EHS101: WHMIS and Lab Safety (Quercus Notes)

Arnav Patil

Department of Electrical and Computer Engineering, University of Toronto

Contents

Preface and Acknowledgements

Took this short online course when I was trying to join UTFR (the formula racing team). These notes are essentially all you need to review before taking the thirty-question quiz (I think you get three attempts).

1 MODULE 1 – Legislation and Internal Practices

Module Learning Objectives:

- Understand Internal Responsibility System.
- Understand enforcement penalties and offences under legislation.
- Understand due diligence and its 3 key factors.
- Understand WHMIS and GHS.

Occupational Health and Safety Law:

- OHS laws are in place both federally and provincially.
- UofT is covered by Ontario Provincial Acts plus federal acts like Bill C-45.

Internal Responsibility System:

- Underlying philosophy of any OHS Act.
- Concept came from James Milton Ham, professor and president of UofT.
- Used by:
  - Employers
  - Management (academics)
  - Employees and workers

Figure 1: Internal Responsibility System

Undergraduate Student Safety:

- UofT Health and Safety Policy Approval by the Governing Council.
- Office of Environmental Health and Safety has numerous activities around student safety.

Rights of Employees Under OHSA:

- Right to Refuse Unsafe Work (3.43-49).
- Right to Participate in Health and Safety Activities
- The Right to Know
- Reprisals (punishment) by employers is prohibited (s.50).

Legislation – Employees:

- Ontario Occupational Health and Safety Act lays out framework for responsibilities.
- Specific laboratory related items are laid out in the Industrial Regulation (OR851).
- Most activities are covered by OHSA "General Duty Clause."

Occupational Illness:

- People can become sick due to exposure to chemicals or other agents.
- Sickness may be diagnosed while exposure is still happening.
- Other diseases like cancer have a long latency period and can develop years after.

Emergency Response:

- Each lab should have procedures for emergency response.
- Some procedures are for specific matters.
- Ensure that you know and understand the emergency procedures that apply to your lab.

Incident Reporting:

- If there is an accident (or incident or near miss) an online accident/incident form must be filled out.
- Form should be filled only after pressing matters have been addressed.
- www.ehs.utoronto.ca

PI Duties and Responsibilities:

- Take reasonable precautions to protect employees.
- Advise employees/students of any potential or actual workplace hazards.
- Ensure that employees use PPE and other required equipment.
- TAs are usually only supervising students; they do not fit "supervisor" under OHSA.
- The PI/Lecturer would be the "supervisor."

Employee Responsibilities:

- Act in compliance with OHSA and other guidelines.
- Use PPE and clothing as directed by the supervisor.
- Report hazards and dangers.
- Work and use equipment safely.
- For more information take course EHS002: Basic Health and Safety Awareness Training.

Lab Specific Health and Safety

High Hazard Chemicals in the Lab:

- Permit needed for High Hazard Chemicals and processes.
- Includes materials like:
  - High toxicity chemicals
  - High hazard corrosives
  - Pyrophoric and water sensitive chemicals
  - Confirmed and probable carcinogens
  - Confirmed reproductive toxins/teratogens
  - Nanomaterials and when making novel compounds.

Biosafety:

- Human Pathogens and Toxins Act and the UofT Biosafety Committee require a Biosafety Permit and biosafety training for any work with materials that meet their definition.

Other Federally Regulated Areas:

- Genetically Modified Organisms – Environment Canada.
- Aquatic Animals and Plant Pathogens – CFIA.
- Please contact EHS for advice on containment.

If working with animals you must:

- Be listed on an animal use protocol form.
- Complete mandatory short courses on animal care.
- Receive additional mandatory training from the animal facility to use any chemical bioagent or radioscope.

Radiation and X-Ray Safety:

- Use of radioactive materials is governed by the Canadian Nuclear Safety Act:
  - In teaching labs students will use only radioactive materials that are under the exemption quantity limit.
  - Use of open sources above the exemption quantities limit is restricted to people with full radiation training.
- Use of X-Ray machines is governed by the Ontario OHSA:
  - Students must take X-ray safety training to use machines.

Lasers:

- Use is governed by "General Duty" clause of the OHSA.
- UofT and Ontario Ministry of Labour/Learning follow requirements of standard ANSI Z 136 – Safe Use of Lasers:
  - In teaching labs students will use only low class or enclosed beam lasers.
  - To use class 3B or class 4 open beam lasers students must take full laser safety training.

Field Research Safety:

- PIs requiring field research need to conform to UofT Guidelines on Safety in Field Research and complete the Field Research Safety Planning Record.
- Students must also follow the Provostial Framework on Off-campus Safety.

Transportation of Dangerous Goods:

- Any people who do tasks related to hazardous materials need to complete Transportation of Dangerous Goods (TDG) training.
- Travelling or traversing a public road constitutes shipping.
- Most materials have partial exemptions on limited quantities.

Environmental Compliance Approvals:

- PIs must notify EHS of changes in hazardous material ventilation.
- O. Reg 419/05 Local Air Quality covers any equipment that generates emissions.
- EHS does dispersion modelling to demonstrate emissions or noise are not a health concern or irritant to neighbours.
- These models are submitted to the Ministry of the Environment.

Controlled Substances and Chemical Weapons:

- Controlled substances have special requirements for usage in research.
- Approval for usage must be obtained from Health Canada.
- See Use of Controlled Drugs in Animal Studies on the EHS page.
- Chemical Weapons are precursors are covered by Federal Law and International treaties.
- Annually EHS sends a compulsory questionnaire from the Federal Government that asks about usage/import/manufacture of certain substances.

Explosives:

- Explosives Act controls the possession, use, import, and manufacture of explosives.
- Important exemptions:
  - Solutions of explosives at less than 1% concentration are exempted from most provisions of the Act and the "Explosives Regulation 2013."
  - Manufacture of less than 5 kg of explosives is allowed at a University.

Waste Disposal:

- Supervisor needs to ensure students are instructed on how to dispose of chemical, biological, and radiological wastes for the teaching lab.

Supervisor Safety Responsibilities and Due Diligence in the Lab

Occupational Health and Safety Law:

- Academic Supervisors/PIs are considered supervisors under the definitions of the OHS Act.
- The Office of EHS provides guidance and support on the above; however, ultimately it is the legal responsibility under OHSA to be informed of all applicable OHS laws.

Due Diligence:

- Due diligence is the level of judgement, care, prudence, determination, and activity that a person should be expected to do under particular circumstances.
- Applies to situations that are not addressed elsewhere in OHSA.

Due Diligence – Processes:

- Having formal processes in the workplace will help demonstrate due diligence:
  - Procedures for common tasks
  - Remedying defects in work areas
  - Ensuring proper training
  - Monitoring compliance
  - Enforcing procedures
  - Communicating risks and hazards.

Due Diligence – Defence:

- Can only be established as a defence if:
  - There is evidence of compliance history through documenting
  - Training includes facilitator, type, and date of training
  - Complaints and recommendations to improve safety
  - Inspection history
  - Control measures to address safety concerns
  - Warnings and reprimands.

Training Matrix:

- UofT has a training matrix for those working or studying in the lab.
- Tool can help establish due diligence around training.
- For each type of lab work there is a course (or set thereof).

Risk Assessment:

- Another part of due diligence is assessing the risk.
- You want to be able to focus your energies on the highest hazard activities.
- The Office of EHS can provide assistance with risk assessment if needed.

Enforcement:

- If non-compliance with legislation is found, MOL and Federal Regulators have the authority to enforce the law.
- Inspectors have the power to:
  - Inspect any part of the university
  - Investigate hazards, accidents, and work refusals.
  - Can also order legal compliance and initiate prosecution.
- Note that any area a worker could be in is a workplace.

Powers of an MOL Inspector:

- Entering a workplace without notice or a warrant.
- Questioning any employee privately or in a group.
- Reviewing or making copies of any workplace document and taking photographs.
- Requiring a workplace to be undisturbed for the purposes of an investigation, inspection, or test.
- Reviewing any employee training documents.
- Seizing anything that is given or in plain view of an inspector that is thought to be in contravention of legislation.
- Requiring hygiene and engineering testing at the owners' expense.

Canadian Criminal Code Section 217.1 (Bill C-45):

- Criminal charges for health and safety violations are now available under the Criminal Code of Canada.
- Any person who has the authority to direct how another person works has a legal duty to "take reasonable steps to prevent bodily harm."
- Charges of $100,000 or more and criminal record on conviction.

Critical Injuries:

- Critical injuries have special urgent MOL reporting requirements.
- Defined as an injury that results in:
  - Unconsciousness
  - Substantial blood loss
  - Arm or leg fracture
  - Arm or leg amputation
  - Burns to a major part of the body
  - Loss of sight in an eye
  - OR placing a life in jeopardy.
- When a critical injury occurs the scene must be secured by Campus Police.

Laboratory Design:

- EHS has developed a set of procedures that delineate the minimum requirements for all new or renovated lab spaces.
- Different rules for 'dry' versus 'wet' labs.
- Project leader is typically Capital Projects Property Management.

Decommissioning and Lab Closure:

- When a lab space is being vacated the EHS "Guidelines for Laboratory Closure" should be followed.
- Procedures for both complete and partial decommissioning are available.

TA's Roles in the Laboratory

Age is More than a Number:

- Young employees in Ontario work 10% of all hours but are injured at a rate of 16%.

Field Teaching:

- Basic wet lab attire is in Module 3 – hazard control.
- PI or lab coordinator would typically be responsible for risk assessment and planning.
- Instructing students to on those hazards before they encounter them.

2 MODULE 2 – WHMIS and GHS

Workplace Hazardous Materials Information System (WHMIS)

Globally Harmonised System (GHS)

Module Learning Objectives:

- Define the primary goal of WHMIS and identify its main exemptions.
- Describe the three main components of WHMIS.
- Identify hazard classes and symbols.
- Understand the different types of WHMIS labels that may be used in the workplace.
- Review a Material Safety Data Sheet and understand what types of information is given.

Introduction to WHMIS:

- WHMIS is a national system for the safe management of hazardous materials.
- Product of joint cooperation between labour, industry, and government.
- Primary goal is to provide workers with information to enable them to work safely with any hazardous materials that they encounter during their job.
- Legislated by:
  - Federal government involves classification, sale, and import of hazardous materials
  - Provincial jurisdiction is when the controlled product enters the workplace.
- Provincial WHMIS is governed by the OHSA and WHMIS regulation (Ont. Reg. 860).

WHMIS Information Delivery:

- Label → MSDS → Training.

Introduction to WHMIS 2015 – The Globally Harmonised System:

- GHS is a system of chemical classification and hazard communication created by the UN.
- Similar to WHMIS 1988 and is being called WHMIS 2015.
- Intended to be understood and standardized across the globe.
- Hazard symbols are slightly different from WHMIS 1988.
- Hazard statements use different hazard groupings versus WHMIS 1988 but the hazards are the same.
- Statements and risk phrases are the same globally and are translated into most languages.
- Safety Data Sheets (SDS's) replaced the Material Safety Data Sheets (MSDS's).

WHMIS 2015 Hazard Symbols:

- WHMIS 2015 symbols can be found on many labels and MSDS's.
- In the hazard slides the GHS symbols will be placed next to their older counterparts.
- Note that within each hazard class there are different hazard categories.
- Important to remember that category 1 is more dangerous than category 2 and 3.
- There are also two signal words: danger and warning with danger being the more severe one.

Figure 2: WHMIS Symbols

Class A – Compressed Gasses:

- Packaged as pressurized, dissolved, or liquefied gas.
- Many health and safety concerns:
  - Toxicity
  - Asphyxiation
  - Frostbite
  - Fire hazards.
- Special concerns due to high pressure – could become a projectile if ruptured.
- In GHS class "gasses under pressure" is classified as a physical hazard.
- Safe handling includes:
  - Regulator detached and cylinder cap on unless in use
  - Secured to a wall or bench
  - Only move using cylinder dolly
  - Keep away from heat.

Class B – Flammable and Combustible Materials:

- Materials that will ignite and continue to burn in air if exposed to a source of ignition.
- GHS Flammables:
  - Symbol includes pyrophoric materials that ignite spontaneously in air.
  - 3 categories.
  - Since the flammable symbol includes more types of hazard now it is important to determine the reason for the symbol – pyrophoric, self-reactive, reactive with water, or just flammable.

Class C – Oxidizing Material:

- Causes another material to burn or make it burn more vigorously.
- Can react chemically to oxidize combustible materials.
- Some are strong enough to work at room temperature or need slight heating.
- Significantly increases the chance for fire or explosion and must be handled and stored properly.

Class D – Poisonous and Infectious Material:

- Three different divisions classify different forms or types of poisonous and infectious materials:
  - D1: Materials causing immediate and serious toxic effects
  - D2: Materials causing other toxic effects
  - D3: Biohazardous infectious materials

Routes of Exposure – Toxins:

- Often it is the body that converts the material into a toxic form.
- Typical routes of exposure in the lab are:
  - Skin
  - Eye
  - Injection
  - Ingestion
  - Breathing.

Routes of Entry – Preventing Inhalation:

- You must work in a fume hood for volatile liquids or powders or a biosafety cabinet for powders only.
- Biosafety cabinets do not protect against vapours or gasses.

Routes of Entry – Prevention of Skin Exposure:

- Gloves should always be worn.
- Lab gloves should be changed at first sign of contamination.
- When combined with a clean lab coat and clothing that covers the rest of the body, exposure should not be significant.

Routes of Entry – Prevention of Eye Exposure:

- Safety glasses to prevent injury from flying objects like broken glass are the minimum in a lab setting.
- Goggles are required for splash protection.
- Face shields are needed for materials that can damage the skin of the face.

Chronic versus Acute:

- An acute hazard causes immediate harm.
- Chronic hazard affects the body after repeated exposure, usually over long periods of time.

Class D – Poisonous and Infectious Material:

- D1 Materials Causing Immediate and Serious Toxic Effects:
  - D1A: Very toxic materials
  - D1B: Toxic materials
  - Classified based on information such as LD50 or LC50.
- D2 Materials Causing Other Toxic Effects:
  - D2A: Very toxic materials
  - D2B: Toxic materials
  - Includes carcinogens, teratogens, reproductive toxins, sensitizers, and irritants.
- D3 Biohazardous Infectious Material:
  - Classification includes organisms and their toxins that may cause disease.
  - Internationally GHS does not use this symbol or hazard group but it will continue to be used in Canada.
- Safe handling of Class D materials:
  - Use a fume hood
  - Avoid skin contact
  - Wear PPE
  - Wash hands after handling and before using the washroom.

GHS Low Toxicity/Chronic Toxicity Symbol:

- Exclamation mark GHS symbol covers some of the materials that would have used the T-exclamation mark.
- Less hazardous category 4 toxins get this symbol as do skin sensitizers.

Class E – Corrosive Materials:

- Corrosive materials cause extensive damage.
- Burning, scarring, and blindness may result from eye or skin contact.
- May corrode metal containers or structures.
- Safe handling practices:
  - Avoid skin contact
  - Wear gloves and goggles
  - Use in a fume hood
  - Store corrosives in containers that are impervious to attack specific corrosive.

GHS Corrosive Symbol:

- Symbol will appear on corrosives.
- There are 3 classes for skin corrosion with 1A being most corrosive followed by 1B and 1C.
- Any material that will cause serious eye damage will have category 1.
- Categories 2 and 3 are irritants and get the exclamation mark symbol.

Class F – Dangerously Reactive Material:

- Undergo vigorous reactions such as polymerization, decomposition, or condensation.
- May react violently under conditions of shock or with an increase in pressure or temperature.
- May also react violently with water to release toxic gasses.

Dangerously Reactive GHS Symbol:

- Dangerously reactive material may have either of the above symbols depending on the exact hazard.
- True explosives (1.1-1.4), self-reacting substances (AB), and organic peroxides (A.B) get the explosive symbol.
- The explosive symbol has not been adopted in Canada but you may still see it on products.
- Less hazardous self-reactives, water reactives, organic peroxides, and pyrophorics get the flammable symbol.

Environmental Hazard – Aquatic Toxicity Symbol:

- Although not required in Canada, may still be seen on labels and SDS's.
- Signifies a product that may cause significant harm if released into a drain.

Labelling

Labels:

- WHMIS labels play an important role in conveying vital information.
- They provide information about:
  - Hazards of the product
  - Precautions needed for handling
  - Reference to MSDS/SDS.
- Three different types of WHMIS labels:
  - Supplier labels
  - Workplace labels
  - Laboratory samples
- Employers are responsible for labelling and relabelling.

Supplier Labels:

- Product identifier
- Supplier name/address/contact
- Hazard symbols
- Signal words (danger, warning, none)
- Hazard statements
- Precautionary statements.

Workplace Labels:

- Required for chemicals used in the workplace not in original supplier-labelled containers.
- Does not need to contain as much information as the supplier label.
- Name, safe handling information, and reference to (M)SDS.

Safety Data Sheets (SDS's):

- Suppliers must provide SDS for each material.
- Readily available for employees while working.
- Either be in electronic or hard copy.
- Under WHMIS 2015, supplier label must be updated by supervisor with hazard section of the SDS when new information available.

WHMIS 2015 (GHS) – Safety Data Sheets (SDS's):

- Identification:
  - Identifies material by brand, chemical, and generic name.
  - Intended use of the product is stated.
  - Supplier and manufacturer and contact information are also provided.
- Hazards – includes label information:
  - Includes regulatory information and exact statements and pictograms that will appear on label.
  - Useful for label changes and workplace labels.
- Hazardous ingredients and information:
  - Section 3 lists all hazardous ingredients and approximate percentage of each ingredient.
  - Chemical abstracts services or CAS number provides a unique number for each pure chemical and some mixtures.
- First aid measures
- Fire fighting measures:
  - Gives conditions for when fires may occur.
  - Also tells you what extinguishing media to use.
  - Tells you about hazardous combustion products.
- Accidental release measures:
  - If you are trained in spill control and the spill is small you can use this section to give you information on spill clean up.
  - If you are not trained, use the personal precautions to safely leave the area while waiting for a spill response team.
- Handling and storage
- Exposure controls/PPE:
  - First part is the level of exposure considered acceptable in a workplace.
  - Time Weighted Average is the average acceptable exposure for a 40-hr work week.

  - Short Term Exposure Level is the acceptable peak exposure for a 15 min period.
  - Ceiling is the max value the level in the air should ever reach.
  - Skin notation means absorption through the skin is an important route of exposure.
- Physical and chemical properties:
  - Can use this information to determine what conditions to avoid.
- Stability and reactivity:
  - If material is unstable in any way, you will find information here.
  - Section tells you what conditions and materials to avoid to prevent unwanted hazardous reactions.
- Toxicological information:
  - Details on toxic effects via different routes of exposure.
  - Almost no information on chemicals used only in the lab since they were never tested.
  - Acute effects like irritation or skin and eye damage are covered.
  - Can find information on chronic effects like the potential to cause mutations and carcinogenicity.
  - Also covers reproductive toxicity and teratogenicity.
  - Information on the potential to affect specific organs.
  - In this section you can find routes and effects of exposure.
  - Can be used for risk assessment.
- Ecological information:
  - Information on toxicity to aquatic animals, persistence, biodegradability, and other environmental measures.
  - Can be left blank in Canada as per federal regulations.
- Disposal considerations:
  - Section provides information on disposal contaminated packaging.
  - All hazardous wastes at UofT are handled by EHS Environmental Protection Services.
  - Also optional in Canada.
- Transport information
- Regulatory information
- Other information.

3 MODULE 3 – Hazards and Controls

Fume Hoods:

- Most common and effective engineering control to protect laboratory personnel against exposure to hazardous materials.
- A fume hood is a ventilated enclosure that draws contaminants away from the user and ensures that they are breathing clean lab air.
- Opening into the hood is controlled by one of more sashes.
- Two common types: constant air volume (CAV) and variable air volume (VAV).
- CAV exhausts air at a constant rate. As the sash is lowered the face velocity increases.
- VAV exhaust rate varies as the sash is adjusted to maintain a constant face velocity.
- Typical fume hood uses as much energy as a private home.
- Closing VAV hoods dramatically reduces energy costs.
- All equipment and materials should be placed at least 6 inches from the back of the face of the hood, these items should not obstruct the movement of air into the hood.
- Keep inside of the fume hood uncluttered.
- Should not be used as a storage area unless it is not in use.

Fume Hood Certification:

- The Office of EHS is responsible for performing the annual certification of fume hoods on all three campuses.
- Certification sticker and marker tape on hood indicate safe operating sash height.

Personal Protective Equipment:

- Lab coats:
  - Mandatory for all wet labs.
  - For work with flames or pyrophoric materials, treated cotton or Nomex is best.
  - For normal work, cotton/poly is OK.
  - No lab coat or gloves are to be used outside the lab.
  - One glove can be kept on handling hazardous materials but only a bare hand should touch door handles.
- Glove selection – ideal:
  - Need a glove that is not attacked by the material being used or by the solvent.
  - Also need a glove that does not allow material or solvent to penetrate.
- Glove types:
  - Lab gloves.
  - Thin types targeted at manual dexterity.
  - Usually 4 or 8 mil in thickness.
  - Double gloving and frequent changing of gloves is often the best defence.

  - Because no one "lab glove" can cover all hazards.
- Eye protection:
  - Safety glasses are for projectiles.
  - Goggles are for splash protection.
  - Fume hood and bio cabinet shields are not sufficient protection.
  - Safety eyewear is required as well.

Acids and Bases:

- Explosion hazard of acids:
  - Aqua regia.
  - Mix of common acids – concentration HCl and nitric acid (1:3 typical).
  - Used for cleansing glassware.
  - If it comes in contact with organics in sealed containers, it usually explodes.
  - Concentrated sulphuric acid can result explosion if mixed with water, bases, or organics.
  - Burns are worse due to dehydration by acid and generation of heat when it reacts with water in skin.
- Acid hazards:
  - Piranha solution is a mixture of sulphuric acid and peroxide.
  - Highly reactive because acid dehydrates peroxide producing atomic oxygen – free radical.
  - Powerful oxidizer can clean off elemental carbon.
  - Dangerous to make – intensely exothermic.
  - Greater than 50% peroxide can produce spontaneous explosions and is vigorous.
  - Should never be placed in sealed containers.
- Other acids:
  - Hydrogen fluoride is an extremely nasty acid that cause local burns.
  - Also is absorbed readily through the skin (non-polar).
  - Sequesters calcium in the blood.
  - Painful therapy to combat systemic effects.
  - Treatment involves extra calcium added to bloodstream intravenously.

Explosion Hazards:

- Peroxides combine fuel and oxidants and make good rocket fuel.
- Can form on storage of other mundane chemicals.
- Perchloric acid.
- Explosive residues from the acid itself and from metal perchlorates formed.
- Very reactive – resulted in fires at UofT.
- Must not be used in an ordinary fume hood.
- Need wash down system.

Mercury Hazard Awareness:

- Forms of mercury:
  - Elemental mercury
  - Organic mercury compounds
  - Inorganic mercury compounds.
- Usually enters the body through inhalation and skin absorption.
- Why is Mercury a Hazard?
  - Mercury is rapidly distributed throughout the body.
  - Mercury vapour readily penetrates cellular barriers.
  - Mercury can cause serious damage to number of systems in the body such as.

Legislations:

- Mercury is a designated substance.
- DSR for mercury came into force in 1982 and amended in 2000 and 2009.
- Regulation 490/09.
- DSRs were brought into being to control worker exposure to particularly toxic substances that were commonly used in industry.
- Total 11 designated substances under the regulation.

Disposal:

- NEVER put elemental mercury down the drain.
- Past practices have resulted in many spills of mercury from plumbing during construction.
- People become exposed as a result and the clean-up is very expensive.
- Call 8-7000 or follow departmental procedures.

Other Highly Toxic Materials:

- Arsenic Arsenates:
  - Inorganic arsenic and arsenates are highly toxic and can bioaccumulate.
  - They have been found to be teratogenic in animals.
  - Arsenic and its inorganic compounds are also confirmed carcinogens.
  - The occupational exposure limit is 0.01 ppm.
  - Arsine AsH3 is a particularly toxic gaseous form with an occupational exposure limit of 0.005 ppm or 5 ppb.
- Cyanides:
  - Hydrogen cyanide and its salts are highly toxic if they enter the body.
  - UofT has a Cyanide Protocol.
- IDLH and OEL's:
  - IDLH – Immediately Dangerous to Life and Health.

  - Level of exposure in humans that will cause irreversible damage.
  - Only available for common industrial chemicals.
  - Typically well derived numbers for very toxic materials.
- OEL – Occupational Exposure Limit:
  - Legal limits in Ontario is 40 hr work week.

Cryogens:

- Cryogens are typically stored in containers that are specifically designed for their usage properties.
- Safety features include:
  - Explosion – gas venting safety valves to prevent overpressure due to gas buildup.
  - Frangible disk in case of failure of valve to release pressure.
- EHS Office has developed a Control Program for Liquid Cryogenic Transfer Facilities.

Good handling practices:

- Must be handled in a well-ventilated area – usually a fume hood.
- Typically LN2 handling areas are well ventilated.
- Hazards:
  - Oxygen concentration as LOX
  - Materials that have a lower boiling point that O2 can cause liquid oxygen to condense
  - Pure LOX can cause inert materials to explode
  - Most common accident is when oxygen is left in a tube cooled in liquid nitrogen
  - Frostbite
  - Eye injury

Carcinogens, Mutagens, and Teratogens:

- Carcinogens:
  - Substance directly causing cancer
  - IARC is the institute that makes the definitive declarations on cancer causing agents
  - Professions and types of work can be cancer-causing agent.
- IARC:
  - Group 1 is definitely carcinogenic
  - Group 2A is probably carcinogenic
  - Group 2B is possibly carcinogenic
  - Group 3 is not classifiable
  - Group 4 is probably not carcinogenic.
- Teratogens:
  - Agents that cause harm to the unborn or future generations.
  - Affect both sexes and people of all fertility.

- Nanomaterials:
  - Many different types/structures.
  - Some are hazardous and some aren't.
  - Nanomaterials produce amplified or more targeted effects.
  - Good for drug delivery but we want to avoid inhaling them.
  - Primarily a hazard when airborne.

Electrical Safety Awareness:

- This course is meant for those who need awareness of electrical hazards because they work with electrical equipment.

Legislation in Ontario:

- Electricity Act is the act governing the use of electricity in Ontario.
- Ministry of Energy manages this Act, safety is handled by Part VIII.

Hazards of electricity:

- Electric shock occurs when the human body allows a current to flow to the ground.
- Occurs because the human body is a better conductor than many other materials such as plastic and wood.
- Electricity can cause burns, interfere with breathing and heart function, and cause muscle convulsions.

Arc Flash:

- Caused when a gap between high voltage conductors is shorted and powerful electric current is conducted through the air.
- Result is an explosion of hot air and metal and a flash capable of burning the skin.

Voltage/Amperage:

- Low Voltage/Amperage – 'household current.'
- Typical type of electricity we all encounter is the 120 to 240 V and 15-30 amp current found in all houses, offices, and labs.
- With sufficient exposure can cause an electric shock potentially leading to death.

Circuit Breakers:

- Designed to interrupt a circuit when too much current is being drawn.
- Happens, for instance, when a short circuit occurs.
- Includes when current is passing thorough a person to ground.
- Usually in a panel relatively far from where electricity is being used.

Breakers and overloading:

- Repeated tripping of breakers due to overloaded circuits can be dangerous.
- Note that breakers are designed to fail in the circuit broken position.
- However, they sometimes fail to break the circuit when needed; can be due to repeated tripping or other factors.

Ground Fault Interrupters (GFI's):

- Outlets or inline units that will stop supplying power in the event that a short circuit occurs.
- They are required within ∼5 feet of a water source.
- Respond faster than panel breakers.
- GFI's should be tested before the plug is used.

Extension cords:

- Extension cords should not be used as permanent wiring.
- Only to be used outside with GFI outlets.
- Never plug a power bar into another.

Laser Safety:

- Laser Hazards:
  - Corneal superficial or deep burns.
  - Cataract.
  - Retinal permanent damage of central or peripheral vision.
  - Optical nerve damaging.
  - Burns skin aging wrinkles cancer.
- Laser classification:
  - 4 classes – 1 is least dangerous and 4 is most dangerous.
  - Split into classes 1 and 1M, 2 and 2M, 3 and 3R.
  - There are limits for visible continuous point lasers.
- Laser usage:
  - Lower laser classes or embedded lasers possess low risk.
  - 3R and class 4 lasers must be registered with UofT prior to use.

Emergency Equipment:

- Eyewash station.
- Safety Shower.

Chemical Storage:

- Peroxides:
  - 3 months discard.
  - 1 year if concentrated.
  - 1 year – increased peroxide formation.

Glassware:

- Explosions:
  - Glassware that has exploded due to excess internal pressure and dramatic changes in temperature.
  - In many of these individuals a student's eyes have been saved by safety glasses.
- Inspection:
  - Glass flows over time and develops internal stresses.
  - If using glassware in a high stress role you should discard.

Bunsen and Meeker Burners:

- Open flames are always a special hazard in labs.
- Should be free of flammables and combustibles.
- Have a cover ready nearby.
- Be particularly careful with use of solvents that form columns of vapour.

Mechanical Hazards:

- Typically found in machine shops.
- Moving parts may catch hair, clothing, and cause serious injuries.
- All moving parts should be covered by guards when the equipment is in operation.