety and Health Services for more information and assistance.

Frequently, the MSDS for a material will contain waste disposal and other information, which will help determine whether a waste might be regulated. Hazardous waste must be collected in containers which are compatible with the waste, do not leak, are kept tightly sealed except during filling, are identified with an approved hazardous waste label, and are under the direct control of the laboratory supervisor. Waste containers shall be separated according to compatibility either by distance or secondary containment.

To dispose of hazardous waste, a collection form must be completed and sent to Occupational Safety and Health Services. A copy of the collection form should be affixed to the containers listed on the form. After approval, Occupational Safety will remove the waste to the collection site for disposal. Occupational Safety and Health Services does not assume ownership of the wastes collected but provides a service to coordinate and assist in disposal. Responsibility for disposal, sampling, chemical analysis, and any other charges incurred as well as the accuracy of the information supplied to OSHS remains with the department requesting collection. Should the

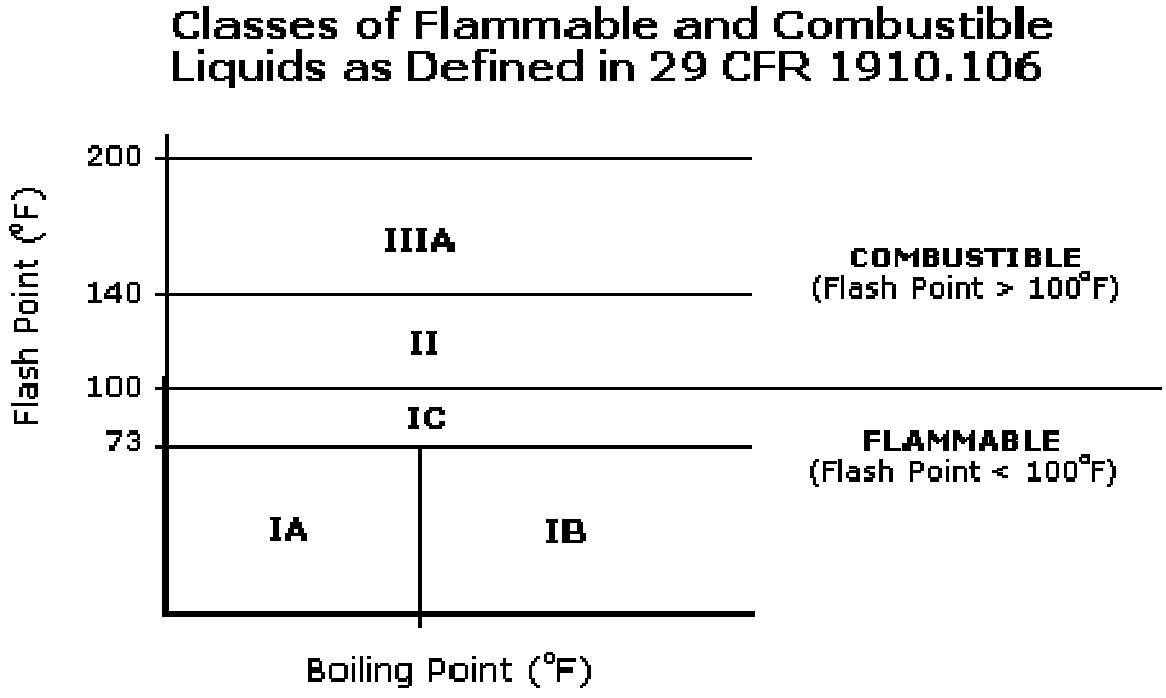
waste be found unacceptable by the disposal facility for any reason, it may be returned to the generator until suitable means for disposal can be arranged.

Occupational Safety and Health Services must be consulted as soon as possible and, preferably, prior to the generation of potential hazardous wastes in order to reduce disposal costs and ensure regulatory compliance. It is the financial responsibility of the lab supervisor to bear the expense for proper chemical disposal. Those funds should be planned into research grants and contracts, or personal incentive accounts.

Flammable Liquids in Laboratories and Chemical Storage Rooms

Several MEEM research and teaching labs use flammable fuels for internal combustion engines or other uses. The permissible amount of flammable material stored in a lab or approved storage area depends on the class (flash point temperatures). Flashpoint means the minimum temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid.

- Class IA flammable liquid – flash point below 73F (22.8C) and a boiling point below 100F (37.7C)
- Class IB flammable liquid – flash point below 73F (22.8C) and boiling point at or above 100F (37.7C)
- Class IC flammable liquid – flash point between 73F (22.8C) and 100F (37.7C)
- Combustible liquid – flash point at or above 100F
- Class II combustible liquid – flash point between 100F (22.8C) and 140F (60C).



Classes of Some Flammable Liquids
Class IA

Liquid		Flash Point (°F)	Boiling Point (°F)	Flammable Limits		Vapor Density Air = 1	PEL (ppm)
Common Name	Other Names			LEL	UEL		
1-1 Dichloroethylene	Vinylidene chloride	0	99	7.3	10.0	3.4	-
Ethylamine		<0	63	3.5	14.0	1.6	10
Ethyl Chloride	Chloroethane	-58	54	3.8	15.4	2.2	1000
Ethyl Ether	Ether	-49	95	1.9	36.0	2.6	400
Isopentane		<-60	82	1.4	7.6	2.5	-
Isopropyl Chloride	2-Chloropropane	-26	97	2.8	10.7	2.7	-
Methyl Formate		-2	90	5.0	23.0	2.1	100
Pentane		<-40	97	1.5	7.8	2.5	1000
Propylene Oxide		-35	93	2.8	37.0	2.0	100

Class IB

Liquid		Flash Point (°F)	Boiling Point (°F)	Flammable Limits		Vapor Density Air = 1	PEL (ppm)
Common Name	Other Names			LEL	UEL		
Acetone		0	134	2.6	12.8	2.0	1000
Benzene	Benzol	12	176	1.3	7.1	2.8	1
Carbon Disulfide	Carbon bisulfide	-22	115	1.3	50.0	2.6	20
1,2-Dichloroethylene	Acetylene dichloride	43	140	9.7	12.8	3.4	200
Ethyl Acetate		24	171	2.2	11.0	3.0	400
Ethyl Alcohol	Ethanol, Grain alcohol	55	173	3.3	19	1.6	1000
Ethyl Benzene		59	277	1.0	6.7	3.7	100
Gasoline		-45	100-399	1.4	7.6	3-4	-

Hexane		-7	156	1.1	7.5	3.0	500
Methyl Acetate		14	135	3.1	16	2.6	200
Methyl Alcohol	Wood alcohol, Methanol	52	147	6.7	3.6	1.1	200
Methyl Ethyl Ketone	MEK, 2-Butanone	21	176	1.8	10	2.5	200
Methyl Propyl Ketone	2-Pentanone	45	216	1.5	8.2	2.9	200
VM&P Naphtha	76 Naphtha	20-45	212-320	0.9	6.0	4.2	-
Octane		56	257	1.0	6.5	3.9	500
Propyl Acetate		58	215	2.0	8.0	3.5	200
Isopropyl Acetate		40	192	1.8	8.0	3.5	250
Isopropyl Alcohol	IPA, 2-propanol	53	180	2.0	12	2.1	400
Toluene	Toluol	40	232	1.2	7.1	3.1	200
Butyl Acetate		72	260	1.7	7.6	4.0	150

Class IC

Liquid		Flash Point (°F)	Boiling Point (°F)	Flammable Limits		Vapor Density Air = 1	PEL (ppm)
Common Name	Other Names			LEL	UEL		
Isoamyl Acetate	Banana Oil	77	288	1.0	7.5	4.5	100
Amyl Alcohol	Pentanol	91	281	1.2	10	3.0	
Butyl	Butanol	84	243	1.4	11.2	2.6	100
Methyl Isobutyl Ketone	MIBK, Hexone	73	246	1.4	7.5	3.5	100
Naphtha (Petroleum)	Mineral Spirits, Petroleum Ether	85-110	302-399	0.8	6.0	4.2	-
Propyl Alcohol	Propanol	77	208	2.1	13.5	2.1	200
Styrene (Monomer)	Vinyl Benzene	90	295	1.1	6.1	3.6	100
Turpentine		95	307-	0.8	-	-	100

			347				
Xylene	Xylol	81-115	281-291	1.1	7.0	3.7	100

Class II

Liquid		Flash Point (°F)	Boiling Point (°F)	Flammable Limits		Vapor Density Air = 1	PEL (ppm)
Common Name	Other Names			LEL	UEL		
Isoamyl		109	268	1.2	-	3.0	100
Cellosolve Acetate	2-Ethoxyethyl acetate	117	313	1.7	-	4.7	100
Cyclohexanone		111	313	-	-	3.4	50
Fuel Oil #1 & #2		100+	-	-	-	-	-
Fuel Oil #4		110+	-	-	-	-	-
Fuel Oil #5		130+	-	-	-	-	-
Kerosene		110-150	180-300	0.7	5.0	4.5	-
Naphtha (coal tar)		100-110	300-400	-	-	4.3	100
Naphtha (High Flash)	100 Naptha Safety Solvent, Stoddard Solvent	100-110	300-400	0.8	6.0	>4.2	500
Methyl Cellosolve	2-Methoxyethanol	115	255	2.5	14.0	-	25

Storage of flammable liquids within a laboratory shall be limited to that required for the operation of the laboratory in addition to the following restrictions for laboratories and chemical storage rooms.

- Containers of Class IA liquids shall not exceed one pint capacity for glass containers, one gallon capacity for metal or approved plastic, or two gallons capacity for safety cans.
- Containers of Class IB liquids shall not exceed one quart for glass containers, five gallons capacity for metal or approved plastic and safety cans.

- Containers of Class IC liquids shall not exceed one gallon capacity for glass containers, five gallons capacity for metal or approved plastic and safety cans.

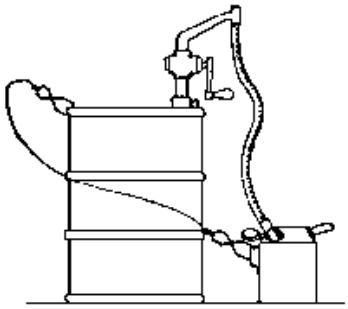
- Containers of combustible liquids shall not exceed one gallon capacity for glass containers, five gallons capacity for metal or approved plastic containers and safety cans, and 60 gallons for metal drums.

- Not more than five gallons of Class I flammable liquids, or 10 gallons for Class I flammable and combustible liquids combined per 100 gross square feet of floor space, shall be stored outside of a UL listed or Fire Marshall approved storage cabinet.

- The maximum total amount of flammable liquids stored inside and outside of approved storage cabinets may not exceed ten gallons of Class I flammable liquids, or 20 gallons for Class I and combustible liquids combined, per 100 gross square feet of floor space.

Grounding of Containers

In the workplace, OSHA requires the use of grounding procedures to eliminate the build up of static electricity while transferring Class I flammable liquids. Diesel fuel and gasoline both have relatively low electrical conductivity so containers and flow lines may not be at the same electrical potential.



When transferring flammable liquids from one container to another, the movement of the flammable liquid creates static charge. This occurs when transferring the liquid through a hose, pipe, or by pouring. The standard engineering control is a grounding system. This is accomplished by attaching a conductive wire between the containers maintaining both at the same electrical potential. The wire must then be suitably earth-grounded to electrical conduits or water pipes, for example. Gas mains and fire sprinkler pipes should not be used for earth ground.

Flammable and combustible liquid containers mounted in the laboratory shall have an earth ground. This may be accomplished by rigid attachment to a building column with all paint or coating removed, for example. Do not attach to a sprinkler pipe as it could be dry and not grounded.

Handling of liquids in plastic containers does not eliminate the possibility of fires caused by static discharge. Because attaching a wire to the outside of a plastic container may not dissipate the charge, metal containers are preferable. If plastic containers are used, they must be UL approved for the liquid that they contain and should be held in an earth-grounded metal support or cage with maximum area contact between the grounded metal and the exterior of the plastic container. The engine or other container into which the fuel flows must also be at the same potential through an earth-ground.

Refrigerators in the Laboratory

Refrigerators (and freezers) are important items of lab equipment and are common in research laboratories. Like many pieces of lab equipment, there are hazards associated with them. *Food or drink for human consumption must never be stored in a refrigerator containing laboratory chemicals and the refrigerator must have an appropriate exterior warning label affixed to it.*

Flammable Materials Stored in Lab Refrigerators/Freezers

A household or commercial refrigerator cannot be used for flammable materials storage because it has many sources of ignition: the thermostat, the interior light, the light switch on the door, and the defrost heater, among others. Most of these are found in the space being cooled. Also, self-defrosting units contain an internal drain that can permit internal vapors to flow into the compressor space below. A flammable-material storage refrigerator has all these sparking devices moved to the exterior of the unit. In the past, MTU Facilities modified conventional refrigerators for flammable storage. That is now prohibited.

If the refrigerator or freezer in your lab is not appropriate for flammables storage, this must be clearly marked.

Other Chemicals Stored in Lab Refrigerators/Freezer

Vapors from improperly sealed or broken containers can accumulate in the refrigerator. In some cases, the vapors may be toxic, causing excessive exposure to anyone opening the refrigerator door. Unless the material has a distinct or offensive odor, the individual may not be aware of this exposure. All lab personnel must be conscientious in properly sealing any containers stored in refrigerators and freezers. Covering beakers and flasks with aluminum foil or plastic wrap is not sufficient. Corks and glass stoppers are good as long as they form a tight seal. Screw-cap tops with a seal inside are much better.

Mercury Handling and Spill Clean-Up

Health Effects

Metallic mercury can be absorbed into the body by ingestion or inhalation. Mercury vapor is odorless, colorless, and tasteless. One milliliter of mercury can evaporate over time and raise levels in excess of allowable limits. Mercury poisoning from exposure by chronic inhalation produces a variety of symptoms including: (1) emotional disturbances, (2) unsteadiness, (3) inflammation of the mouth and gums, (4) general fatigue, (5) memory loss, and (6) headaches. In most cases of exposure by chronic inhalation, the symptoms of poisoning gradually disappear when the source of exposure is removed. Improvement may be slow and complete recovery may take years.

Storage and Handling

Because of the health effects of mercury and the extremely difficult and time-consuming procedures required to properly clean spills, every effort should be taken to prevent accidents involving mercury. Where possible, eliminate it from the laboratory.

Always store mercury in unbreakable containers and store in a well-ventilated area. When breakage of instruments or apparatus containing mercury is a possibility, the equipment should be placed in an enameled or plastic tray or pan that can be cleaned easily and is large enough to contain the mercury. Transfers of mercury from one container to another should be carried out in a fume hood over a tray or pan to confine any spills.

IF AT ALL POSSIBLE, the use of mercury thermometers and manometers should be avoided. If a mercury thermometer is required, many are now available with a Teflon coating that will prevent shattering. Always wash hands after handling mercury to prevent skin absorption or irritation.

Air Monitoring

Any mercury spill has the potential to generate airborne concentrations in excess of safe levels. Contact MTU Occupational Safety and Health Services at 487-2118 for air monitoring of the spill area BEFORE cleanup to determine the airborne concentration. Large spills or spills with elevated vapor levels may dictate cleanup by a qualified contractor.

Protective Clothing

For small spills, a lab coat, safety glasses, and gloves should be used. Gloves made of the following have been rated as excellent for protection against elemental mercury: (1) chlorinated polyethylene (CPE), (2) Polyurethane, (3) Viton, (4) Butyl Rubber, (5) Polyvinyl Chloride (PVC), (6) Nitrile Rubber, (also known by several brand names), and (7) Neoprene.

If mercury has been spilled on the floor, the workers involved in cleanup and decontamination should wear plastic shoe covers. The MTU Occupational Safety and Health Office should be called immediately if a spill is extensive enough to require workers to kneel or sit where mercury has been spilled since impermeable clothing will be required.

Cleanup of Spills

Special spill kits are available from a variety of sources. If a spill kit is purchased, follow the enclosed directions. Alternatively, a kit can be assembled with the following components:

- Protective gloves;
- Mercury suction pump or disposable pipettes to recover small droplets;
- Elemental zinc powder (or commercial amalgam material);
- Dilute sulfuric acid (5-10%) in a properly labeled spray bottle;
- Sponge or tool to work amalgam;
- Plastic trash bag;
- Plastic container (for amalgam);
- Plastic sealed vial for recovered mercury.

Major Spills

Any spill more than 10 grams is a large spill and should not be cleaned up by laboratory personnel. Alert the neighbors and clear the area. Close the doors behind the area and do not allow reentry. Call MTU Public Safety at 123 for immediate assistance. A large spill will require the use of special respiratory protection.

Minor Spills

- Isolate the area so that the mercury cannot be tracked around. Spilled mercury can spread a very long way.

- Wearing protective clothing, pools and droplets of metallic mercury can be pushed together and then collected by a suction pump or disposable pipette. Very small amounts can be picked up with adhesive tape. Store recovered mercury in a sealed plastic vial labeled "Mercury".

- After the gross contamination has been removed, sprinkle the entire area with zinc powder. Spray the zinc with the dilute sulfuric acid. (Or apply a commercial powder according to manufacturer's directions).

- Using the sponge or other stiff tool, work the zinc powder/sulfuric acid into a paste consistency while scrubbing the contaminated surface and cracks or crevices. To minimize contamination of housekeeping items, stiff paper may be used to assist in cleaning up the amalgam. After the paste has dried, it can be swept up and placed into the plastic container for disposal.

- Paper towels, shoe covers, sponges, and anything used for the cleanup should be placed in the trash bag to be disposed of as contaminated material.

- Wash hands thoroughly.

- Contact MTU Occupational Safety and Health Services for information regarding the disposal of mercury clean-up materials.

Liquid Nitrogen

Liquid nitrogen is frequently used in chemical research laboratories for the purpose of cooling. Liquid nitrogen is a valuable coolant because of its low boiling point, inexpensive price, and low toxicity. Liquid nitrogen has the advantage that it does not support combustion.

Handling Liquid Nitrogen

Cryogenic liquids such as liquid nitrogen can cause severe “burns” upon eye or skin contact. Splashes are common when handling liquid nitrogen and safety goggles must be worn at all times when working with this material. In fact, it is not unusual for spills and splashes of liquid

nitrogen to become trapped under rings, bracelets, watchbands, or inside gloves, and this can result in serious and painful injuries.

In addition loose protective gloves that can be easily removed in the event of a spill should be worn when handling liquid nitrogen (alternatively, potholders may sometimes be more convenient for handling small containers of cryogenic materials). Particular care must be taken to prevent un-insulated vessels containing liquid nitrogen from coming into contact with unprotected parts of the body, since extremely cold materials can become frozen to the skin such that separation is not possible without serious injury.

Containers for Liquid Nitrogen

The properties of some materials (including metals) change drastically when exposed to cryogenic liquids such as liquid nitrogen. Containers for such liquids must be selected carefully to ensure that they can withstand the temperatures and pressures to which they may be exposed. Liquid nitrogen is commonly stored in smaller vacuum Dewar flasks that should be taped to minimize the hazard in the event of an implosion.

Transportation

Inside buildings and from room to room, the best transport is by a Dewar that has carrying handles or is on wheels and that has a pressure relief valve or pressure venting lid. A wide-base Dewar which is stable on a wheeled cart qualifies as on wheels.

For short distances in hallways it is acceptable to hand-carry a pint (~ 500 mL) or smaller Dewar of nitrogen which has no handles, if and only if

- the Dewar is your only load (no books, no coffee, no other items), and;
- the vessel has a venting lid (a cork or loose stopper is fine), and;
- you are carefully watching for people who will run into you, and;
- the vessel is carried with both hands and as far away from your face as comfortably possible.

Dispensing Liquid Nitrogen

Liquid nitrogen must be dispensed only into smaller Dewars which either have carrying handles or are on wheels, and which have pressure relief valves or pressure venting lids. Persons filling Dewars must wear full length trousers/pants or full length apron, and footwear that covers the entire foot, along with goggles or face shield and cryo-gloves.

Persons filling a container must be in constant attendance to the filling operation.

PHYSICAL AND ENERGY HAZARDS

Standard Operating Procedures (SOP)

Operational checklists that are followed for each procedure are basic to critical operations. Complex procedures that are performed based on memory of a checklist are prone to incidents or accidents.

In addition to engineering controls, all equipment and associated systems that rely on operational steps being performed in a specific order during startup, normal operation, or shutdown will have a printed step-by-step SOP prominently displayed at the point(s) of operation of the equipment. Equipment users will purposefully follow the SOP checklist. Remember, tasks that are repetitive and performed without purposeful reliance on a SOP are highly prone to accidents.

Personal Protection

It is the responsibility of the lab supervisor to ensure that employees know of specific hazards (chemical and otherwise), what personal protection equipment (PPE) is required to be used, that PPE is available to the employee(s), that employees are trained on the proper use of the PPE, and the use of PPE is enforced.

It is the responsibility of the employee to properly use the PPE at all appropriate times and it is the responsibility of the lab supervisor to ensure that PPE is used.

- Eye protection (safety glasses) meeting ANSI Z87.1 is required for employers, employees, and visitors in a laboratory at times when eye protection is required in the laboratory.

- Ear protection appropriate for the frequency and intensity of acoustic emission will be worn when required in the laboratory.

- Contact lenses with safety glasses are permissible when required in a lab. However, there are locations on campus where contact lenses are prohibited. Generally, it is bad practice to use contact lenses when there is a chemical splash hazard, even though goggles and/or a face shield are used.

- Chemical splash goggles and/or full face shields shall be worn during chemical transfers and handling operations as conditions dictate.

- Bare feet are prohibited in any lab at any time. Sandals or open-web sneakers are prohibited in labs where chemical spills present a hazard.

- Lab coats or aprons will be worn when chemical spills present a hazard. Layers buy time in the event of chemical exposure.

- Thermal-resistant gloves that can be quickly removed will be worn while transferring cryogenic liquids or when working with exothermic reactions.

- Long hair and loose clothing, especially long sleeves, shall be confined close to the body to avoid being caught in moving machinery or equipment.

- It is a violation of MTU safety policy to use a respirator, including a paper dust mask, without prior approval by MTU OSHS.

Pressurized Gas Cylinders

Pressurized cylinders of gas may present chemical, physical, and energy hazards. The gas itself may be chemically hazardous and the fact that it is at high pressure presents an energy hazard. Gas cylinders stored or used in a laboratory will be secured to a rigid structure with proper cylinder brackets and chains / straps to reduce the physical hazard. A cylinder will not be unsupported and will not be leaned against a wall or corner.

Full cylinders are delivered to a central holding area adjacent to the MEEM machine shop on the Basement floor. Empty cylinders will be returned to that same area for disposition. Cylinders will be transported between this holding area and the specific laboratory location using a handcart specifically designed for the transport of gas cylinders. The cylinder(s) will be properly secured in the handcart. Cylinders will be properly labeled as Full, In Service, or Empty.

A cylinder will never be rolled (horizontal or vertical) to, from, or within a laboratory. Prior to any cylinder movement, the main cylinder valve will be closed and any secondary valves or regulators will be removed. The valve protector cap will be put in place.

Glassware and Disposal

All glassware will be handled and stored with care to minimize breakage. All broken glassware will be immediately disposed of in a broken glass container.

All evacuated or pressurized glass apparatuses shall be shielded to contain chemicals and glass fragments should implosion or explosion occur.

Unattended Operation

It is not unusual for a laboratory activity to take place over very long periods of time, either during the normal work day, at night, or both. It is recognized that unattended operation of certain equipment or processes is a necessary part of research. However, it must also be recognized that unattended operation of certain equipment or processes presents a hazard. Therefore, it is necessary for the lab supervisor to ensure that unattended operation can be accomplished without incident.

A completed Unattended Operation Notice (***Appendix J***) will be placed on the outermost door(s) of the laboratory, the laboratory doors will be locked, and the laboratory lights will remain on.

APPENDIX A

Portions of CFR 29 1910.1200 Represented by This Hazard Communication Program

The complete document can be found on the Department of Labor – OSHS website.

1910.1200(a)(2) Evaluating the potential hazards of chemicals, and communicating information concerning hazards and appropriate protective measures to employees, may include, for example, but is not limited to, provisions for: developing and maintaining a written hazard communication program for the workplace, including lists of hazardous chemicals present; labeling of containers of chemicals in the workplace, as well as of containers of chemicals being shipped to other workplaces; preparation and distribution of material safety data sheets to employees and downstream employers; and development and implementation of employee training programs regarding hazards of chemicals and protective measures.

1900.1200(b)(1) This section requires chemical manufacturers or importers to assess the hazards of chemicals which they produce or import, and all employers to provide information to their employees about the hazardous chemicals to which they are exposed, by means of a hazard communication program, labels and other forms of warning, material safety data sheets, and information and training. In addition, this section requires distributors to transmit the required information to employers. (Employers who do not produce or import chemicals need only focus on those parts of this rule that deal with establishing a workplace program and communicating information to their workers. Appendix E of this section is a general guide for such employers to help them determine their compliance obligations under the rule.)

1910.1200(b)(2) This section applies to any chemical which is known to be present in the workplace in such a manner that employees may be exposed under normal conditions of use or in a foreseeable emergency.

1910.1200(b)(3) This section applies to laboratories only as follows:

1910.1200(b)(3)(i) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced;

1910.1200(b)(3)(ii) Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible during each workshift to laboratory employees when they are in their work areas;

1910.1200(b)(3)(iii) Employers shall ensure that laboratory employees are provided information and training in accordance with paragraph (h) of this section, except for the location and availability of the written hazard communication program under paragraph (h)(2)(iii) of this section; and,

1910.1200(b)(3)(iv) Laboratory employers that ship hazardous chemicals are considered to be either a chemical manufacturer or a distributor under this rule, and thus must ensure that any containers of hazardous chemicals leaving the laboratory are labeled in accordance with

paragraph (f)(1) of this section, and that a material safety data sheet is provided to distributors and other employers in accordance with paragraphs (g)(6) and (g)(7) of this section.

1910.1200(b)(4) In work operations where employees only handle chemicals in sealed containers which are not opened under normal conditions of use (such as are found in marine cargo handling, warehousing, or retail sales), this section applies to these operations only as follows:

1910.1200(b)(4)(i) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced;

1910.1200(b)(4)(ii) Employers shall maintain copies of any material safety data sheets that are received with incoming shipments of the sealed containers of hazardous chemicals, shall obtain a material safety data sheet as soon as possible for sealed containers of hazardous chemicals received without a material safety data sheet if an employee requests the material safety data sheet, and shall ensure that the material safety data sheets are readily accessible during each work shift to employees when they are in their work area(s); and,

1910.1200(b)(4)(iii) Employers shall ensure that employees are provided with information and training in accordance with paragraph (h) of this section (except for the location and availability of the written hazard communication program under paragraph (h)(2)(iii) of this section), to the extent necessary to protect them in the event of a spill or leak of a hazardous chemical from a sealed container.

1910.1200(e) "Written hazard communication program."

1910.1200(e)(1) Employers shall develop, implement, and maintain at each workplace, a written hazard communication program which at least describes how the criteria specified in paragraphs (f), (g), and (h) of this section for labels and other forms of warning, material safety data sheets, and employee information and training will be met, and which also includes the following:

1910.1200(e)(1)(i) A list of the hazardous chemicals known to be present using an identity that is referenced on the appropriate material safety data sheet (the list may be compiled for the workplace as a whole or for individual work areas); and,

1910.1200(e)(1)(ii) The methods the employer will use to inform employees of the hazards of non-routine tasks (for example, the cleaning of reactor vessels), and the hazards associated with chemicals contained in unlabeled pipes in their work areas.

1910.1200(f)(5) Except as provided in paragraphs (f)(6) and (f)(7) of this section, the employer shall ensure that each container of hazardous chemicals in the workplace is labeled, tagged or marked with the following information:

1910.1200(f)(5)(i) Identity of the hazardous chemical(s) contained therein; and,

1910.1200(f)(5)(ii) Appropriate hazard warnings, or alternatively, words, pictures, symbols, or combination thereof, which provide at least general information regarding the hazards of the

chemicals, and which, in conjunction with the other information immediately available to employees under the hazard communication program, will provide employees with the specific information regarding the physical and health hazards of the hazardous chemical.

1910.1200(f)(6) The employer may use signs, placards, process sheets, batch tickets, operating procedures, or other such written materials in lieu of affixing labels to individual stationary process containers, as long as the alternative method identifies the containers to which it is applicable and conveys the information required by paragraph (f)(5) of this section to be on a label. The written materials shall be readily accessible to the employees in their work area throughout each work shift.

1910.1200(f)(7) The employer is not required to label portable containers into which hazardous chemicals are transferred from labeled containers, and which are intended only for the immediate use of the employee who performs the transfer. For purposes of this section, drugs which are dispensed by a pharmacy to a health care provider for direct administration to a patient are exempted from labeling.

1910.1200(f)(8) The employer shall not remove or deface existing labels on incoming containers of hazardous chemicals, unless the container is immediately marked with the required information.

1910.1200(f)(9) The employer shall ensure that labels or other forms of warning are legible, in English, and prominently displayed on the container, or readily available in the work area throughout each work shift. Employers having employees who speak other languages may add the information in their language to the material presented, as long as the information is presented in English as well.

1910.1200(g) "Material safety data sheets."

1910.1200(g)(1) Chemical manufacturers and importers shall obtain or develop a material safety data sheet for each hazardous chemical they produce or import. Employers shall have a material safety data sheet in the workplace for each hazardous chemical which they use.

1910.1200(g)(2) Each material safety data sheet shall be in English (although the employer may maintain copies in other languages as well), and shall contain at least the following information:

1910.1200(g)(2)(i) The identity used on the label, and, except as provided for in paragraph (i) of this section on trade secrets:

1910.1200(g)(2)(i)(A) If the hazardous chemical is a single substance, its chemical and common name(s);

1910.1200(g)(2)(i)(B) If the hazardous chemical is a mixture which has been tested as a whole to determine its hazards, the chemical and common name(s) of the ingredients which contribute to these known hazards, and the common name(s) of the mixture itself; or,

1910.1200(h) "Employee information and training."

1910.1200(h)(1) Employers shall provide employees with effective information and training on hazardous chemicals in their work area at the time of their initial assignment, and whenever a new physical or health hazard the employees have not previously been trained about is introduced into their work area. Information and training may be designed to cover categories of hazards (e.g., flammability, carcinogenicity) or specific chemicals. Chemical-specific information must always be available through labels and material safety data sheets.

1910.1200(h)(2) "Information." Employees shall be informed of:

1910.1200(h)(2)(i) The requirements of this section;

1910.1200(h)(2)(ii) Any operations in their work area where hazardous chemicals are present; and,

1910.1200(h)(2)(iii) The location and availability of the written hazard communication program, including the required list(s) of hazardous chemicals, and material safety data sheets required by this section.

1910.1200(h)(3) "Training." Employee training shall include at least:

1910.1200(h)(3)(i) Methods and observations that may be used to detect the presence or release of a hazardous chemical in the work area (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

1910.1200(h)(3)(ii) The physical and health hazards of the chemicals in the work area;

1910.1200(h)(3)(iii) The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used; and,

1910.1200(h)(3)(iv) The details of the hazard communication program developed by the employer, including an explanation of the labeling system and the material safety data sheet, and how employees can obtain and use the appropriate hazard information.

APPENDIX B

The goal of defining precisely, in measurable terms, every possible health or physical effect that may occur in the workplace as a result of chemical exposures cannot realistically be accomplished. This does not negate the need for employees to be informed of such effects and protected from them. The following outlines principles and procedures of hazard assessment.

For purposes of this section; any chemical which meets any of the following definitions are considered hazards and should be labeled with the following words defined below in bold.

(1) "**Carcinogen**:"

A chemical is considered to be a carcinogen if:

- It has been evaluated by the International Agency for Research on Cancer (IARC), and found to be a carcinogen or potential carcinogen; or
- It is listed as a carcinogen or potential carcinogen in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or,
- It is regulated by OSHA as a carcinogen.

(2) "**Corrosive**:"

A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. For example, a chemical is considered to be corrosive if, when tested on the intact skin of albino rabbits by the method described by the U. S. Department of Transportation in appendix A to 49 CFR part 173, it destroys or changes irreversibly the structure of the tissue at the site of contact following an exposure period of four hours. This term shall not refer to action on inanimate surfaces.

(3) "**Highly toxic**:"

A chemical falling within any of the following categories:

- A chemical that has a median lethal dose (LD50) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
- A chemical that has a median lethal dose (LD50) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.
- A chemical that has a median lethal concentration (LC50) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within hour) to albino rats weighing between 200 and 300 grams each.

(4) "**Irritant**:"

A chemical which is not corrosive but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. A chemical is a skin irritant if, when tested on the intact skin of albino rabbits by the methods of 16 CFR 1500.41 for four hours exposure or by other appropriate techniques, it results in an empirical score of five or more. A chemical is an eye irritant if so determined under the procedure listed in 16 CFR 1500.42 or other appropriate techniques.

(5) "**Sensitizer**:"

A chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.

(6) "**Toxic**:"

A chemical falling within any of the following categories:

A chemical that has a median lethal dose (LD50) of more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

- A chemical that has a median lethal dose (LD50) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) when the bare skin of albino rabbits weighing between two and three kilograms each.
- A chemical that has a median lethal concentration (LC50) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 or 300 grams each.

(7) "**Target organ effects**."

The following is a target organ categorization of effects which may occur, including examples of signs and symptoms and chemicals which have been found to cause such effects. These examples are presented to illustrate the range and diversity of effects and hazards found in the workplace, and the broad scope employers must consider in this area, but are not intended to be all-inclusive.

- Hepatotoxins: chemicals which produce liver damage. Signs & Symptoms: Jaundice; liver enlargement. Chemicals: Carbon tetrachloride; nitrosamines.
- Nephrotoxins: Chemicals which produce kidney damage. Signs & symptoms: Edema; proteinuria. Chemicals: Halogenated hydrocarbons; uranium.
- Neurotoxins: Chemicals which produce their primary toxic effects on the nervous system. Signs & Symptoms: Narcosis; behavioral changes; decrease in motor functions.

- Agents which act on the blood or hematopoietic system: Decrease hemoglobin function; deprive the body tissues of oxygen. Signs & Symptoms: Cyanosis; loss of consciousness. Chemicals: Carbon monoxide; cyanides.
- Agents which damage the lung: Chemicals which irritate or damage pulmonary tissue. Signs & Symptoms: Cough; tightness in chest; shortness of breath. Chemicals: Silica; asbestos.
- Reproductive toxins: Chemicals which affect the reproductive capabilities include chromosomal damage (mutations) and effects on fetuses (teratogenesis). Signs & Symptoms: Birth defects; sterility. Chemicals: Lead; DBCP.
- Cutaneous hazards: Chemicals which affect the dermal layer of the body. Signs & Symptoms: Birth defects; sterility. Chemicals: Lead; DBCP.
- Eye hazards: chemicals which affect the eye or visual capacity. Signs & symptoms: Conjunctives; corneal damage. Chemicals: Organic solvents; acids.

(8)"**Compressed gas**":

- A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or
- A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg. C) regardless of the pressure at 70 deg. F (21.1 deg. C); or
- A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 deg. C) as determined by ASTM D-323-72.

(9)"**Explosive**":

A chemical that causes a sudden almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

(10)"**Flammable**":

A chemical that falls into one of the following categories:

"Aerosol, flammable"

An aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

"Gas, flammable:

- A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of thirteen (13) percent by volume or less; or
- A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than twelve (12) percent by volume, regardless of the lower limit;

"Liquid, flammable"

Any liquid having a flashpoint below 100 deg. F (37.8 deg. C), except any mixture having components with flashpoints of 100 deg. F (37.8 deg. C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

"Solid, flammable"

A solid, other than a blasting agent or explosive as defined in 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

(11)"**Organic peroxide**"

An organic compound that contains the bivalent-O-O-structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

(12)"**Oxidizer**"

Chemical other than a blasting agent or explosive as defined in 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

(13)"**Pyrophoric**"

A chemical that will ignite spontaneously in air at a temperature of 130 deg. F (54.4 deg. C) or below.

(14)"**Unstable (reactive)**"

A chemical which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

(15)"**Water-reactive**"

A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

APPENDIX C

Employee Safety Orientation and Training Checklist

Name_____

Position_____Supervisor_____

1. By Safety Officer / Safety Committee

_____ Right-to-Know Law
_____ Standard Operating Procedures
_____ Chemical Procurement, Storage, Handling
_____ PPE
_____ Labeling
_____ Waste Handling
_____ Housekeeping
_____ Engineering Controls
_____ Emergency Action Plan

Training Completed by_____Date_____

Employee Signature_____Date_____
(Signature acknowledges that the above topics have been communicated and understood)

2. By Laboratory Supervisor

_____ Introduction to operations where chemical and physical hazards are present/types of hazards encountered.
_____ Required work practices
_____ PPE
_____ Emergency procedures
_____ Detection of chemical hazards
_____ Location and training on SOP(s), MSDS(s)
_____ Labeling system

Training Completed by_____Date_____

For Building/Room Number_____

Training Completed by_____Date_____

For Building/Room Number_____

Employee Signature_____Date_____
(Signature acknowledges that the above topics have been communicated and understood)

Occupational Safety and Health Services (2003)

OSHS Case Number:_____

Supervisor's Incident Report

PLEASE READ THE INSTRUCTIONS BEFORE COMPLETING THIS FORM!

This form should be completed by the IMMEDIATE SUPERVISOR and NOT THE INDIVIDUAL involved in the incident.

It is the Supervisor's responsibility to initiate necessary corrective actions and to report the action taken (or to be taken in the case of training or a repair, etc.) on this form. It is essential that the cause(s) of the incident be identified and corrected where possible to avoid a reoccurrence.

This form must be completed within 24 hours after learning of the incident and returned to the OSHS office.

Provide as much detail as possible and do not leave blank spaces, indicate none, N/A, or unknown where appropriate. Attach additional information if needed.

Person Involved: _____ Male: ____ Female:____
(Last Name) (First Name) (Middle Initial)

Local Home Address: _____ City: _____Zip: _____

Birth Date: ____/____/____ Phone: _____Dept _____ Job Title: _____

Status (Check One): ___ Employee ___Student Employee ___Student

Date of Hire at MTU: ____/____/____ Years of (MTU) Experience in Present Position: _____

Indicate Medical Treatment Required (answer each question):

	YES	NO	
First Aid Given?			Who: _____
Treated by Doctor?			Who: _____
Treated in Emergency Room?			Where: _____
Hospitalized Overnight?			Where: _____

Date Employee will Return to Work: ____/____/____ OR Anticipated Date: ____/____/___

Date of Incident: ____/____/___

Time of Incident: _____ am/pm

Time employee began work: _____ am/pm

What was the employee doing just before the incident occurred? Describe the activity, as well as the tools, equipment or material the employee was using. Be specific. Examples: "climbing a ladder while carrying roofing materials"; "spraying chlorine from hand sprayer"; "daily computer key-entry."

What happened? Tell us how the incident/injury occurred. Examples: "When ladder slipped on wet floor, worker fell 20 feet"; "Worker was sprayed with chlorine when gasket broke during replacement"; "Worker developed soreness in wrist over time."

Where did the incident occur? Building: _____ Room Number: _____Other: _____

What was the injury or illness? Tell us the part of the body that was affected and how it was affected; be more specific than "hurt," "pain," or "sore." Examples: "strained back"; "chemical burn, hand"; "scalp laceration."

Injury description (fill-in blank, circle choice, or N/A):

Body Part(s) Involved: _____ AND

(Circle as appropriate) left right upper lower top bottom

Type of injury/illness (e.g. cut, strain, crush, etc.): _____

What object or substance directly harmed the employee? Examples: "concrete floor"; "chlorine"; "radial arm saw." If this question does not apply to the incident, write "NA".

If the incident involved a fatality, Date of Death:___ /___/___ AND contact OSHS immediately.

Describe any corrective actions taken or to be taken as a result of this incident:

If a corrective action will be taken later, it will be followed up by whom:

Supervisor's Signature: _____ Date: ____/____/____

Supervisor's Name (please print): _____Work Phone: _____

MEEM Chair: _____

Send original to OSHS
Keep a copy for your file

APPENDIX E

MEEM Safety Audit Checklist

Audit Date:

Inspection Team Members:

Room or Area:

Responsible Faculty/Staff:

	Yes	No	Audit Focus
8			Are SOPs available for the audited laboratory?
9			Is up to date Safety Manual, Chemical Inventory, and MSDS located in the lab/area?
10			Is housekeeping adequate?
11			Are electrical cords in good condition?
12			Are electrical cords used properly?
13			Are chemicals labeled properly?
14			Are chemicals stored properly?
15			Is appropriate personal protective equipment available and properly used?
16			Is proper clothing being worn?
17			Is emergency equipment unobstructed?
18			Are aisles and doors unobstructed?

Other Notes:

APPENDIX F

GRADUATE STUDENT LABORATORY EXIT FORM

To be completed by Graduate Students at the time they submit their "Scheduling of Final Oral Examination Form" (M5 or D7)

Name_____ Date_____

Degree_____

Thesis/Dissertation Title_____

My Research has been conducted in room(s)_____ Bldg(s)_____

For my Research Project I have used the following Chemicals and / or Equipment:

_____
_____
_____
_____
_____
_____
_____

_____I have properly disposed of all chemicals and returned appropriate equipment used during the course of my research.

OR

_____ I have reassigned the chemicals and equipment to:_____

Signed by: The approval page on your Thesis/Dissertation will not be signed by the Department Chair until this form is complete.

Student_____ Date_____

Advisor_____ Date_____

Safety Officer _____ Date_____

Dept. Chair_____Date_____

APPENDIX G

Certain hazardous chemicals should not be mixed or stored with other chemicals because a severe reaction can take place or an extremely toxic reaction product can result. The label and MSDS will contain information on incompatibilities. The following table contains examples of incompatible chemicals (reference source: chem-safety.com):

CHEMICAL	KEEP OUT OF CONTACT WITH
Acetic Acid	Chromic acid, nitric acid hydroxyl compounds, ethylene, glycol, perchloric acid, peroxides, permanganates
Acetone	Concentrated nitric and sulfuric acid mixtures, Acetylene Chlorine, bromine, copper, fluorine, silver, mercury
Alkali Metals	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, the halogens
Ammonia, anhydrous	Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid
Ammonium Nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Any reducing agent
Azides	Acids
Bromine	Same as chlorine
Calcium Oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents.
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organic or combustible materials
Chromic Acid	Acetic acid, naphthalene, camphor, glycerin, turpentine, alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Chlorine Dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide

CHEMICAL	KEEP OUT OF CONTACT WITH
Cumene Hydroperoxide	Acids, organic or inorganic
Cyanides	Acids
Flammable Liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Hydrocarbons	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic Acid	Nitric acid, alkali
Hydrofluoric Acid	Ammonia, aqueous or anhydrous
Hydrogen Peroxide	Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, flammable liquids, oxidizing gases
Hydrogen Sulfide	Fuming nitric acid, oxidizing gases, acetylene, ammonia (aqueous or anhydrous), hydrogen
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Sulfuric acid
Nitric Acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases.
Nitrites	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic Acid	Silver, mercury
Oxygen	Oils, grease, hydrogen; flammable liquids, solids, or gases
Perchloric Acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood
Peroxides, organic	Acids (organic or mineral), avoid friction, store cold
Phosphorus (white)	Air, oxygen, alkalies, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium Chlorate	Sulfuric and other acids
Potassium Permanganate	Glycerin, ethylene glycol, benzaldehyde, sulfuric acid

CHEMICAL	KEEP OUT OF CONTACT WITH
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium Peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric Acid	Potassium chlorate, potassium perchlorate, potassium permanganate (or compounds with similar light metals, such as sodium, lithium, etc.)
Tellurides	Reducing agents

APPENDIX H

Request for Collection of Waste Chemicals

Requested by _____ **Date** _____

Department / Office / Division _____ **Telephone** _____

Location of Waste Chemicals _____

Disposal Approved by _____ **Date** _____

Item No.	Chemical Name / Description	EPA Waste ID No.*	Physical State**	Quantity	Container Size
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

* **Refer to EPA hazardous waste tables or contact OSHS**

** **Indicate whether waste is solid, liquid, gas, or sludge**

APPENDIX I

Chemical waste containers used to store or accumulate chemical waste prior to disposal must be properly labeled. Additionally, incompatible chemical wastes must be segregated into different containers. Containers must be chemically stable for the contents. Each container must have the following information prominently and durably displayed on the container.

Federal Laws Prohibit Improper Disposal

If found, contact the nearest Police or Public Safety Authority or the U.S. Environmental Protection Agency

Generator Information

Name:
Institution: **Michigan Technological University**
Address: **1400 Townsend Drive**
City: **Houghton**
State: **Michigan 49931**

EPA Identification Number: **MID065453268**

EPA Waste ID Number:

Accumulation Start Date:

APPENDIX J

Unattended Operations Notice

Operation:

Start Date/Time:

End Date/Time:

Location in Lab:

Hazard Description:

In Case of Emergency Contact Public Safety At 123

For question or concerns, contact:

Student Name:

Phone Number:

Faculty Name:

Phone Number:

Miscellaneous Safety Practices and Suggestions

General

Tasks that are highly repetitive and require no thought are very prone to accidents.

Always know what is supposed to happen before an action is taken. If that does not happen, then you are not in control of the situation.

Too much sensory input (task loading) will cause some portion of the input to be filtered out by the brain. This lost information can be what keeps you safe.

Do not allow yourself to be distracted and do not be a distraction to others.

Electrical and Other Energy

Current = Voltage / Resistance (See next page also!)

1 milliampere (mA)	perceptible with the major effect being involuntary muscle reflex, reflex could cause a hand to move into a hazardous location producing an injury greater than the shock.
5 – 25 mA	an adult can lose control of muscles resulting in the loss of ability to let go of a conductor. "Let-go" current for men is typically 9 mA and for women it is typically 6 mA. This level of current causes involuntary muscle contraction greater than the body's ability to relax or reverse the contraction.
25 – 75 mA	very painful and injurious, can cause unconsciousness, prolonged contact can cause death due to paralysis of respiratory muscles.
75 – 300 mA	for more than ¼ second, this level can be immediately fatal due to ventricular fibrillation, AC is more dangerous than DC in this range.
2.5 A	stops heart instantly, body overheats, skin and internal organs are burned.

Dry, clean, and unbroken skin has a high electrical resistance due to dead cells (~400,000 Ohms), however subdermal tissue has low resistance. Current flow = 120V / 400,000 = 0.3 mA. ***Clean, dry, and unbroken skin is RARELY present.***

Wet (normal skin oil), unbroken skin has a resistance of ~ 15,000 Ohms. Current flow = 120V / 15,000 = 8 mA ***(LET-GO CURRENT).***

Internal tissue resistance is typically 300 to 500 Ohms. Current flow = 120V / 500 = 240 mA ***(FATAL).***

Current scales with voltage.

A ground fault circuit interrupter (GFCI) measures the electrical current through the wiring into itself and the electrical current through the wiring out of itself. A difference between the two means current is leaving the device via a path other than the wiring (perhaps through a person). When sensed, the device opens the circuit in ~ one cycle of the AC (~16 msec). GFCIs must be used where there is increased hazard due to shock such as on devices that use or handle conductive liquids or where there is a risk of spillage of liquids onto outlets and power strips. If you have to place your hand into water held in an electrical device, or you must stand in water or on a wet surface, the device must be powered through a GFCI outlet or GFCI extension cord. GFCI panel breakers are also available. GFCI outlets and extension cords are not expensive.

Energy storage devices and systems, such as electrical capacitors, pressure sources, and suspended weights are required to have physical lock-out devices, systems, and procedures prior to working on such systems. Electrical capacitors can store significant energy and release that energy in a very short time resulting in lethal power levels. Capacitors must be shorted through an appropriate resistance to "bleed down" the energy. Pressurized systems must be vented and the sources locked-out prior to any work. Suspended weights must be removed or securely held at their lowest possible potential. In the case of lock-outs, there are also formal required tags that must be placed notifying that the energy source must not be activated.

Most Commonly Cited Safety Violations During Audits

Unlabeled, mislabeled, or open containers of liquid;

Chemicals improperly stored, incompatible storage, flammable storage;

Blocked fire alarms and extinguishers;

Cluttered rooms restricting egress routes;

Daisy-chained powers strips, permanent equipment powered through extension cords;

Trip hazards, tip hazards from storage on top of cabinets;

No MSDS or chemical inventory;

Children present.