INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

Laboratory Safety Manual

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1. ILRI LABORATORY SAFETY PROGRAM

The ILRI Research Platform laboratories are located in Nairobi – Kenya and Addis Ababa - Ethiopia with Labs hosted by other institutions rented by ILRI in Locations where ILRI has Offices and / or projects.

It is the goal of ILRI to: provide employees with a safe and healthy working environment, promote safe and healthy work conditions and practices and establish and maintain an effective safety and health program

1.1 PURPOSE OF THE LABORATORY SAFETY MANUAL

The responsibility for the development, and monitoring of the ILRI Research Platform Safety Program lies within the Environment, Occupational health & Safety Office.

The manual has been developed to:

A) provide the laboratories with the most current safe work practices, guidelines and minimum standards they shall use in developing and improving their own occupational safety and health program;
B) To comply with the requirements of Kenyan legislation and other internationally acceptable standards.

It uses the OHSAS 18001 Specification and WHO guidelines as reference documents. It is anticipated that this manual will be reviewed and revised in five years from date of publication.

1.2 ILRI POLICY

ENVIRONMENT HEALTH & SAFETY POLICY

As a reflection of ILRI's core values of respectfulness, responsiveness and responsibility: ILRI requires all its campuses to promote excellence in Environment Health & Safety (EH&S) by:-

- Striving to continuously enhance the awareness of Environment, Health & Safety issues by developing and attaining EHS targets and objectives.
- Carrying out research activities in an environmentally and socially responsible manner.
- Providing information, training facilities and follow up to enable staff, contractors, collaborators and visitors carry out their duties safely without harm to themselves and the environment.
- Integrating Environment, Health & Safety activities in all planning, processes and decision making.
- Minimizing waste from source by substitution, recovery or land recycling and ensuring waste disposal on and off site is done in a responsible and acceptable manner.
- Adopting a comprehensive approach to research that includes exerting positive influence on collaborators and donors.
- Complying with local regulatory legislation and internationally acceptable Environment Health & Safety standards.
- Providing effective occupational health & hygiene programs.
- Involving employees in decision making on EH&S matters.
- Providing appropriate information and guidance to ILRI collaborators undertaking research on ILRI campus.
- Adopting, maintaining and testing procedures, contingency plans and resources for effectively dealing with emergencies.
- Reward members of staff who make outstanding contributions to the efforts of EHS department in its quest to achieve its objectives.

1.3 HAZARD PREVENTION PROGRAM REQUIREMENTS

The occupational safety and health program in ILRI Research Platform must follow the Hazard Prevention Program requirements of ISO 18000 guideline. The components of the program must include:

- an implementation plan;
- a hazard identification and assessment methodology;
- hazard identification and assessment;
- preventative measures;
- employee education; and
- a program evaluation

The ILRI laboratory safety manual provides tools to ensure compliance to these guideline requirements.

The hazard identification and assessment methodology and actual assessments are identified in the Job Hazard Analysis, Workplace Inspection and Hazardous Occurrence & Reporting Chapters.
The preventative measures component of the health and safety program are identified abundantly throughout the laboratory safety manual as many safe work practices are listed for the hazards identified.
The employee education requirements are identified throughout the manual as well as the training programs offered by the Environment occupational health & safety office (EOHSO)
The implementation plan component requirements are met by using the laboratory manual as a tool to provide guidance on what to implement in each ILRI laboratory. Institutional performance objectives are developed based on Continual Improvement Reviews that are performed at the laboratory.

1.4 DUE DILLIGENCE

Due diligence is the level of judgment, care, prudence, determination, and activity that a person would reasonably be expected to have under particular circumstances. Applied to occupational health and safety, due diligence means that employers shall take all reasonable precautions, under the particular circumstances, to prevent injuries or accidents in the workplace. This duty applies to situations that are not addressed elsewhere in the occupational health and safety legislation.
To exercise due diligence, an employer must implement a plan to identify possible workplace hazards and carry out the appropriate corrective action to prevent accidents or injuries arising from these hazards.
ILRI Research Platform will meet its due diligence requirements if they have in place a safety program that complies with this laboratory safety manual. This would include written safety policies, procedures, practices, training and auditing.

1.5 ROLES AND RESPONSIBILITIES

1.5.1 *Duties of Employers, Employees, Occupational health & safety Committee (OHS) Members and Occupational health & safety Representatives*

Many specific duties of employers, employees, OHS committee members and OHS representatives are identified in each chapter of the laboratory safety manual.

Although work place safety and health is a shared responsibility by both the employer and employee, the overall responsibility to ensure that the requirements of this manual and the ILRI OHS program are met, is the Deputy Director General – Research.

The Deputy Director General - Research in cooperation with the Environment Occupational Health & Safety Officer and the Institutional Environment Occupational Health & Safety committee will develop yearly continual performance objectives for ILRI.
It is essential that managers consult with and involve employees and Occupational Safety and Health (OHS) Committees. All OHS Committee members should strive to reach a consensus at meetings in an attitude of cooperation.
OHS legislative responsibilities are as follows:

Factories Act (Kenya & Ethiopia)
The Occupational Safety Act (2007) Kenya
ILO guidelines
WHO guidelines
OIE guidelines
NIH guidelines

In addition to the requirements of this acts and guidelines, the employer must also perform a survey of their facility to determine the location and condition of any material containing asbestos.

1.5.2 *ILRI Environment Occupational Health & Safety Officer (EOHSO)*

The role of the *ILRI Environment Occupational Health & Safety* Officer is to establish and maintain a ILRI-wide safety program in coordination with laboratory area coordinators, Safety Representatives, safety committees, managers and employees.
The EOHSO is a resource that the laboratories can use on OHS issues in consultation with the Safety

Committees and laboratory staff, develop ILRI safety policies and procedures including this manual;

- co-ordinate development of the ILRI safety program;
- provide guidance and advice on safety policies;
- monitor and audit safety programs for compliance with legislation, policies and procedures;
- act as a resource for laboratory area coordinators, Safety Representatives, safety committees, laboratory managers and employees;
- review and approve protocols, manuals and guidelines relating to safety and containment; and
- promote and provide safety and health training.
- coordinates the completion of the Employers Annual Hazard Occurrence Report Form and the Annual OHS Committees Report. as required by Department of Occupational health & Safety.
- serves as a liaison for the ILRI Research Platform with regulatory officials and agencies such as the Public Health, Department of Occupational Health & Safety, Fire Departments and other government regulatory bodies.

1.5.3 ***Laboratory area coordinator (LAC)***

At each laboratory there is a local contact for the EHSO to network with on OHS issues. This person is Safety Representative for their work site. They may also have no other role to play in safety other than that required in this section.

- to be a liaison from the EOHSO to the laboratory area and employees relating to information on the ILRI OHS program;
- the LAC may gather, with supervisory approval, OHS related information at the work site upon request from the EOHSO;
- the LAC should attend the site safety Representatives committee meetings.
- maintain current knowledge and reference materials on safety regulations, policies and procedures;
- provide safety and health consulting services for employees, supervisors, safety and health committee members;
- establish and monitor safety and health programs including WHMIS, emergency response and TDG;
- prepare and review standard operating protocols and procedures with regards to safety and health and coordinate preparation and review of research SOPs;
- coordinate safety and health training, including the safe use of personal protective equipment;
- distribute safety-related educational/awareness materials and information;
- ensure that new employees complete their OHS orientation. This would include reading the pertinent sections of this manual and completing a test. They would also have to ensure that the local OHS orientation requirements are completed;
- assist the safety and health committee with annual facility inspections, investigation of all workplace accidents, and other committee activities;

1.6 TRAINING

Training is the cornerstone of any occupational health and safety program. The requirements for training are specified throughout the manual. There is also a ILRI OHS Training sop that must be followed. Environment Occupational Health & Safety Office offers several courses for ILRI laboratory staff. These courses include;

- Workplace Hazardous Materials Information System (WHMIS) Course
- Safe Transportation of Dangerous Goods Training – 2 days
- Occupational health & safety Committee Course - 2 days
- Handling Small Chemical Spills Course - half day
- Use of chemical/ Biological Safety Cabinets – 2hrs
- Handling of chemical/biological or radiation spills – half a day
- Biological safety training – 2 days
- Chemical safety training– 2 days
- Radiation safety training– 2 days
- Animal handlers training – 1 day

The following videos are available on request from the EOHS office;

Title	
Safety in the Research Laboratory ▪ Radio nuclide Hazards ▪ Chemical Hazards ▪ Emergency Response	Howard Hughes Medical Institute
Safety in the Research Laboratory ▪ Chemical Storage Hazards	Howard Hughes Medical Institute
Safety in the Research Laboratory ▪ Assessing Risks of Toxic Chemicals	Howard Hughes Medical Institute
Safety in the Research Laboratory ▪ Centrifugation Hazards	Howard Hughes Medical Institute
Laboratory Safety and Health	Kaufman and Associates
ETHIDIUM - The Red Medicine	Country wise Communication
Safe Use of Pesticides in the Greenhouse	Michigan State University
W.H.M.I.S.	Health and Welfare Canada
Pesticide Handlers and the Worker Protection Standard	
Radiation Video ▪ Liquid Scintillation ▪ Filter Counting ▪ Coated Plate Assays ▪ Luminescence	
Safe Use of Biological Cabinets or The Case of the Contaminated Cultures	Eagleson Institute
Safe Use of Chemical Fume Hoods	Eagleson Institute
Health and Safety Starter Pack DVD: ▪ Manual Handling ▪ Fire Risk Assessment ▪ Computer Safety ▪ Driving Safety ▪ Risk Assessment ▪ Stress in the Workplace	Seton

▪ Fire Safety Essentials ▪ Health and Safety Induction ▪ Health and Safety in the Office ▪ Slips, Trips and Falls	

Contact the EOHSO (e.khaemba@cgiar.org) for more information on the above mentioned training /courses videos or for an updated list.

1.7 DOCUMENTATION

Procedures must be established and maintained for documentation supporting the OHS policy and the requirements specified in this manual.
The format of the documentation is dependent on several factors. Some of the documentation required must follow a specific format as outlined in this manual or legislation.
All ILRI Research Platform are advised to meet the requirements of ISO/IEC 17025.

The documentation procedures must include :

- current versions that are readily available and easily accessible.
- periodically reviewed, revised
- approved for adequacy by authorized personnel.

1.8 RECORDS AND RECORD MANAGEMENT

Each ILRI laboratory Platform shall establish and maintain records and a records management system.
The following is a minimum standard of OHS records that must be kept on file and maintained at each laboratory platform. Questions relating to how long certain records must be kept on file can be addressed to the EOHSO. Other chapters of this manual, legislation and individual laboratories may require more documentation than stated below.

- OHS Training Records
- Work Place Inspection Reports
- Hazardous Occurrence/Incident Reports
- OHS Committees Meeting Minutes
- Hygiene Reports
- Air Monitoring Reports
- Personal Protective Equipment - Use, Maintenance and Fit Testing Records
- Annual Employers Hazardous Occurrence Report
- Annual OHS Committee Report
- OHS and Fire Inspection Reports
- Fire & Other Emergency Equipment Testing Records
- Emergency Response Drills
- Risk Assessment, Job Hazard Analysis (JHA) & Safe Work Practices
- New Equipment Safety Review (which may be part of the JHA process)
- Record of Injuries and Occupational Diseases
- Internal & External Audits and Continual Improvement Reviews
- Kenyan Radiation protection board License
- ILRI Radiation Safety certificate
- Inspection, Maintenance & Calibration Records (such as bio safety cabinets, fume hoods, boilers, autoclaves)
- Transportation of Dangerous Goods Training Records

1.9 AUDITS AND CONTINUAL PERFORMANCE REVIEWS

Audits and continual performance reviews of the ILRI Laboratory OHS Program will be conducted by the EOHSO. The audits will be based on current performance reviews of OHS program elements.

1.10 SENIOR MANAGEMENT REVIEWS

To ensure the success of the OHS program, senior managers (Directors of ILRI) must participate in reviewing the program on an ongoing basis. This involves as a minimum reviewing;

- Hazardous Occurrence Reports
- Work Place Inspection Report
- OHS Audits & Continual Performance Review

Any OHS related reports submitted by other government departments such as

- Kenya Plant Health Inspectorate Services (KEPHIS), Department of Veterinary Services (DVS), National Council of Science & Technology (NCST) etc.
- Hazardous Occurrence Reports Analysis
- OHS Committee Reports

2. SAFE USE OF LABORATORY EQUIPMENT

Working with laboratory equipment is a daily task for many employees. The safe use of this equipment is an important element of a hazard prevention program. The following safe work practices provide minimum standards for ILRI employees to follow when working with the equipment.

NOTE: Before a new piece of laboratory equipment is purchased, the employer must perform a safety assessment to ensure all hazards associated with the use of the equipment are identified.

2.1 SAFE WORK PRACTICES

2.1.1 Autoclaves[1]

- wear personal protective equipment including heat & cut resistant gloves, a rubber apron, rubber sleeve protectors, and if there are sharps hazards (e.g. biological waste) wear heat and cut resistant gloves
- before using the autoclave, check inside the autoclave for any items left by the previous user that could pose a hazard (e.g. sharps)
- clean the drain strainer before loading the autoclave
- check plastic materials to ensure they are compatible with autoclaving, including bags (some impede steam penetration while others may melt during the cycle), containers, trays and items to be autoclaved
- do not overload bags and containers (should not be more than 3/4 full). Avoid stacking or crowding of items. Load autoclave as per manufacturer's recommendations
- containers and bags can be placed in trays to contain spillage, however, bags loaded into trays with deep sides may require longer cycle times as air pockets may be created at the bottom of the container; use trays with low sides
- arrange containers and bags in the autoclave in a manner that permits free circulation of steam around each container
- to prevent bottles from shattering during pressurization, the caps of containers with liquids must be loosened before loading
- use a tray with a solid bottom and walls to contain the contents and catch spills
- individual glassware pieces should be on a tray on a shelf or rack and never placed directly on the autoclave bottom or floor
- make sure the door of the autoclave is fully closed (latched) and the correct cycle has been selected before starting the cycle
- before removing autoclaved items; wait 5 minutes for loads containing only dry glassware; 10 minutes for autoclaved liquid loads; let glassware cool for 15 minutes before touching it with ungloved hands; let liquids stand for a full hour before touching with ungloved hands; be sure others in the area know a heat hazard is present

2.1.2 Biological Safety Cabinets

Follow these **start-up procedures** when preparing for work in the BSC:

- turn on the fluorescent light and cabinet blower if off
- check the air intake and exhaust grilles for obstructions, and check the pressure gauge reading (indicates filter loading; if you don't know what the acceptable reading is for your cabinet ask the certifier)
- if the cabinet is equipped with an alarm, test the alarm and switch it to the "on" position
- confirm inward air flow by holding a tissue at the middle of the edge of the viewing panel and ensuring that it is drawn in at an angle of 450

- allow the cabinet to operate unobstructed for 10 minutes
- disinfect the interior surfaces with 70% ethanol, or a suitable, non-corrosive, disinfectant
- assemble all materials required for the procedure and load into the cabinet; do not obstruct the air grilles; depending on the work performed it may be necessary to line the working surface with absorbent paper with plastic backing; segregate "clean" items from "contaminated" items
- wait five minutes to purge airborne contaminants from work area

Follow these procedures for working in the cabinet:

- don protective clothing and gloves as appropriate
- perform operations as far to the rear of the work area as possible
- avoid moving materials or excessive movement of hands and arms through the front access opening during use; such movements disrupt the laminar air barrier at the opening of the cabinet which can allow contaminants to enter or escape from the cabinet; when you do enter or exit the cabinet, do so from straight on; allow the cabinet to stabilize before resuming work.
- keep discarded contaminated material to the rear of the cabinet; do not discard materials in containers outside of the cabinet
- do not work with open flames inside the cabinet; the provision of natural gas to BSCs is not recommended. Open flames in the BSC create turbulence, disrupt airflow patterns and can damage the HEPA filter; when suitable alternatives (e.g., disposable sterile loops, micro-incinerators) are not possible, touch-plate micro burners that have a pilot light to provide a flame on demand may be used.[2]
- if there is a spill during use, all objects in the cabinet should be surface decontaminated; disinfect the working area of the cabinet while it is still in operation (do not turn the cabinet off) see Spills Chapter for more information

Follow these procedures upon completion of the work:

- allow the cabinet to run for five minutes with no activity
- objects in contact with contaminated material should be surface disinfected before removal from the cabinet
- open containers should be closed or covered before being removed from the cabinet
- remove contaminated gloves and dispose as appropriate; wash hands
- don clean gloves and remove materials from cabinet to biohazard bag for autoclaving, incubator, etc
- using 70% ethanol, or a suitable non-corrosive disinfectant, disinfect interior surfaces of the cabinet; periodically remove the work surface and disinfect the area beneath it; periodically wipe the surface of the UV light with ethanol
- turn off the fluorescent light and cabinet blower when appropriate (some cabinets must be left on at all times; if you are unsure, check with your cabinet certifier, safety officer, or building maintenance staff)

2.1.3 - Ultraviolet Radiation in Biological Safety Cabinets

The use of Ultra Violet(UV) Radiation germicidal lamps in Biological Safety Cabinets is strongly discouraged. Any persons wishing to use the UV in the BSCs must receive training on the following safe work practices and on the hazards of UV radiation before they use the lamps.

- UV irradiation of the work area should only be used as a SECONDARY method of maintaining the disinfected status of a cabinet. NEVER rely on UV alone to disinfect a contaminated work area
- UV light is ineffective if a microbial cell is protected by dust, dirt, or organic matter. A liquid chemical disinfectant should be the primary method of cleaning and disinfecting the interior of a BSC
- UV light does not penetrate into cracks or through the grill work of a BSC. The spill area under the work

surface of a BSC is a favorite hideout for fungal spore and hardy bacteria
- the intensity of the UV lamp is affected by the accumulation of dust and dirt on its surface.
- do not touch a UV bulb with your bare hands; the natural oils on your hand may leave a fingerprint and create dead space on the bulb's surface.
- UV bulbs must be cleaned frequently, by turning off the UV light and wiping off the surface of the room temperature bulb with 70% alcohol
- the fan should be off, and the sash should be closed, if possible, when the UV light is on.
- the UV lamp should NEVER be on while an operator is working in the cabinet, or nearby, as exposure to UV light can cause painful eye and skin burns
- signage is REQUIRED on the front of the BSC which indicates the presence of UV light hazards along with general usage and personal protection requirements
- the stainless steel interior of the BSC will reflect potentially hazardous illumination around the inside and out of the opening of the cabinet. UV lamps should be turned OFF while the room is occupied by other personnel
- UV exposure can cause damage to the cornea of the eyes, skin burns and skin cancer. This can exists well after the output of the lamps has dropped below the biocidal level
- the UV lamp should be tested with a UV meter during the annual certification of the BSC, by an approved BSC certifier to ensure that the proper intensity (I=1/d2; 40 microwats/cm2) is being delivered at the appropriate wavelength (253.7nm) in the center of the work surface
- due to the mercury content of a UV lamp, it must be disposed of as a hazardous waste
- UV light can cause deterioration of some tubing; this can be dangerous if you are using a touch-o-matic burner with natural gas tubing in a BSC
- UV light cannot be considered as a possible decontaminant unless the lamp is properly maintained (cleaned often and checked yearly)

A significantly more effective and recommended strategy to reduce or eliminate contamination utilizes well-practiced microbiological procedures, good aseptic techniques, standard operational procedures for working in BSCs, and thorough decontamination procedures with a tested, effective disinfectant before and after BSC use.[3]

2.1.4 Centrifuges

Centrifuges may pose a hazard as a result of the creation of infectious aerosols and hazardous chemical leaks.
- use stoppered tubes that have been inspected to be free of cracks or chips; stress lines can develop at the junction of the sides and bottom of tubes
- ensure that the cups are properly balanced
- ensure to properly attach the rotor and lid
- use sealed safety cups or rotors that are loaded and unloaded in a biological safety cabinet or fume hood. The outside of the cups should be disinfected when removed from the cabinet. Using individually sealed carriers may reduce the amount of aerosols or chemical vapors in the event of a breakage.
- floor model centrifuges used for biologics should ideally be located in a separate room with the exhaust vented through a HEPA filter; biological safety cabinets will only provide containment for some small, low-speed centrifuges
- for centrifuging solvents, a mobile exhaust hood should be positioned over the centrifuge to capture vapors when a sample tube breaks
- the use of free spinning centrifuges is prohibited
- all centrifuges must be equipped with a locking mechanism so that the lid is not opened while the rotor is turning. Older models which do not have a lock-out mechanism should have a warning sign and this warning should be part of the operating instructions.

If **breakage is known or suspected** to have occurred during centrifugation:
- power should be switched off and machine left unopened for at least 30 minutes to allow aerosols or vapors

to settle
- wearing suitable protective clothing (strong gloves, respirator in some cases) and using long forceps, remove carriers and any broken glass
- soak broken tubes and glass in disinfectant; swab all contaminated surfaces, including cups or buckets, trunnions and rotor with a non corrosive disinfectant; autoclave as many parts as possible
- if breakage involves a biologic, disinfect bowl of centrifuge allowing sufficient contact time with disinfectant prior to clean up

2.1.5 Ultracentrifuge

The ultracentrifuge is a commonly used piece of laboratory equipment that rapidly spins materials in a rotor while under vacuum in order to separate materials by density. Its rotors are exposed to enormous forces every time they are used. Experience has shown that when rotors are used incorrectly, they can fail catastrophically, resulting in destruction of the entire centrifuge and damage to the laboratory.

To prevent such failure of the equipment, all ultracentrifuge manufacturers require that ultracentrifuge users maintain an up-to-date use log for each rotor. Manufacturers also require that each time a rotor is used, it must be given a thorough visual inspection for any signs of damage or weakness.

The purpose of the use log is to ensure that the amount of stress imposed upon the rotor is known exactly, so that the rotor may be used for its full lifetime without risking excess stress.

A rotor can also be "de-rated" by a qualified service technician, who establishes a new, lower rpm and G-force limit for the remainder of the rotor's life. This can extend the rotor's useful life, as long as it is never exposed to conditions that exceed the reduced rating. In order to ensure safety, ultracentrifuge users should do the following:

- Read carefully (and reread if it's been a long time between uses) the manufacturer's instructions for use and care of each rotor you use. Different manufacturers of very similar rotors may have different requirements based upon rotor characteristics that may not be visible. Users must understand the applications and limitations of each individual rotor.
- Take time to visually inspect each rotor for any signs of damage, corrosion, or weakness before using it, every time it is used. Be careful to keep the rotor chamber or swinging bucket pairs correctly balanced, and make absolutely sure that the rotor cover is attached correctly. Enter each rotor use in the log when the run is completed. Immediately clean up any spills that occur anywhere on the ultracentrifuge or rotor and dry the rotor before oxidation can occur.[4]

2.1.6 Microscopes

It has been determined that microscope eyepieces may provide a potential route of transmission of both bacterial and viral infections. Large outbreaks of conjunctivitis have been attributed to the sharing of microscopes among employees. See also the Ergonomics chapter for information on microscopes.
To prevent the transfer of pathogens:

- gloves used to handle contaminated specimens should be removed before using the microscope
- disinfect microscope eyepieces and other areas that may be contaminated using a non corrosive, nontoxic disinfectant,

When using a fluorescent microscope:
- do not open the lamp housing when in operation or when hot from recent use for any type of microscope
- wear a face shield and gloves when changing mercury bulbs (mercury bulbs may implode, causing contamination)

Immersion oils containing polychlorinated biphenyls (PCBs) should not be used. It is also good practice to wash hands before using the microscope.

2.1.7 Microtomes

The following safety precautions should be followed when working with microtomes and microtome knives:

- always keep the knife in the knife case when it is not in the knife holder
- if possible, clamp the specimen before securing the knife
- make sure the microtome is in the locked position when positioning paraffin blocks
- when changing the specimen, cover the knife edge with the guards or remove the knife from the holder
- use a brush, forceps and microscope slide to remove sections from the knife; don't use your fingers

2.1.8 Microwave Ovens

All microwave ovens should receive regular maintenance and cleaning. Inspect door seals to ensure there is no damage to any part of the seal or door. Exercise caution when heating liquids; superheating is possible. Verify that metal is not in or on the containers nor the samples to be microwaved. Metals in the microwave may cause dangerous electrical arcs and fire. Signage should be posted on the outside of doors in rooms where microwaves are in use.

2.1.9 Mixers, Blenders, Grinders, Sonicators

These equipment items pose a danger of: 1. creating and dispersing infectious aerosols 2. chemical hazards 3. noise hazards and 4.the physical hazards of moving parts to the operator.

- infectious aerosol generating equipment used to manipulate infectious materials must be operated in a biological safety cabinet. All containers should be opened in a biological safety cabinet after processing
- Inspect equipment before use for damaged parts (e.g., gaskets, caps , bottles) and verify that it is specifically designed for laboratory use with built-in safety features (e.g. stainless steel construction, autoclave able etc.)
- when operating blenders, wrap the lid with a disinfectant soaked paper towel
- blenders should be designed to prevent leakage from the rotor bearing or at the cover
- allow aerosols to settle by wait a few minutes before opening the containers
- be aware of the hazards associated with moving parts of the equipment; wear protective eyewear and hearing protection (if noise level exceeds legislative standards)
- do not use flammable solutions in a sonicator; use water-based solutions only; do not place anything on a tank bottom and run with levels recommended by the manufacturers
- when grinding dry materials, use local ventilation or respirators to control fine particulate matter

2.1.10 Needles, Broken Glass and Other Sharps

In addition to accidental injections, needles, broken glass and other sharps can create hazards from infectious aerosols. For example, using used syringes cut with needle cutting devices prior to disposal has been demonstrated to generate infectious droplets and aerosols. Accidents involving the use of syringe filter units have resulted in infectious material and chemical being sprayed into the eyes of users.

- dispose of needles directly into a sharps container; do not bend, break or recap needles; do not remove needles from disposable syringes
- use only needle locking syringes (Luer-lok type)
- inspect all glassware for cracks, stars, or stress lines before use
- use long forceps or tongs to pick up pieces of broken glass; use a brush and dustpan to pick up small pieces and a wet paper towel held in tongs to pick up tiny glass particles broken glass and other sharps that have been decontaminated must not be mixed with the regular garbage, they should be placed in a well-labeled, puncture-resistant container
- avoid filtering viscous fluids or heavy suspensions that may clog the filter and force it from the syringe. Ideally, this procedure should be carried out in a BSC or fume hood, but when this is not possible, gloves and a face shield should be worn
- pass liquids slowly through the filters to avoid creating high pressures

2.1.11 Pipettes

Historically, pipetting was responsible for a number of laboratory-acquired infections and ingestion of hazardous chemicals. These incidents are completely avoidable. There are a large variety of pipetting aids on the market to suit individual needs and preferences. Additionally, studies have demonstrated the production and dispersal of infectious aerosols from sloppy pipetting procedures.

- never pipette by mouth; use a mechanical pipetting device. For microbiological purposes, these should be autoclavable and be provided with aerosol protection to reduce the possibility of contaminating the pipetting aid.
- avoid mixing by alternate suction and expulsion through a pipette; do not bubble air from a pipette to mix fluids
- plug the top end pieces of pipettes with cotton
- avoid loss of material from the tip of the pipette onto hard work surfaces; a disinfectant soaked paper towel should be placed on the working surface
- the contents of the pipette or tip should be expelled gently down the sides of tubes or discharged slowly close to the surface of a liquid
- use pipetting devices equipped with filters to protect the device from internal contamination

2.1.12 Vacuum Equipment

Central vacuum systems as well as portable systems from biosafety areas should have a disinfecting trap and HEPA filter in line before entering the vacuum lines. This will keep the lines and collection systems from being contaminated and keep biohazards from being discharged to the atmosphere.

Vacuums employing water baths in conjunction with evaporation equipment (i.e. rotovaps attached to bench top vacuum generators) have the potential to absorb the highly volatile solvents. During maintenance of such systems, water from the vacuum equipment should be disposed of with chemical waste not down the drain.

2.1.13 Water Baths

Water baths can become contaminated with infectious agents and pose aerosol hazards to workers and contamination hazards to research materials. To prevent contamination, clean the water bath regularly and add a disinfectant (quaternary ammonium compounds or phenolics are available specifically for water baths).

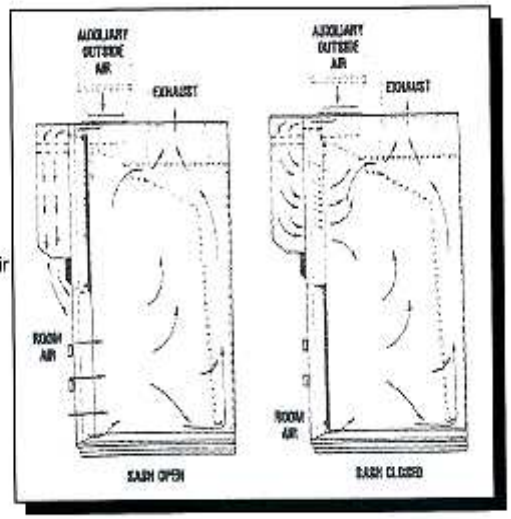
2.2 TYPE OF FUME HOODS

Fume hoods should be routinely used to contain hazardous gases, vapors, mists, aerosols and particulates generated

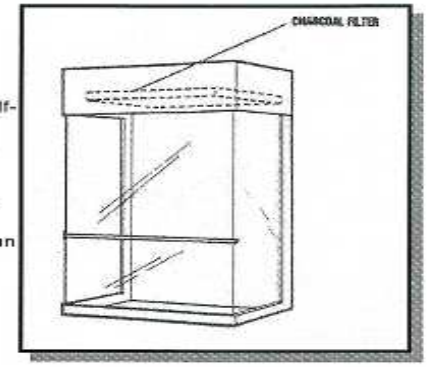
during the manipulation of chemical substances. Airflow into the hood is achieved by an exhaust blower which "pulls" air from the room into and through the hood and exhaust system. This "pull" at the opening of the hood is measured as face velocity.

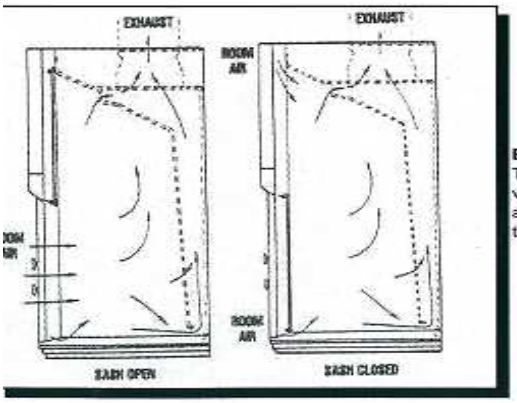
All laboratory fume hoods can be described as one of four types: by-pass, re-circulating, conventional, auxiliary air.

Auxiliary-air hoods
Auxiliary-air hoods are special hoods with a supply air system separate from the room supply system.

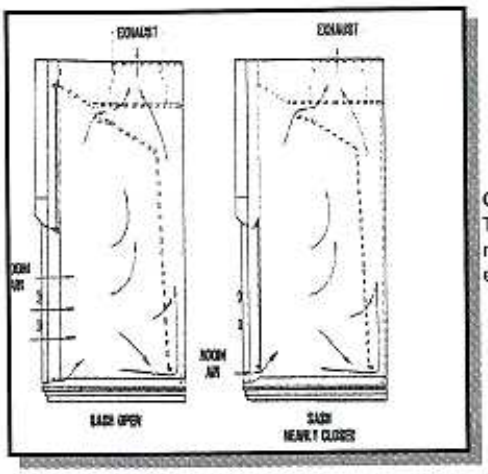


Ductless/recirculating hood
Ductless/recirculating fume hoods are self-contained units which filter air from the hood and return it to the laboratory. The filters are designed to retain specific chemicals, however, without strict monitoring, there is a potential danger of releasing trace quantities into the laboratory air. They are less desirable than conventional fume hoods.





By- pass hood
The bypass hood operates at a constant exhaust air volume, regardless of sash position. This is accomplished with openings above the hood sash, through which air passes when the sash is closed.



Conventional hood
The conventional hood is a basic enclosure with a movable front sash. As the sash is opened the air volume entering the hood remains constant.

Perchloric acid should only be used in a designated perchloric acid hood. These hoods have special construction materials to prevent a reaction with perchloric acid, integral work surfaces, "wash-down capability" and coved interiors.

Canopy hoods are designed to remove steam or odors from large apparatus such as ovens, steam baths or autoclaves. Canopy hoods are not suitable for most chemical work and must not be used as a substitute for a fume hood. They draw contaminated air through the breathing zone of the user, are ineffective in capturing heavy vapors and aerosols, are highly affected by air turbulence and fail to provide adequate "pull" beyond [3]a few inches from the opening.

Slotted benches have narrow horizontal openings at the rear of a work bench, connected to an exhaust duct. They are only suitable for work with low to moderate toxic materials.

2.2.1 Fume hood Safe Work Practices

Containment and efficient removal of fumes are only effective if fume hoods are maintained and used properly. The following recommendations should be observed when operating chemical fume hoods:

- each hood must be checked for adequate face velocity upon installation, and at least annually thereafter in accordance with applicable testing standards; the correct face velocity should be prominently displayed on the fume hood (for conventional hoods this is normally 0.40 and .50m/s (80-100 fpm) with a sash opening of 30cm)
- a maintenance program must be developed and include the following: every six months the baffles, sash and interior surfaces should be cleaned; every 12 months additional maintenance should include inspection for corrosion and correct operation, and testing of all systems and alarms
- the face velocity should be verified before commencing work; check the indicator, if present. Attaching a strip of paper to the opening only tells you if there is inward airflow (i.e. it does not give an indication of the face velocity)
- an alarm warning, both visual and audible, alerting users of incorrect face velocities or abnormal airflow conditions would also be beneficial installed on the fume hood. The warning system must also be maintained.
- stop working in the fume hood if the ventilation system malfunctions and immediately report the problem to your supervisor
- have an emergency plan in case of spills or power failure

- when working in the fume hood or performing maintenance, personal protective equipment is required (gloves, eye/face protection)
- materials should be placed at least 15cm inside the hood; large apparatus can obstruct airflow and can be slightly elevated to allow fumes to pass under them
- keep all objects away from the air foil and baffle openings
- adjust the sash to the smallest opening in which you can work comfortably to maximize face velocity, minimize exposure and provide additional physical protection from splattering or explosion
- always open the sash slowly and use slow arm movements while working in the hood
- only equipment and chemicals involved in the experiment should be present in the fume hood so airflow is not jeopardized; the hood must not be used as a storage cabinet
- avoid cross drafts in front of the hood (i.e. open windows, heavy pedestrian traffic, opening and closing doors
- never remove the air foil or modify a chemical fume hood in any way
- do not lean your head into the hood. It will disturb air flow and places yourself at risk of chemical exposure
- when the hood is not in use the sash should be closed

2.3 EMERGENCY EQUIPMENT

2.3.1 Fire Extinguishers

Employees working with flammable liquids must receive training on the types and proper use of fire extinguishing equipment. Most laboratories have the potential for class A (combustibles - wood, paper, cloth), class B (liquid fuels - solvents, oil, gasoline), class C (electrical - fuse boxes, motors), and less commonly class D (combustible metals - sodium, potassium, phosphorus) fires.

- carbon dioxide extinguishers can be used for class B and C fires
- ABC dry chemical extinguishers are most versatile and can be used against class A, B and C fires; the dry chemical residue is a corrosive powder which must be cleaned off
- water extinguishers are only useful for class A fires; can be dangerous if used around electrical equipment
- class D dry chemical extinguishers are designed for metal fires only

To Use a Fire Extinguisher follow the steps below:

P: Pull and twist the locking pin to break the seal
A: Aim low, and point the nozzle at the base of the fire
S: Squeeze the handle to release the extinguishing agent
S: Sweep from side to side until the fire is out

Be prepared to repeat the process if the fire breaks out again.

2.3.2 Eyewashes and Safety Showers

Emergency eyewash and shower equipment should be provided wherever there is risk of accidental splashes of chemicals to the skin or eyes. This equipment must conform to the requirements of the American National Standards Institute (ANSI) standard Z358.1- 1998 "Emergency Eyewash and Shower Equipment".

2.3.3 Safe Work Practices for Eyewashes and Safety Showers

- only potable water should be supplied to eyewashes and safety showers
- delivered water temperatures should not be at the extremes (comfortable range is 15oC - 35oC)

- such equipment should be located within 10 seconds to reach and 100 feet from the chemical hazard
- they should be easy to locate (e.g., in the normal path or egress) and identified with a highly visible sign
- eyewashes must be capable of delivering greater than 1.5 litres/min of water for 15 min.
- they should deliver a curtain of low-pressure aerated water, preferably over the entire face (most splashes into the eye also splash surrounding skin); plumbed eyewash stations (i.e., permanently connected to a source of potable water) are recommended.
- small eyewash units attached to the laboratory sink are not as good as the special-use units because their operation can be compromised by some activities in the sink.
- eyewash bottles are not acceptable eyewashes. They do not deliver sufficient amounts of water and are often contaminated with microorganisms
- portable, self-contained eyewash stations also have a limited amount of fluid and pathogenic amoebae capable of causing serious eye infections have been found in these stations
- hand-held drench hoses may be used in conjunction with safety shower/eye wash stations but are not a substitute for them; they are versatile and useful for splashes to small areas of the body
- all employees who might be exposed to chemical splashes and dust, particles or objects entering the eye must be trained in the proper use of emergency eyewashes and showers; the following recommendation should be followed:
- know the locations of safety showers and eyewashes, and how to use them; keep routes free and areas under showers clear
- eyes should be flushed for at least 15 minutes, holding the eyelids open; rinse the eyes completely, under and behind the eyelid (this may be difficult as the natural tendency is to close the eyes, however, if sufficient washing has not been accomplished, severe and irreparable damage can result)
- if only one eye is splashed, take care not to contaminate the other eye (e.g., hold other eye closed, cover other eye with the non contaminated hand)
- training for eyewashes should include instruction in the removal of contact lenses (the wearing of contact lenses is not recommended in areas where the potential for hazardous materials entering the eye exists)
- for splashes to the body, the entire showering time should be no less than 15 minutes; once clothes have been completely soaked, they can be removed (at least down to the underwear) during the showering process
- a helper may be required to ensure complete cleansing
- always seek medical attention as soon as possible after the 15 min wash period
- in some situations, shower water and clothing may need to be disposed of as hazardous waste
- eye/face washes must be activated weekly to flush the line and verify proper operation; let the water flow for at least three minutes
- showers must be activated weekly to flush the line and verify proper operation

2.4 FIRST AID

First-aid services must be provided to employees in accordance with the *Factories and other places of work Act*. Requirements of these directives include reporting procedures, training, and the provision of first-aid attendants, kit, and rooms.

- employees sustaining injuries or illness shall report to a first-aid attendant or seek medical treatment as required
- In the event of accidental contact with the skin or eyes, use eyewash stations and chemical deluge showers to flood the affected area for at least 15 minutes; always seek medical attention.
- every injury or illness which requires first-aid treatment shall be recorded in a treatment record book and maintained for 10 years
- adequate numbers of qualified first-aid attendants (holding valid St. John Ambulance Standard First-Aid Certificate) shall be maintained
- up-to-date lists containing the names and location of first-aid attendants must be

posted by the telephone in all areas

- arrangements for first-aid training is the responsibility of the employer
- first-aids kits placed throughout the laboratories and at designated first-aid stations must include the items that may be needed for emergencies as determined by the risk assessments.
- Cyanide antidote kits and oxygen are available for exposures to cyanide; all employees working in the area where cyanide is used must be trained in the use of the kit and administration of oxygen; a specific protocol must be established for cyanide work

3.0 BIOLOGICAL SAFETY

This biosafety section of the manual meets the requirements of the following publications.

- Laboratory Biosafety Manual, 2nd Edition, World Health Organization,
- Laboratory Biosafety Guidelines, 3rd Edition, Health Canada,
- Containment Standards for Veterinary Facilities 1st edition, 1996 ILRI,(2nd edition in progress)
- OIE standard for contained veterinary Facilities

It would be prudent to have the most current electronic or hard copies of these documents.

3.1 HANDLING OF INFECTIOUS AGENTS

3.1.1 Laboratory-acquired infections

Laboratory-acquired infections in laboratory personnel handling human pathogens, zoonotic agents, cell cultures, animals and diagnostic specimens can happen. Such agents as Brucellosis, tuberculosis, Q fever, psittacosis, leptospirosis and vesicular stomatitis have reportedly caused lab-acquired infections. The outcome of accidental infections ranges from complete recovery, to permanent disability, to death.

There are several ways in which laboratory-acquired infections can be initiated:

- ingestion - transfer of microorganisms to the mouth via fingers, pens, food, drink or pipetting
- inhalation - inhalation of airborne microorganisms, centrifuge accidents in the form of aerosols
- inoculation - can occur with accidental inoculation with needles, sharps, cuts from sharp objects and broken glass, bites and scratches by animals, bites from ectoparasites
- contact - splashes of infectious material into the eyes, mucous membranes, non intact skin, transfer of microorganisms to the eyes by contaminated fingers

3.1.2 Minimizing Aerosol Hazards

Aerosol formation is potentially the most significant form of biohazard. Unlike droplets which settle rapidly and contaminate lab surfaces, aerosols remain airborne for long periods and can easily travel throughout the laboratory (and in some cases the building) via air currents and the ventilation system. Certain laboratory manipulations are known to create aerosols as follows (ways of minimizing or eliminating aerosol hazards are indicated):

- **using a loop** - use a cooled loop when inserting into a culture; ensure the loop is completely closed; the shank should be no more than 6 cm in length (avoids vibrations); avoid flaming a loop in an open flame (use a loop micro incinerator or pre sterilized plastic loops)
- **plating cultures** - streak plates where the surface of the medium is smooth (i.e., avoid bubbles)
- **pipetting** - do not mouth pipette; use "to deliver" pipettes to avoid blowing out the last drop; drain pipettes gently with the tip against the inner wall of the receiving vessel; use pipettes with plugs to reduce contamination of the pipetting device; work over an absorbent material (e.g., plastic-backed pad) to avoid aerosol dispersion from drops falling on hard surfaces; do not mix materials by alternate suction and expulsion through a pipette (use a vortex mixer)
- **centrifugation** - use sealed safety cups and sealed rotors; load and unload cups inside a biological safety cabinet; biological safety cabinets do not retain particles ejected from centrifuges and should not be used as an enclosure for centrifuges
- **blending and homogenizing** - use a laboratory blender with a tight fitting gasket lid and leak proof bearings (domestic kitchen blenders leak and release aerosols); wait as long as possible before opening the lid after mixing

- **manipulating a needle and syringe** - when withdrawing a needle from a stoppered bottle, wrap the needle and bottle cap in a disinfectant soaked absorbent; use Luer-Lok syringes; dispose of needles directly into a puncture- resistant sharp container without further manipulation (needle-cutting devices have been shown to release aerosols)
- **opening tubes** - avoid using tubes with push-in and screw-in closures (when these tubes are opened, the film of liquid trapped between tube and closure breaks and releases aerosols); use a vortex mixer instead of inverting tubes; wait 30 seconds after shaking a tube before opening the cap; open tubes of hazardous material in a biological safety cabinet only
- **pouring infectious material** - where possible, avoid pouring off the supernatant fluid after centrifugation, cell washes, etc. (this leads to aerosol production and contamination of the outside rim of the tube); the use of pipettes for such procedures is preferable; disinfectant soaked absorbents can be used to wipe the rims of tubes; infected material can be poured through a funnel, the end of which is below the surface of disinfectant in the discard container (the top of the funnel should be slightly larger than the discard container so it rests securely and disinfectant should be poured through the funnel after use)
- **breakage** - plastic culture tubes, flasks, bottles and dilution tubes are preferable to glass (not only reduces risk of generation of aerosols but also minimizes cuts and accidental inoculation)
- **opening ampoules of lyophilized cultures** - avoid hasty opening by snapping the neck which can lead to the sudden inrush of air and dispersal of contents (mark a file mark near the middle of the cotton plug and apply a red-hot glass rod to crack the glass; allow time for air to seep into the ampoule and gently remove the top and plug; add liquid for re-suspension slowly to avoid frothing)

3.2 BIOLOGICAL SAFETY CABINETS

When properly maintained and used in conjunction with good laboratory techniques, biological safety cabinets (BSC) provide effective primary containment for microorganisms. BSCs act as barriers to prevent the escape of aerosols into the laboratory environment and hence minimize the risk of airborne infections. See Chapter 1 - Safe Use of Laboratory Equipment for safe work practices to follow when using a BSC.

Every employee working in a BSC must be trained in its correct use and maintenance. They should also have a good understanding of the different types of cabinets and how they work. The correct selection, location, installation and certification of the BSCs are also critical to its performance in containing aerosols.

3.2.1 Classes of BSCs

There are three classes of biological safety cabinets: Class I, Class II and Class III.

Note: Horizontal clean benches which direct air toward the operator are not biological safety cabinets and must not be used for handling infectious, toxic or sensitizing materials.

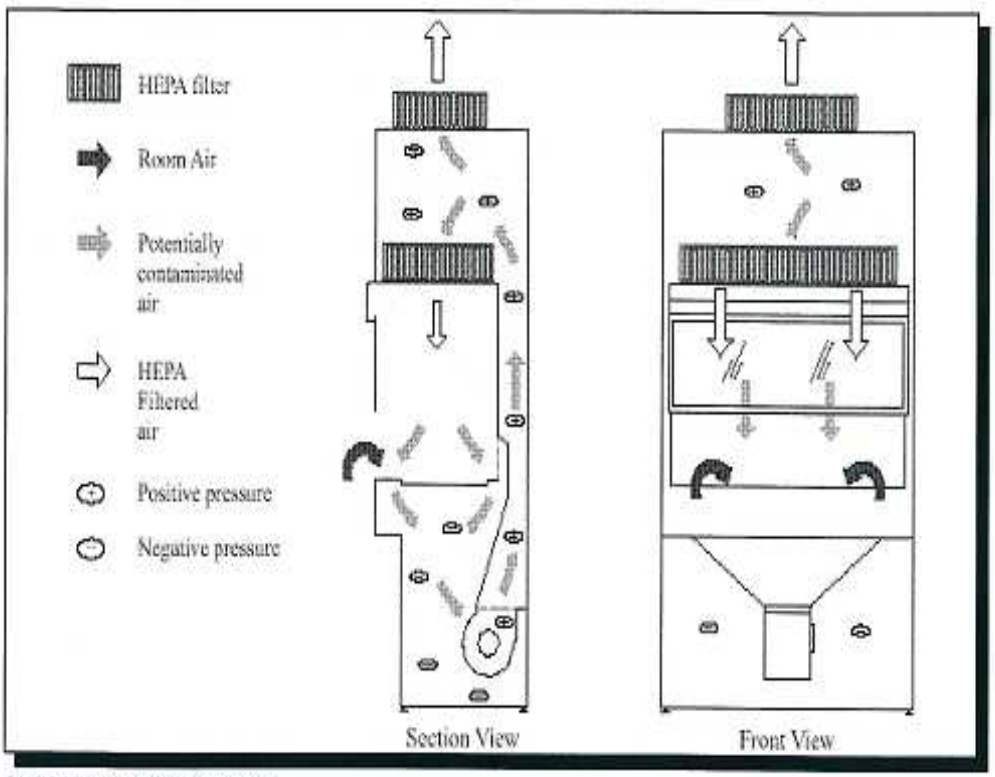
Class I - cabinets have un-recirculated air flow away from the operator that is discharged through a High Efficiency Particulate Air Filter (HEPA) filter. The cabinets provide good operator protection but do not protect the material within the cabinet (the product) from contamination.

Class III - cabinets are totally enclosed and gas-tight with HEPA filtered supply and exhaust air. Work is performed with attached long-sleeved gloves. Class III cabinets protect the worker and the product.

The remainder of this section will provide detailed information on Class II cabinets, the class used most frequently in ILRI Research Platform.

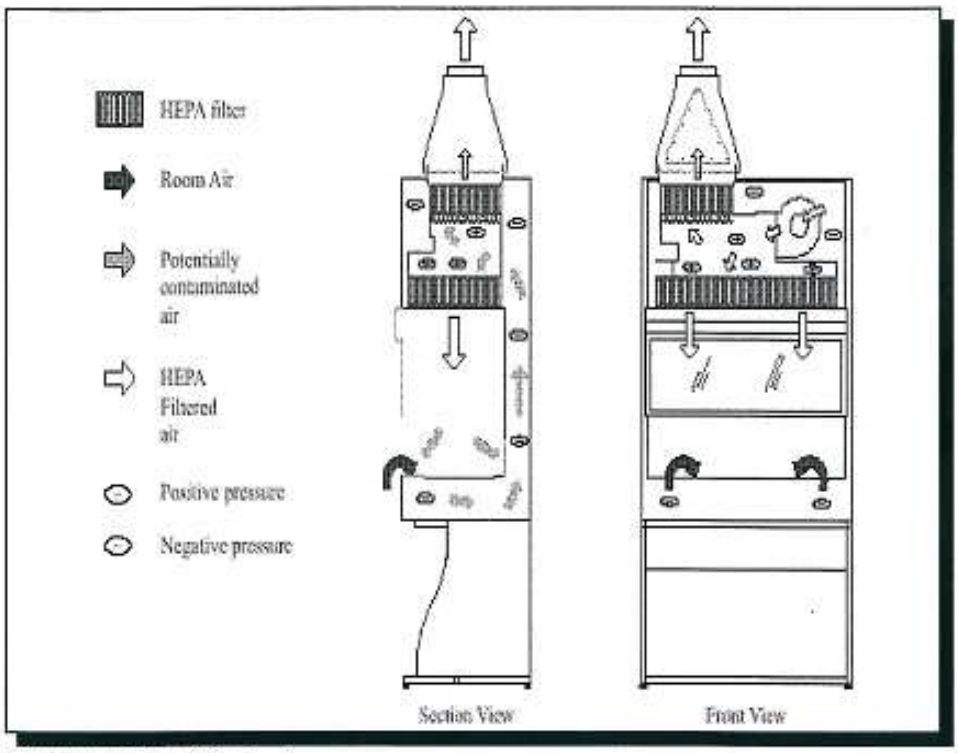
Class II - cabinets have inward air flow for personnel protection, downward HEPA- filtered air for product

protection and HEPA-filtered exhaust air for environmental protection. They are divided into two types (A and B) based on construction, air flow velocities and patterns, and exhaust systems. Basic characteristics are as follows:[1]



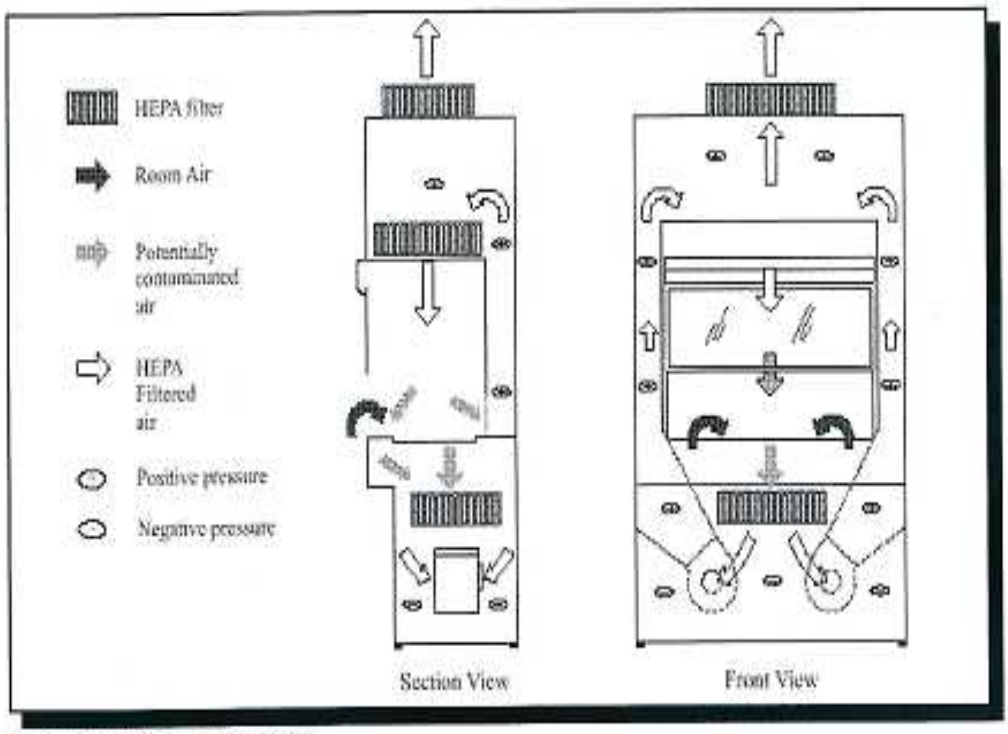
CLASS II TYPE A1 Cabinet

- Cabinet air may be recirculated back into the laboratory or ducted out of the building by means of a "thimble" connection (i.e., a small opening around the cabinet exhaust filter housing) whereby the balance of the cabinet is not disturbed by fluctuations in the building exhaust system.
- The thimble must be designed to allow for proper certification of the cabinet (i.e., provide access to permit scan testing of the HEPA filter).
- Maintain a minimum average face velocity of 0.38 m/s (75 ft/min).
- May have positive pressure contaminated ducts and plenums.
- Are not suitable for work with low levels of volatile toxic chemicals and volatile radionuclides



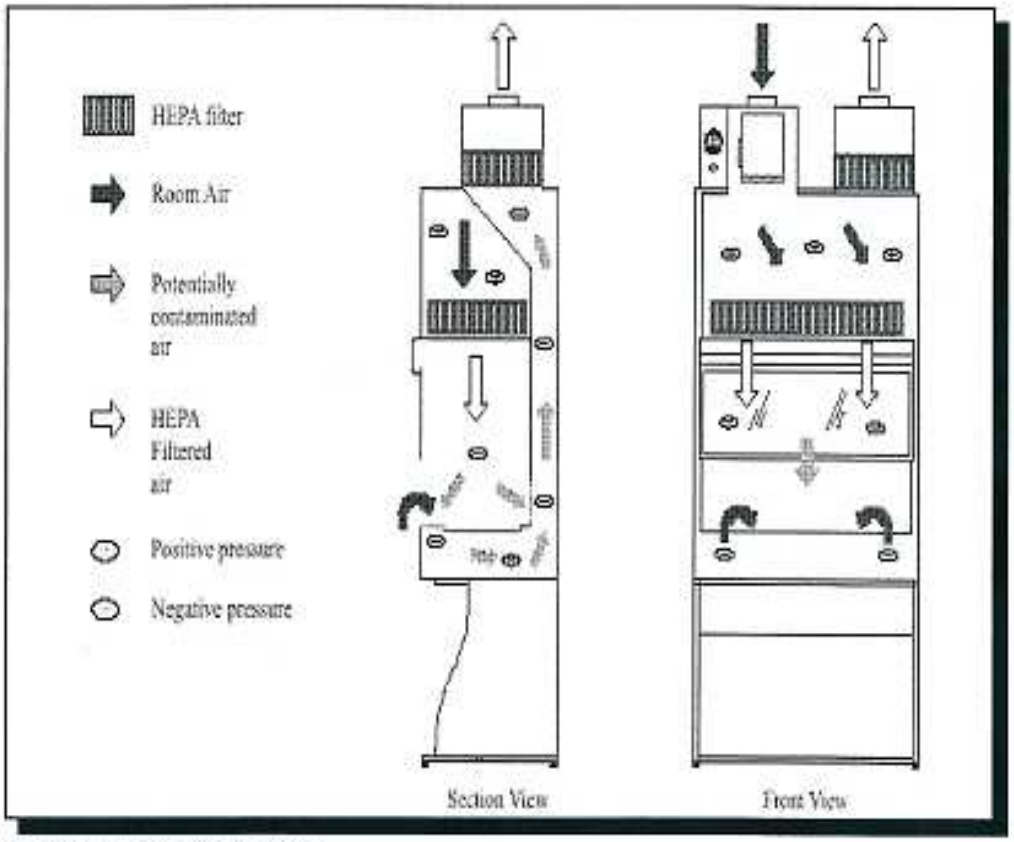
CLASS II TYPE A2 Cabinet

- Cabinet air may be recirculated back into the laboratory or ducted out of the building by means of a "thimble" connection (i.e., a small opening around the cabinet exhaust filter housing) whereby the balance of the cabinet is not disturbed by fluctuations in the building exhaust system. The thimble must be designed to allow for proper certification of the cabinet (i.e., provide access to permit scan testing of the HEPA filter).
- Maintain a minimum average face velocity of 0.5 m/s (100 ft/min).
- Have ducts and plenums under negative pressure.
- Is suitable for work with minute quantities of volatile toxic chemicals and trace amounts of radionuclides.



CLASS II TYPE B1 Cabinet

- Hard-ducted through a dedicated duct exhausted to the atmosphere after passage through a HEPA filter; contain negative pressure plena.
- Maintain a minimum average face velocity of 0.5 m/s (100 ft/min).
- Recirculate 30% of the air within the cabinet.
- Suitable for work with low levels of volatile toxic chemicals and trace amounts of radionuclides.



CLASS II TYPE B2 Cabinet

- Does not recirculate air within the cabinet.
- Maintain a minimum average face velocity of 0.5 m/s (100 ft/min).
- Hard-ducted through a dedicated duct exhausted to the atmosphere, 100% of cabinet air, after passage through a HEPA filter; contain negative pressure plena.
- Suitable for work with volatile toxic chemicals and radionuclides.

3.2.2 Installation and Certification

Biosafety cabinets should be located away from high traffic areas, doors and air supply/exhaust ducts that could disrupt its air flow patterns. A minimum clearance of 12 in (30 cm) should be provided between the exhaust outlet on the top of the cabinet and any overhead obstructions. Whenever possible, a 30cm clearance should also be provided on each side of the cabinet, to allow for access.

Certification, by qualified service personnel, of BSCs is critical to their performance and must be carried out at least annually and whenever the cabinet is moved or serviced. Cabinets must be cleared of all materials, the interior surface wiped down with disinfectant by laboratory staff prior to certification. Where infectious materials (including human or simian cell lines) have been manipulated in the cabinet, the cabinet should be decontaminated prior to certification using either formaldehyde gas or vaporized hydrogen peroxide.

The following certification tests must be carried out :

- **Downward Velocity Profile** - air velocity below the supply air filter inside the cabinet is measured (performed by measuring velocity at multiple points inside the cabinet); important to maintain protection of materials handled inside a cabinet
- **Work Access Face Velocity** - air velocity at work access opening area is measured (performed by measuring velocity at exhaust filter discharge and calculating face velocity); it is important to maintain protection for the operator
- **HEPA Filter Leak Test** - integrity of supply and exhaust HEPA filter and filter housings is measured (performed by generating an aerosol in the cabinet and scanning the downstream side of the filter for leakage); important to maintain sterile working conditions inside cabinet and prevent microorganisms from exhausting into the laboratory
- **Airflow Smoke Patterns** - establish the air flow patterns around the work access opening and within the work area (performed by passing a smoke source along an access perimeter, within the cabinet, and around the inside of the window); important to ensure smooth flow with no dead spots, reflux or escape from the cabinet

Measuring and testing equipment must be calibrated and maintained in accordance with the specified standard. A copy of the certification report must be provided to the laboratory and kept on file (ideally, a pocket containing the report should be affixed to the cabinet exterior). A label indicating the date of certification, the date of the next certification, to what standard the tests were performed and the name of the certifier must be affixed to the exterior of the cabinet.

3.3 CRYOGENICS

Cryogenics include substances such as dry ice and non- liquefied gases (oxygen, nitrogen, air and hydrogen). Fire and explosion may result from certain escaping cryogens such as oxygen and hydrogen. Rapid evaporation can lower available oxygen in the immediate area, creating oxygen-deficient atmospheres.

Severe frostbite can occur due to contact with super cold liquids or materials stored in them. Frostbite hazards are also present when handling materials stored in low temperature freezers.

3.3.1 Safe Work Practices for Handling Cryogenics

- to reduce hazards from explosion due to pressure buildup from evaporation, containers should not be tightly closed and should have fittings to relieve pressure
- storage areas should be well ventilated to avoid asphyxiation
- wear loose fitting insulated gloves (they can be thrown off quickly if liquid spills or splashes on them) and a

face shield with safety goggles; full-length aprons should not have pockets and coats should not have pockets or cuffs
- objects should be cooled slowly into cryogenic liquids; never use glassware not designed for low temperature storage
- areas where cryogens are stored and used must have warning signage on the outside of room.
- if dispensing is done from a large storage tank of liquid nitrogen specific work practices utilizing personal and room alarms must be developed.
- avoid leaning into dry ice chests; reach into the chest with special tongs
- Refrigerators and freezers need to be periodically defrosted and decontaminated, e.g. to remove broken containers. Gloves, gowns and respirators should be worn during decontamination and all contaminated materials, including cleaning supplies and protective clothing, should be sterilized by autoclaving before discarding, reusing or laundering.
- most cryogenic liquids are odorless, colorless, and tasteless when vaporized. When cryogenic liquids are exposed to the atmosphere, the cold boil-off gases condense the moisture in the air, creating a highly visible fog.
- always handle these liquids carefully to avoid skin burns and frostbite. Exposure that may be too brief to affect the skin of the face or hands may damage delicate tissues, such as the eyes. Wear gloves to remove materials from low temperature freezers.
- boiling and splashing always occur when charging or filling a warm container with cryogenic liquid or when inserting objects into these liquids. Perform these tasks slowly to minimize boiling and splashing. Use tongs to withdraw objects immersed in a cryogenic liquid. Use a metal funnel when transferring liquids.
- never touch un-insulated pipes or vessels containing cryogenic liquids. Flesh will stick to extremely cold materials. Even nonmetallic materials are dangerous to touch at low temperatures.
- cylinders and Dewars should not be filled to more than 80% of capacity, since expansion of gases during warming may cause excessive pressure buildup.
- check cold baths frequently to ensure they are not plugged with frozen material.
- Neither Liquid nitrogen nor liquid air should be used to cool a flammable mixture in the presence of air, because oxygen can condense from the air, leading to an explosion hazard.

3.4 LABORATORY BIOLOGICAL CONTAINMENT FACILITIES

Laboratories must be constructed and operated appropriate bio-containment containment levels (e.g. level 2, level 3 and level 4) and standards depending also on what agents will be in use.

Specific containment requirements (room design and operational protocols) are outlined in the
- Laboratory Biosafety Manual, 2nd Edition, World Health Organization,
- Laboratory Biosafety Guidelines, 3rd Edition, Health Canada,

All laboratories must meet the containment requirements to be listed in this document if they are working with animal pathogens. Any work with human pathogens must conform with the specific requirements from the ministry of public health.

The containment level required depends not only on the risk to human health, but also on a variety of other factors, such as the prevention of the escape of the animal pathogens into the environment where they might infect the indigenous animal population.

3.4.1 General Precautions When Working in a Biological Containment Laboratory

- good microbiological laboratory practices intended to avoid the release of infectious agents are to be employed.
- appropriate signage indicating the nature of the hazard being used (e.g., biohazard sign, containment level)

must be posted outside each laboratory; if infectious agents used in the laboratory require special provisions for entry, the relevant information must be included on the sign; the contact information of the laboratory supervisor or other responsible person(s) must also be listed.

- entry must be restricted to laboratory staff and other persons on official business; only persons meeting specific entry requirements (e.g. immunization, serum screening, specific medical exams) may enter containment laboratories
- all persons entering a containment area must be trained to know and follow the operational protocols for the project in progress
- employees working in the containment area must have general knowledge of the physical operation and design of the laboratory (e.g. air pressure gradients between zones, directional air flow patterns, alarm signals for air systems failure, containment perimeter, drainage)
- smoke testing (i.e. with a smoke pencil) should be done periodically by lab staff to verify airflow and detect leaks
- entry/exit protocols for persons, equipment, and samples must be written, posted (or be readily available) and followed; these protocols must address protective clothing, removal of items from containment, decontamination and waste disposal
- emergency procedures for spill clean-up, BSC failure, fire, animal escape and other emergencies must be written, easily accessible and followed.
- all people working in the containment area must be trained in and follow the operational protocols for the project in process. Trainees must be accompanied by a trained staff member. Visitors, maintenance staff, janitorial staff and others, as deemed appropriate, must also be provided with training and/or supervision commensurate with their anticipated activities in the containment area.
- personnel must receive training on the potential hazards associated with the work involved and the necessary precautions to prevent exposures to zoonotic agents and the release of non-indigenous agents; personnel must show evidence that they understood the training required; training must be documented and signed by both employee and the supervisor (see Chapter 16)
- a risk assessment shall be performed to determine what, if any health and medical surveillance programs need to be implemented.

3.4.2 Minimum Operational Requirements for a Level 2 Laboratory

The following describes the minimum operational practices required at containment level 2 laboratory.

- a documented procedural (safety) manual must be available for all staff, and its requirements followed; it must be reviewed and updated regularly
- personal must be trained in and follow the safe use of laboratory equipment biological safety cabinets, procedures to minimize the production of aerosols, decontamination and emergency response
- laboratory reference material should be kept in the laboratory zone
- open-toed and high-heeled shoes must not be worn in the laboratory
- eye and face protection must be worn as identified by the appropriate job hazard analysis
- laboratory doors must be kept closed as required by the facility design
- BSCs must be used for procedures that may produce infectious aerosols and that involve high concentrations or large volumes of bio-hazardous material. Laboratory supervisors, in consultation with the Biological Safety Officer/Institutional Biosafety Committee, should perform a risk assessment to determine which procedures and what concentrations and volumes necessitate the use of a BSC
- personnel must receive training on the potential hazards associated with the work involved and the necessary precautions to prevent exposure to infectious agents and release of contained material; personnel must show evidence that they understood the training provided; training must be documented and signed by both the employee and supervisor; retraining programs should also be implemented.

- eating, drinking, smoking, storing of food, personal belongings, utensils, applying cosmetics, and inserting or removing contact lenses are not permitted in any laboratory; wearing jewelry is not recommended in the laboratory.
- oral pipetting of any solution is prohibited in any laboratory.
- long hair must be tied back or restrained so that it cannot come into contact with hands, specimens, containers or equipment.
- access to laboratory and support areas is limited to authorized personnel.
- doors to laboratories must not be left open (this does not apply to an open area within a laboratory).
- open wounds, cuts, scratches and grazes should be covered with waterproof dressings.
- laboratories are to be kept clean and tidy. Storage of materials that are not pertinent to the work and cannot be easily decontaminated (e.g., journals, books, correspondence) should be minimized; paperwork and report writing should be kept separate from such bio-hazardous materials work areas.
- protective laboratory clothing, properly fastened, must be worn by all personnel, including visitors, trainees and others entering or working in the laboratory; suitable footwear with closed toes and closed heels must be worn in all laboratory areas.
- where there is a known or potential risk of exposure to splashes or flying objects, whether during routine operations or under unusual circumstances (e.g., accidents), eye and face protection must be used. Careful consideration should be given to the identification of procedures requiring eye and face protection, and selection should be appropriate to the hazard.
- gloves (e.g., latex, vinyl, co-polymer) must be worn for all procedures that might involve direct skin contact with bio-hazardous material or infected animals; gloves are to be removed before leaving the laboratory and decontaminated with other laboratory wastes before disposal; metal mesh gloves can be worn underneath the glove. hands must be washed after gloves have been removed, before
  leaving the laboratory and at any time after handling materials known or suspected to be contaminated. A completed job hazard analysis will help identify glove usage.
- protective laboratory clothing must not be worn in non laboratory areas; laboratory clothing must not be stored in contact with street clothing.
- if a known or suspected exposure occurs, contaminated clothing must be decontaminated before laundering (unless laundering facilities are within the containment laboratory and have been proven to be effective in decontamination).
- the use of needles, syringes and other sharp objects should be strictly limited; needles and syringes should be used only for patenteral, intraperitoneal injections and aspiration of fluids from laboratory animals and diaphragm bottles;
- caution should be used when handling needles and syringes to avoid auto- inoculation and the generation of aerosols during use and disposal; where appropriate, procedures should be performed in a BSC; needles should not be bent, sheared, recapped or removed from the syringe; they should be promptly placed in a puncture-resistant sharps container before disposal.
- work surfaces must be cleaned and decontaminated with a suitable disinfectant at the end of the day and after any spill of potentially bio-hazardous material; work surfaces that have become permeable (i.e., cracked, chipped, loose) to bio-hazardous material must be replaced or repaired.
- contaminated materials and equipment leaving the laboratory for servicing or disposal must be appropriately decontaminated and labeled or tagged-out as such.
- efficacy monitoring of autoclaves used for decontamination with biological indicators must be done regularly (i.e., consider weekly, depending on the frequency of use of the autoclave), and the records of these results and cycle logs (i.e., time, temperature and pressure) must also be kept on file.
- all contaminated materials, solid or liquid, must be decontaminated before disposal or reuse; the material must be contained in such a way as to prevent the release of the contaminated contents during removal; centralized autoclaving facilities are to follow the applicable containment level 2 requirements.
- disinfectants effective against the agents in use must be available at all times within the areas where the bio-hazardous material is handled or stored.
- leak-proof containers are to be used for the transport of infectious materials within facilities (e.g., between

laboratories in the same facility).

- spills, accidents or exposures to infectious materials and losses of containment must be reported immediately to the laboratory supervisor; written records of such incidents must be maintained, and the results of incident investigations should be used for continuing education
- an effective rodent and insect control program must be maintained [2]

3.5 DECONTAMINATION AND WASTE DISPOSAL

All contaminated materials must be decontaminated before disposal or cleaning for reuse. Laboratory surfaces, rooms and equipment may also require decontamination (i.e. prior to servicing). It is the responsibility of each laboratory to see that proper decontamination procedures are followed and that containment is not breached. The choice of method is determined by the nature of the material to be treated: if it is disposable, is adversely affected by heat, cannot be penetrated by steam, etc.

3.5.1 Autoclaves

Infectious lab wastes can be effectively decontaminated in either a gravity displacement or pre vacuum autoclave operating at 121 to 1320C. Pre vacuum autoclaves remove the air from the chamber by pulling a vacuum before the saturated steam enters, resolving problems with air entrapment during removal of air by gravity displacement.

Instruction in the operation, loading and monitoring of autoclaves must be provided to all employees with any involvement in autoclaving.

The size of containers and their distribution in the autoclave are important. Tight fitting containers do not permit steam penetration. Piling containers above one another and packing in as much as possible will usually ensure decontamination failure.

Biological indicators are used to develop processing times for typical loads and to monitor the efficacy of the decontamination process. In an animal pathogen containment level 2 facility, efficacy monitoring must be done at least weekly, depending on the frequency of use of the autoclave, and records of the results kept on file.3 Thermocouples, placed at the centre of a load, can also be used to monitor the internal temperature of the load. Records should also be kept of the time, temperature, and pressure for each load.

3.5.2 Basic Procedure for Efficacy Monitoring Using Biological Indicators

- biological indicators (ampoules containing 10^4-10^6 cfu/ml of B. stearothermophilus spores) are placed in the centre of a typical load (each different type of load should be tested separately)
- a control indicator is left outside of the autoclave
- the load is processed according to standard operating procedures, taking into account the lag time required for the internal temperature in the centre of the load to reach the sterilization temperature (this time will vary depending on the nature of the waste to be sterilized); B. stearothermophilus spores exposed to 121oC are killed in 15 minutes, however, the total cycle time depends on the load
- after completion of the cycle, the autoclave is opened and the biological indicators retrieved
- indicators are incubated at 56oC and examined for growth after 48 hours; a color change from purple/red to yellow indicates growth and sterilization failure (parameters of time and/or temperature have not been met); if there is no color change after 48 hours, the sample should be re incubated for a further 48 hours and examined for growth
- absence of growth indicates that sterilization of the load was achieved, representing a 4-6 $_{10}$ reduction in B. stearothermophilus spores
- failure to achieve sterilization may be due to overloading or improper loading of the autoclave (i.e. the centre of the load failed to reach sterilization temperature), or insufficient sterilization time; the process should be

repeated until the necessary loading configuration and sterilization time have been determined; this time and load configuration should be used for all subsequent cycles for that type
of load

***Note**: Rapid readout biological indicators (based on enzymatic activity) containing B. stearothermophilus spores can be used. After 1 hour incubation at 560C in a fluorometer, the presence of a red light indicates fluorescence and sterilization failure. Non-fluorescence is indicated by illumination of a green light and signifies adequate sterilization.*

***Note**: Chemical indicators for steam, time and temperature are useful for day-to-day monitoring, however, must not be used as an indicator of sterility. They are really only effective to indicate that the autoclave failed to reach a high enough temperature and, therefore the sterilization should be repeated. Monitoring using biological indicators is also required. Labels and tapes that indicate only the attainment of a temperature, not*
its duration, are not recommended.

***Note:** All measuring devices on autoclaves that are used to determine the conditions achieved (e.g. timers, thermometers, pressure gauges) must be verified for accuracy and calibrated on a routine basis.*

3.5.3 Incinerators/Tissue Autoclave

Incineration is an acceptable method of treating animal carcasses and pathological wastes. New technologies (i.e. tissue autoclave) are also acceptable provided they are proven to be effective in rendering the waste noninfectious.

- Local (NEMA) regulatory requirements for incinerator operation/emissions and tissue autoclave discharges must be followed
- written protocols must be developed and followed for the packaging, labeling, storage and transport of waste materials, and for the loading, operation and cleaning of incinerators and tissue autoclaves
- all employees responsible for loading, operation and cleaning of such equipment must be trained and be provided with the necessary protective equipment (e.g. respirator for cleaning out ashes, harness for loading)
- employees generating the waste must also be trained and know what materials may be offered for treatment and how they must be packaged, labeled and stored

3.6 IMPORT PERMITS

The Department of Veterinary Services (DVS) – Ministry of Livestock & fisheries (Kenya) reviews permit applications for the importation of animal and zoonotic pathogens, assesses containment facilities for import purposes, and issues the import permits. The division also maintains a database of animal and zoonotic pathogens, and their corresponding containment levels. A permit to import is required for the importation of all animal pathogens into Kenya.

Similar requirements apply to all African union countries, Asia and around the world.
Note; Before importing any biological material to any country, establish the countries requirement. Contact the EOHSO for any assistance.

3.6.1 Application for Permit to Import Animal Pathogens

Applications to import animal pathogens into Kenya are made to the DVS. Following their evaluation and approval of the application, a permit is issued that must accompany the pathogen into Kenya. The import permit will specify the conditions under which the pathogen is to be maintained and work with the pathogen is to be carried out.

The "Application for Permit to Import" form must be completed and signed by the applicant. Applicants are also

required to submit the "Facility Certification for the Importation of Animal Pathogens", which must be signed by both the applicant and EOHSO. These forms are available at:

Director
Department of Veterinary Services (DVS)
P.O. Box
Upper Kabete
NAIROBI
Emails: director@dvskabete.go.ke
http://www.livestock.go.ke/

3.6.2 Importing Zoonotic Pathogens

Pathogens that affect animals and humans require import permits from Ministry of health.

3.6.3 Facility Certification for the Importation of Animal Pathogens

Those handling animal pathogens should verify that their facility complies with the physical design requirements and the operational practices described in the *Containment Standards for Veterinary Facilities* and has been approved by the regulatory agency.
Laboratories importing pathogens at animal pathogen (AP) containment Level 2 are required to complete and sign a detailed inspection checklist. AP 2 laboratories may be inspected to verify compliance with the conditions specified on the permit. Applicants importing pathogens at AP containment Levels 3 or 4 must have their facilities inspected and approved by the DVS prior to receiving a Permit to Import.

After an on-site inspection of a facility and its procedures, any incidences of non- compliance are submitted to the applicant together with a letter requesting appropriate corrective action. Once corrective steps have been taken, and compliance is achieved, an import permit can be issued. Follow-up inspections may be performed to verify that permit conditions continue to be met. Self certification checklists for AP 2 laboratories are to be re- submitted every two years. Containment level 3 and 4 laboratories are re-certified annually.[4]

4.0 CHEMICAL DISINFECTANTS

Disinfectants are intended to kill microorganisms. They may also be hazardous to humans and the environment, especially when concentrated. The use of disinfectants can impact worker safety directly and indirectly. Direct exposure to a hazardous chemical may result when a disinfectant is used inappropriately (e.g. failure to wear personal protective equipment when diluting concentrate).

Indirect impact on worker safety can occur as a result of an exposure to viable pathogens when an inappropriate product is selected (e.g. a disinfectant (a product that kills vegetative only bacteria) used against non-enveloped virus), or an effective product is used inappropriately (e.g. diluted too much). Workers should learn about the products required for disinfection of the agents with which they will be working, including recommended directions for use (i.e. application method, contact time, personal protective equipment, precautions, first aid, disposal, etc) as well as chemical characteristics (i.e. toxicity, chemical compatibility, storage stability, active ingredient identity, concentration,).

Much of this information is provided on the container label. Some manufacturers may also be willing to share reports of efficacy testing for their products. Where possible, technologies that are routinely validated using biological indicators (e.g. autoclave, ethylene oxide sterilizers) are preferable to liquid chemical disinfectants.

Different classes of active ingredients are described in the following pages. Given that product effectiveness depends on the active ingredient(s) as well as the identity and concentration of other ingredients in the formulation, it is difficult to make generalizations about contact times and concentrations needed to kill specific pathogens. Users should therefore choose a registered product, read the label before using, and follow the directions for use carefully.

Given that manufacturers are permitted to test their own products to demonstrate label claims, it is prudent to consider whether manufacturers' claims are consistent with the recognized characteristics of the active ingredient and with current research published in peer-reviewed scientific journals. A great deal of credible information is available in Disinfection, Sterilization, and Preservation, Fifth Edition1 and the Journal of Hospital Infection Control and Epidemiology2.

When selecting a disinfectant, check the label for a drug identification number or a pest control products registration number. These products are labeled for use in food processing facilities, on medical devices or in health care facilities.

It is also good to remind users of disinfectants that they should be aware that there may be potential incompatibilities with other chemicals.

DEFINITIONS

Appropriate selection and use of disinfectants requires an understanding of the terms used by manufacturers on labeling.

Cleaning: The removal, usually with detergent and water, of adherent visible soil, blood, protein substances, and other debris from the surfaces, crevices, serrations, joints, and lumens of instruments, devices, and equipment by a manual or mechanical process that prepares the items for safe handling and/or further decontamination.

Decontamination: Disinfection or sterilization of infected articles to make them suitable for use. In a more general sense, decontamination is the process of freeing a person or object from potentially harmful material. This material can be infectious microorganisms, harmful insects, or toxic or radioactive chemicals.

Disinfection: The destruction of pathogenic and other kinds of microorganisms by thermal or chemical means.

Disinfection is a less lethal process than sterilization because it destroys most recognized pathogenic microorganisms, but not necessarily all microbial forms, such as bacterial spores. Disinfection processes do not ensure the margin of safety associated with sterilization processes.1
Sanitizer: products that reduce the level of microorganisms present by significant numbers, i.e., 99.9% or more, or to acceptable levels established by federal or provincial health authorities.4

Antiseptic: a chemical which kills microorganisms capable of infecting an animal or human and causing a toxic condition.

Disinfectant: an antimicrobial agent capable of destroying pathogenic and potentially pathogenic microorganisms on inanimate surfaces. A disinfectant without specified target organisms on the container label is regarded only as a bactericide.5

Low-level disinfectant: a disinfectant that kills most vegetative bacteria and lipid or medium-sized viruses.3

Intermediate-level disinfectant: a disinfectant that kills vegetative bacteria, most viruses and most fungi but not bacterial spores.6

High-level disinfectant: a disinfectant that kills all microbial pathogens, except large numbers of bacterial endospores when used in accordance with labeling.[3]

Bactericide: an antimicrobial agent capable of destroying bacteria, but not necessarily bacterial spores or mycobacteria.[3]

Germicide: Synonymous with disinfectant.[3]

Virucide: an antimicrobial agent capable of destroying viruses.[3]

Tuberculocide: an antimicrobial agent capable of destroying mycobacteria.[3]

Sporicide: An antimicrobial agent capable of destroying bacterial spores.[3]

Chemosterilant: An antimicrobial agent capable of destroying all forms of microorganisms (including bacterial spores) on inanimate surfaces.[3]

Note: (This claim is demonstrated using a sporicidal test. Even products labeled as "chemosterilants" cannot be expected to inactivate prions).

4.1 FACTORS INFLUENCING GERMINAL ACTION

Many chemical disinfectants are available on the market. When choosing a product for use it is important to consider a number of factors that influence a disinfectant's effectiveness.

Resistance of Microorganisms
Microorganisms generally exhibit a descending order of resistance to chemical disinfectants as follows:

Table 1 Microorganisms ranked according to relative susceptibility to chemical disinfectants.6

SESCEPTIBILITY	MICRO ORGANISMS	DISINFECTANTS REPORTED TO BE EFFECTIVE
Extremely resistant	Prions	Unusually resistant to chemical disinfectants. High concentrations of Sodium Hypochlorite or heated strong solutions of sodium hydroxide are reported to be effective.
Highly resistant	Protozoal oocysts	Ammonium hydroxide, halogens (high concentrations) halogenated phenols
	Bacterial Endospores	Some acids, aldehydes, halogens (high concentrations) pyroxygen compounds
Resistant	Mycobacteria	Alcohols, Aldehydes, some alkalis, halogens, some peroxygen compounds, some Phenols
	Non enveloped viruses	aldehydes, halogens, pyroxygen compounds
Susceptible	Fungal spores	Some alcohols, aldehydes, biguanides, halogens, peroxygen compounds, some Phenols
	Gram negative bacteria Enveloped Viruses Gram positive bacteria	alcohols, aldehydes,alkalis, biguanides, halogens, peroxygen compounds, some Phenols some QACs
Highly susceptible	Mycoplasmas	Acids, alcohols, aldehydes, alkalis, biguadines, halogens, peroxygen compounds, phenols, QACs

4.2 Table 2 The antimicrobial spectrum of chemical disinfectants.[6]

Categories of Microbial Pathogens									
	Bacteria					Viruses			
Disinfectant Class [a]	Gram-positive	Gram-negative	Myco-bacteria	Endo-spores	Fungal-spores	Enveloped	Non-Enveloped	Protozoa (coccidial oocysts)	Prions (agents of BSE and scrapie)
Acids(mineral)	++	+	-	+-[b]	+-	_	+-[c]	-	-
Alcohols	++	++	++	-	+	+	-	-	-
Aldehydes	++	++	+	++	++	++	++	-	-
Alkalis	++	++	+	+	+	+	+-[c]	+-[d]	+-[e]
Biguanides	++	++	-	-	+	+	-	-	-
Halogens									
Chlorine compounds	++	++	+	+	++	++	++	+-[f]	+-[g]
Iodine compounds	++	++	+	+	++	++	+	+-[f]	-
Peroxygen compounds									
Hydrogen peroxide	++	++	+-	+[h]	+	++	+-	+-	-
Peracetic acid	++	++	++	++	++	++	+	+-	-
Phenols [i]	++	++	+	-	+	+	-	+-[j]	-
QACs	++	+	-	-	+	+	-	-	-

++, highly effective **+, effective** **+-, limited activity** **-, no activity**

a. The activity of complex disinfectants may vary in accordance with their formulation and the data presented relate to use under ideal conditions.
b. HCl is sporicidal.
c. Organic and mineral acids as well as alkalis inactivate the virus of foot and mouth disease.
d. Ammonium hydroxide is coccidiocidal.
e. Hot 1M NaOH is reported to be effective.
f. Concentration- and time- dependent effect.
g. High chlorine concentrations required for inactivation.
h. High concentrations required.
i. Individual phenolic compounds may vary in their antimicrobial spectrum.
j. Some phenolic disinfectants are coccidiocidal.

Organic load

Organic soil (e.g. manure, blood, milk, bedding, feed) protects microorganisms from contact with disinfectants and can neutralize many germicides (e.g. Sodium hypochlorite). Removal of bedding, litter, feed, etc., and cleaning prior to disinfection will reduce organic load. All cleaning materials and items removed prior to disinfection must be decontaminated prior to disposal.

Cleaning prior to disinfection may be inappropriate when there is a risk of zoonosis or foreign animal disease. Under such circumstances, disinfectants that remain active in the presence of considerable amounts of organic material should be selected (e.g. phenolic disinfectants). Look for product labels that indicate that the disinfectant was tested in the presence of organic soil (e.g. 5% serum). It may be appropriate to spray contaminated material with disinfectant and allow it to remain wet for a lengthy contact time (e.g. 30 minutes), to dispose of gross contamination, to thoroughly clean surfaces, then to reapply the disinfectant according to label directions.

Surface topography
Uneven, cracked or pitted surfaces, especially wooden surfaces and earth floors, can hide microorganisms and are difficult to disinfect.

High bacterial levels have been recovered from various surfaces in farm buildings after cleaning: wood - 22,500 organisms/100 cm2; concrete - 12,500 organisms/100 cm2; brick - 75,600 organisms/100 cm2; metal - 13,900 organisms/100 cm2; plastic 100 organisms/100 cm2.

Method of application
Surfaces of a building may be treated with a disinfectant solution by brushing or by spraying. Portable items should be soaked in a tank of disinfectant. Fumigation may be used but is inefficient in buildings with ill-fitting doors and windows, damaged roofs, etc.

Concentration of germicide
Generally, the higher the concentration, the more rapid the kill. There are some situations where this general rule is not true. Some chemicals cannot be used because of extreme damage to surfaces or tissues. If concentration is reduced enough to avoid damage, it may no longer possess sufficient germicidal activity to be effective.

Cost should be calculated per volume (liter) of the use-dilution rather than per cost of the concentrate.

Contact time
The contact time is the period of time that the treated surface remains wet. An effective contact time will depend on the disinfectant and the microorganisms present. Read the directions for use carefully on the disinfectant label. Given that users are unable to determine which microorganisms are present, manufacturers are required to provide a single contact time that will be effective against all of the microorganisms listed on their product's label.
Fast acting disinfectants should be selected because longer contact times may be difficult to achieve. Although alcohols may be bactericidal after an extended contact time (e.g. 10 minutes), they are unlikely to remain on surfaces for this period due to evaporation.

Temperature
Elevated temperatures generally enhance germicidal action. However, elevated temperatures may be hard to achieve and may accelerate evaporation, thus reducing the contact time.

Relative humidity (RH)
Relative humidity can influence the activity of some disinfectants, particularly formaldehyde. The antimicrobial activity of formaldehyde gas fumigation is maximized with relative humidity in excess of 70%.

Water hardness
Some germicides are less effective when diluted in hard water (e.g., QAC's, phenolics). Look for product labels that indicate that the disinfectant was diluted in hard water (e.g. 400 ppm CaCO3) prior to efficacy testing.

pH
The activity of some disinfectants is affected by pH (halogens tend to work better at lower pH). Read the directions

for use carefully. Avoid mixing disinfectants with other chemicals.

Stability/Storage
In-use dilutions of some disinfectants (sodium hypochlorite, alkaline glutaraldehyde) may not be stable over long periods, especially in the presence of heat or light. Therefore, products should be stored in a dark, cool location. Prepare only enough disinfectant for immediate use.

Directions for use
Manufacturers' directions for use on the container label may include limitations associated with the product and should be followed carefully in order to ensure maximum effectiveness.

Table 3 Factors that may contribute to the failure of disinfection programs.

Disinfectant factors	Environmental factors	Other factors
Selection of a disinfectant ineffective against the pathogen	Residual organic matter due to inadequate cleaning	Reintroduction of infectious agents by infected animals, fomites, transport vehicles, food, water, personnel, rodents, insects, birds, or clinically normal carrier animals.
Other Disinfectant inappropriately diluted (too dilute, or too concentrated)	Lack of contact with disinfectant because of unsuitable surfaces	
Insufficient contact time allowed	Biofilm formation on surfaces	
Temperature too low for optimal activity	Temperature too low for optimal activity Inactivation of quaternary ammonium compounds and biguanides by residual soaps and detergents	
Relative humidity too low for gaseous disinfectants	Improper application to surfaces or equipment Inadequate treatment of water supply Interference with the activity of quaternary ammonium compounds and biguanides by synthetic materials and plastics.	

4.3 TYPES AND USES OF CHEMICAL DISINFECTANTS

Chlorine
Available in liquid, powder or tablet form. Determining the appropriate concentration of available chlorine to use will depend on the intended use and the amount of organic material present. The following concentrations of available chlorine are typically used:

Sanitizing rinse for precleaned food contact surfaces: 100 ppm (1 bleach*: 499 parts water)
General disinfection of pre-cleaned surfaces: 5,000 ppm (1 bleach* : 9 parts water)

General disinfection of soiled surfaces: 10,000 ppm (1 bleach : 4 parts water)

*Household bleach (e.g. JIK) contains approximately 5.25% sodium hypochlorite (52,500 ppm free available chlorine).

- effective against vegetative bacteria, mycobacteria, viruses, and fungal spores, and has some sporicidal

activity
- generally short contact time (i.e. 2-3 minutes) for all but bacterial spores (which require a minimum of at least 30 minutes exposure.)
- solutions should be prepared fresh and kept in light-protected containers
- highly corrosive to metals and is neutralized by organic material
- concentrated solutions are corrosive to eyes and skin.
- never mix chlorine releasing compounds with other chemicals. Doing so may cause the production of toxic chlorine gas.
- always add dry chlorine to water. Never add water to dry chlorine because the release of energy as heat may cause fire or explosion.

Iodine
Available as aqueous solutions, tinctures (solution in alcohol), and as iodophores. Iodophores consist of iodine complexes with a carrier molecule to increase solubility and to provide sustained release of iodine (e.g. povidone-iodine).

- effective against enveloped viruses, vegetative bacteria, fungi and exhibit limited activity against mycobacteria, non-enveloped viruses and bacterial spores
- generally short contact time (i.e. 2-3 minutes) for vegetative bacteria and enveloped viruses; contact time for other organisms is product dependant
- disadvantages include the staining of treated objects, corrosiveness and neutralization by organic material

Alcohol
Available as ethyl or isopropyl alcohol; 70% in water is the most effective concentration. Alcohol should generally not be used to disinfect large areas of the laboratory, bench-tops, etc. (may be a fire hazard)

- effective against enveloped viruses and vegetative bacteria (i.e. 2-3 minutes);longer contact times (10 minutes) required for activity against fungi and mycobacteria; variable activity against non-enveloped viruses; no activity against bacterial spores
- longer contact times difficult to achieve due to loss by evaporation
- alcohol should not be used on large areas or on electrical equipment because of fire hazard

Phenolics
There are a wide variety of phenolics available; generally used as substituted phenols in combination with detergents. Activity and contact time is dependent on the particular formulation.

- effective against enveloped viruses and vegetative bacteria; variable activity against fungi and mycobacteria, depending on product; limited activity against non- enveloped viruses; no activity against bacterial spores
- not easily neutralized by organic material and non-corrosive
- disadvantages include toxicity, a pungent unpleasant smell and neutralization by hard water

Quaternary ammonium compounds (QACs)
There are wide variety of QACs available with built-in detergent action. Typically QACs have a limited spectrum of activity.

- effective against bacteria and enveloped viruses; limited activity against fungal spores and some non-enveloped viruses; no activity against mycobacteria and bacterial spores.

Glutaraldehyde
Available as a 2% acidic solution supplied with a bicarbonate compound to activate the product. Although alkaline

glutaraldehyde has improved antimicrobial activity, it is less stable than acidic glutaraldehyde.

- broad spectrum of activity against all classes of microorganisms (but not against prions). Activity against non-enveloped viruses and mycobacteria requires at least 20 minutes contact time. Activity against bacterial endospores requires prolonged contact time (> 3 hours).
- Although glutaraldehyde is effective in the presence of moderate soil, it does not readily penetrate organic material. Soil that has not been removed prior to treatment also tends to stick.
- Not corrosive to metal.
- Activated (alkaline) product has limited shelf-life
- Adverse health effects including mucous membrane irritation, contact dermatitis, and occupational asthma have been reported.

Formaldehyde
Supplied as solid Para formaldehyde (flakes or tablets), or as liquid formalin (37% solution of formaldehyde in water containing 100 ml/l of methanol as a stabilizer). Products are also available that slowly decompose and release formaldehyde gas onto surfaces (e.g. Profilm (Reg. No. 15508) and Fumalyse (DIN 00892807) which contain the active ingredient 2-(hydroxymethyl)-2-nitro-1,3-propanediol).

- broad spectrum of activity against all classes of microorganisms (but not against prions). More susceptible to inactivation by organic material than glutaraldehyde.
- suspected carcinogen
- Antimicrobial activity maximized when fumigation is conducted 20oC and 70% Rh

Fumigation of rooms and buildings: generate formaldehyde gas by heating Para formaldehyde, 10.5 g/m3 (0.3 g/ft3), or boiling formalin, 18 ml formalin + 35 ml water/m3 (0.5 ml formalin + 1 ml water/ft3). All openings including windows and doors should be sealed before gas is generated. Fumigation should be conducted at a temperature of at least 20oC and relative humidity of 70%. Contact time of at least 4 hours is needed, preferably overnight. Neutralization should then be carried out using ammonium carbonate (0.66 g ammonium carbonate for every gram of Para formaldehyde).

Formaldehyde gas is extremely hazardous. Fumigation with formaldehyde must only be performed by experienced individuals who have received the appropriate training.
General surface disinfection using 5% liquid formalin requires prolonged contact time of at least 30 minutes (3 hours for activity against bacterial spores). Five percent (5%) liquid formalin is prepared by diluting 1 part liquid formalin (37% formaldehyde) in 19 parts water, providing a solution that contains 18,500 ppm formaldehyde.

Hydrogen peroxide
Hydrogen peroxide is available as a concentrated 30% solution in water. In-use solutions should be diluted to 6% hydrogen peroxide. Stabilized hydrogen peroxide products (7% H_2O_2) have recently been cleared as chemosterilants for use on critical medical instruments (e.g. Virox STF, DIN 02240954) and as general disinfectants for use on surfaces (e.g. Virox 5, DIN 02239828).

- effective against vegetative bacteria, mycobacteria, fungi, viruses and spores. Note: sporicidal activity requires higher concentrations of hydrogen peroxide (7%) and extended contact times (6 hours). Follow label directions carefully.
- not compatible with aluminum, copper, zinc or brass.
- may be unstable when exposed to heat and light. Stabilized products are now commercially available.

Other peroxygen based disinfectants are available (e.g. Virkon S, DIN 02125021).Testing has demonstrated good bactericidal and virucidal activity but limited fungicidal, mycobactericidal and sporicidal activity.

Chlorhexidine
Available as a 4% solution of chlorhexidine gluconate in a detergent base (used undiluted) and as concentrated alcohol-based solutions requiring dilution prior to use. Alcoholic solutions show superior activity to aqueous solutions.

- effective against enveloped viruses and Gram-positive bacteria; limited activity against Gram-negative bacteria and fungi. Ineffective against mycobacteria, non- enveloped viruses, and bacterial endospores.Œ

Chlorhexidine is typically used as an antiseptic hand wash and teat-dip because it is effective against Gram-positive bacteria commonly found on skin (e.g. *Staphylococcus aurous).*

4.4 IN USE TESTING OF PRODUCTS

The following published methods can be used to verify product efficacy claims and to test products against specific target organisms. Several variables can be modified to approximate the conditions for use typical in your facility (e.g. contact time, organic load, carrier surface).

- Test Method E2111-00. Standard Quantitative Carrier Test Method To Evaluate the Bactericidal, Fungicidal, Mycobactericidal and Sporicidal Potencies of Liquid Chemical Germicides.[8]
- Test Method E1053-97. Standard Test Method for Efficacy of Virucidal Agents Intended for Inanimate Environmental Surfaces.[9]

For new programs, it is recommended to use in-use testing to validate efficacy of disinfectants.

5.0 WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS)

WHMIS is an internationally acceptable system that provides employers and workers with information about the hazardous materials they work with on the job to protect their health and safety. WHMIS is the cornerstone of a hazard prevention program in the workplace.

WHMIS is an information delivery system from suppliers of hazardous materials to employers to workers. The system includes:

- **Supplier and Workplace Labels** - warning labels on containers – see Section 5.2
- **Material Safety Data Sheet (MSDS)** - safety data sheets provide further detailed information on hazards and preventative measures - see Section 5.3
- **Worker Education** - explains how to use this information and what types of training programs are available for employees - see Section 5.4

Every ILRI laboratory must develop and follow a WHMIS program specific to the hazardous materials they handle. The program must include each of the three elements described in detail below. The LAC is responsible for providing WHMIS labels, obtaining up-to- date MSDS etc.

Information on how WHMIS labeling applies to Laboratories is found in Section 5.5.

5.1 CONTROLLED PRODUCTS

Controlled products are substances that meet the criteria for inclusion in the WHMIS hazard classes and divisions. Once a substance falls into one of the WHMIS classes, the provisions for WHMIS labeling, MSDS and worker education come into effect. It is the responsibility of the supplier (manufacturer or packager of a controlled product) to determine if a substance is in fact a controlled substance. The regulations lay out the
tests which are to be used to make that determination. If the substance is produced in the workplace, the employer must then make the determination. For substances received prior to implementation of WHMIS (Jan 2008), the employer is responsible for classification.

All controlled products in our workplace must be classified. In most cases, this is done by the supplier. WHMIS uses classifications to group chemicals with similar properties or hazards. The Controlled Products Regulations specifies the criteria used to place materials within each classification.

It is interesting to note that many products have more than one classification. For example, picric acid is both an oxidizer and a dangerously reactive material.

There are six hazardous material classifications, each with a hazard symbol:
(NOTE: See the Chemical Safety Module for the Safe Work Practices for each of these classifications)

Compressed Gas - A substance that at room temperature (200C) is in the gaseous state and kept under pressure., e.g. acetylene, oxygen.

Class B - **Flammable and Combustible Material** - A solid, liquid or gas that will ignite and continue to burn if exposed to a flame, e.g. propane, ethanol, acetone.

Class C - **Oxidizing Material** - A substance which causes or contributes to the combustion of another material, or is an organic peroxide, e.g. hydrogen peroxide, nitric acid

Class D - **Poisonous and Infectious Material** - Materials causing: immediate and serious toxic effects (Division 1); other toxic effects (Division 2); and, infectious materials (Division 3), e.g.: cyanides, benzene, rabies virus. (NOTE*: See the Module on Biological Safety for hazard prevention for infectious substances*)

Class E - Corrosive Material - A substance that will destroy tissue and corrode metal, e.g. sulphuric acid, sodium hydroxide.

Class F - Dangerously Reactive Material - A material which can react vigorously with water to produce a poisonous gas, which will undergo vigorous polymerization, decomposition or condensation, or can become self-reactive under conditions of shock, or increase in pressure or temperature, e.g. ether peroxides, picric acid.

Some products have been exempted from WHMIS labeling and MSDS requirements. They include some consumer products, cosmetics, drugs, wood and wood products, pest control products, and radioactive substances. Consumer products are products, materials, or substances available in quantities and packaging designed for the consuming public.

An inventory of all controlled products in the workplace must be established and the specific hazards of their use, storage and handling must be reviewed.

5.2 WHMIS SUPPLIER AND WORKPLACE LABELS

5.2.1 Roles & Responsibilities

Employer

- Employers are responsible for ensuring that all controlled products being used in the workplace are properly labeled.
- Employers are responsible for checking that the supplier labels have been provided and applied to controlled products received at the workplace. If products arrive from the supplier without labels, employers must obtain a supplier label from the supplier or obtain the required information from the
  supplier to produce the label. Material may be stored for a limited time while the employer attempts to get a supplier label. Employers must affix supplier labels on all inner containers even when the outer container has an evident supplier label.
- Employers are responsible for proper labeling of controlled products brought to the workplace by a contractor. Employers must ensure the contractor understands WHMIS and complies with its requirements.

Employee

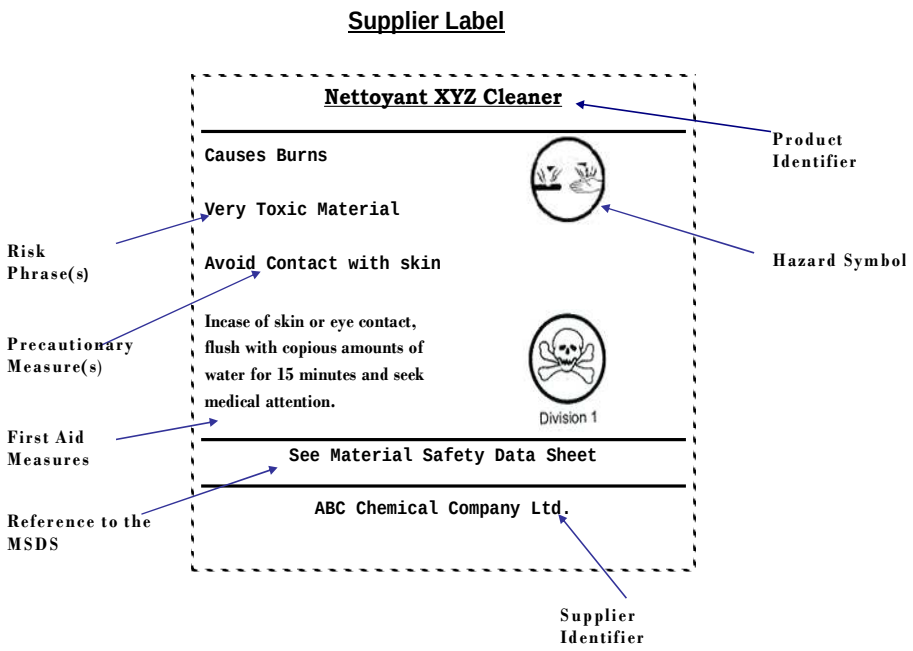
- Employees are responsible for informing employers about damaged, illegible or missing labels.
- Employees must read the label and follow the directions before using the product.

5.2.2 Seven Components of a Supplier Label

The supplier label should provide seven pieces of information:

- product identification
- hazard symbols which apply to the material
- risk phrases (brief description of the hazard and effects of harmful exposure on the body)
- precautionary measures (brief instructions for safe use of the material)
- first aid measures (how to treat persons who have been exposed to the material)
- a statement advising that a material safety data sheet (MSDS) is available
- supplier identification

Modifications are permitted in the content required on supplier labels for small containers (100 ml or less in volume) and, in some cases, for laboratory supply house chemicals and laboratory samples.



5.2.3 Three Components of a Workplace Label

If the supplier label becomes illegible or is accidentally removed, employers must develop and apply a workplace label. Workplace labels are also required when products are transferred from the supplier container to another container and for hazardous materials produced in the workplace. Workplace labels must contain the following pieces of information:

- product identification
- safe handling information
- a statement advising that a MSDS is available

When the product is used in the laboratory and will be under the control of the employee who decanted the material from the original container, a simple means of identifying the product is adequate only if the product is for immediate use or used within the shift. Material flowing through pipes, or kept in process or reactions vessels, or in tanks, must also be identified using labels, placards, colour coding, tags, or other means which identify the material so that the worker is warned of its presence.

5.3 MATERIAL SAFETY DATA SHEETS (MSDS)

The MSDS is a technical bulletin which provides detailed hazard, precautionary and emergency information on a controlled product. MSDS are intended to supplement the information on labels with more detailed information about the potential hazards of using the product. The MSDS must include what can reasonably be expected to be known about the material and the hazards it may present to workers.

5.3.1 Roles & Responsibilities

Employer

- Simply providing MSDS to employees is not sufficient. The employer must ensure that employees are trained and understand the information presented in the MSDS and how to apply this information to the safe handling, storage and disposal of the controlled product
- The employer is responsible for ensuring that all controlled products entering the workplace have an up-to-date MSDS. If no MSDS is available, the employer must attempt to get one from the supplier and store the material until it arrives.

Employee

- Employees must report to their supervisor when discovering an incomplete MSDS, an expired MSDS, or the absence of a required MSDS.
- Employees must read and understand the MSDS before they use the product.

5.3.2 Nine Required Sections on a MSDS -
NOTE: (Refer to the Chemical Safety Module for MSDS definitions)

- product information
- hazardous ingredients (names, concentrations)
- physical data (physical state, odour, vapor pressure, boiling point, etc.)
- fire and explosion hazards (flashpoint, auto-ignition temperature, flammability limits, means of extinction, etc.)
- reactivity data (stability, incompatibility, temperature and pressure reactivity, decomposition, etc.)
- toxicological properties (adverse health effects, route of exposure, acute/chronic effects, LD50, TLV, carcinogenicity, etc.)
- preventive measures (personal protective equipment, spill procedures, safe handling, storage requirements)
- first aid measures (instructions for initial treatment of exposed persons for each route of entry)

5.3.3 Location of MSDS

Every MSDS must be current and up-to-date (must be less than three years old). It must be revised within 90 days of any new hazard information becoming known. The supplier must supply a MSDS for every controlled product sold.

Copies of the MSDS must be accessible to employees. MSDS in an electronic form can also be used providing that the computer terminal and program are maintained in working order and is readily available to all employees. In addition, employees must be trained to use the electronic system. However, if MSDS in an electronic form are not readily available, a binder containing MSDS for each workplace (i.e.

each laboratory section) must be kept up-to-date and readily available.

Due to liability issues, supplier MSDS from suppliers other than the supplier of the controlled product should not be used.

5.3.4 MSDS for Infectious Substances

MSDS for infectious materials (WHMIS Class D3) are also required. The content requirements, which are slightly different from those listed above for chemicals include: health hazards including pathogenicity, infectious dose, and mode of transmission; zoonosis; vectors; viability including susceptibility to disinfectants and physical inactivation; medical surveillance, treatment and immunization; and laboratory hazards
and containment requirements. It may be necessary to prepare own MSDS.

5.4 WORKER EDUCATION

Worker education programs are intended to show workers how to use the WHMIS labels and MSDS, and how to work with hazardous materials in a healthy and safe
manner.

5.4.1 Roles & Responsibilities

Employer

- It is the employer's responsibility to provide WHMIS training to educate employees and their supervisors working with or near hazardous materials.

Employee

- The employee must participate in the educational sessions offered by the employer and apply the knowledge learned in their training.

The training is general with respect to the requirements of WHMIS, and specific to actual controlled products present in the workplace of workers and supervisors who are taking the training. The WHMIS training program must be developed in consultation with the safety and health committee and it shall include:

- education on the content, the purpose, and significance of the information on labels and MSDS
- identification of the hazardous materials in the workplace and where they are used and stored
- education on the hazards of controlled products, how chemicals enter the body and what effects they have on the body
- training in procedures for safe storage, handling, use and disposal of controlled products
- training on where and when personal protective equipment is used
- the details of emergency plans for dealing with spills, leaks, fires and exposure
- the location of MSDS; including any computer training to allow workers access to electronic

MSDS information

While written or oral tests are an acceptable means of evaluating that the worker has understood the training material, the real test of the training is on-the-job. Assessments must be made to ensure each employee's ability to apply the information to the controlled products they use.

The worker education program must be reviewed at least once a year, or more often if conditions in the workplace change or new information becomes available. There are a variety of means of demonstrating that reviews have been conducted, for example, in the annual facility inspection report or through the minutes of the health and safety committee.

Refresher courses must be offered on a regular basis (minimum once every two years) and when a training need has been identified as a result of a workplace inspection or accident review. Completion of refresher training course is valid for three years.

5.4.2 On Line Training

The use of self directed computer learning courses is a popular way to deliver generic occupational safety and health training. If generic orientation or refresher WHMIS training is delivered this way, it must be approved by the Institutional safety committee, the EOHSO. On-line training is not a substitute for workplace specific training. Other traditional methods of WHMIS training, such as classroom and videos can still be used.

5.4.3 - Which WHMIS Courses Should I Take?

- for the person who does not use a WHMIS product such as administrative staff, they may take a simple WHMIS awareness program such as a Symbols Game.

- for new staff or existing staff that will be using WHMIS products they must take a complete WHMIS course that meets the requirements outlined above and successfully pass a test.

- for staff that have completed the original WHMIS course, refresher training only is needed in subsequent years. A successful completion of a test is also required.

For clarification on this section contact the EOHSO.

5.5 HOW WHMIS APPLIES TO LABORATORIES

Persons working in laboratories are typically better informed about the hazards posed by products in their workplace than persons working outside of the laboratory setting. Many laboratories follow minimum guidelines for labeling instances when a chemical is decanted from its original (supplier labeled) container. This involves the WHMIS requirements that:

- the product is clearly identified and is legible to all employees in the workplace.
- a current material safety data sheet is available (sec. 5.3); and
- worker education is given on the controlled product (sec. 5.4)

The ILRI EOHSO would like to recommend that (a best practice) as showed in the image below be adopted at ILRI

Product

Date Made □ **Date Received** □	**Signature**

MSDS □ YES □ NO

Classification

Personal Protective Equipment

Workplace label for larger containers in the laboratory

0.05M Citrate Buffer

ASSIGNED LOT #: 06 CITR 16

PREPARATION DATE: 06.04.11

EXPIRY DATE: 06.04.18

MADE BY: Q. Kubay PH:4.499

MSDS kept in Room A1288

Label for small bottles that workplace labels do not fit on (Label enlarged for viewing)

5.6 WORK SITE WHMIS HAZARD PREVENTION CHECKLIST

The following checklist will be used to evaluate your Laboratory compliance to WHMIS.
There are many tasks facing the EOHSO while trying to comply with WHMIS. The following checklist will help the EOHSO to identify these tasks. The list contains questions that can be answered either "yes" or "no". A question answered with a "no" may identify an area requiring attention. Please note that not all questions may be relevant to all work areas.

General

[ ] Do you know which materials in your workplace are controlled products?

Labeling and Identification

[ ] Do all containers of controlled products received from a supplier have a supplier label?

[ ] Do all containers of controlled products produced for internal use have workplace labels?

[ ] Do you have workplace labels on controlled products that have been decanted from the original supplier container into another container?

[ ] Have you applied either a supplier or a workplace label to the containers of controlled products received as bulk shipments?

[ ] Have you posted a placard with workplace label information for any controlled product not in a container?

[ ] Is all hazardous waste that is generated and stored on site identified?

MSDSs

[ ] Do you have supplier MSDS on file for all controlled products received from a supplier?

[ ] Are all your MSDS dated within the last three years?

[ ] Do workers have easy access to MSDS?

[ ] Does the joint health and safety committee, if any, or a worker representative have easy access to all MSDS?

Worker Education

[ ] Did you consult your joint health and safety committee when developing the worker education program?

[ ] Have all affected workers been trained?

[ ] Do workers know what WHMIS is?

[ ] Are the content and significance of information on a WHMIS label understood?

I.e. - What is a hazard symbol?

- What do you do if there is no label?

[ ] Is the content and significance of information on the MSDS understood?

[ ] Do workers know the proper procedures for the safe handling of controlled products?

I.e. - Have procedures for the safe handling of controlled products been developed?

- What protective equipment needs to be worn?

- What other controls are used to minimize exposure or risk?

[ ] Do workers know what to do in an emergency?

[ ] Do workers know what to do in areas where fugitive emissions are present?

[ ] Do workers know how to safely store and handle hazardous waste?

[ ] For controlled products received from a supplier, are you aware of any differences in hazard information from the supplier label and MSDS, and have you explained these differences to your workers?

[ ] Have workers been trained respecting controlled products in pipes, reaction or process vessels, tank cars etc.?

[ ] Do you have a mechanism for reviewing the worker education program once a year?

6.0 CHEMICAL SAFETY

The safe handling and storage of chemicals are of paramount importance in a laboratory setting for new and established employees. Before an employee starts work they shall read the Material Safety Data Sheet on the chemicals they are using and understand the dangers associated with their use. The employee must follow the safe work practices outlined in this chapter, as a minimum standard in their workplace. Remember it is everyone's responsibility to ask, learn about and understand the hazards of chemicals in their workplace.

See also Section 5 - Workplace Hazardous Materials Information System (WHMIS) for information on Chemical labeling and material safety data sheets (MSDS).

6.1 WORKING WITH TOXIC CHEMICALS

6.1.1 How Toxic Chemicals Effect Us

Toxic chemicals damage living tissue or interfere with its metabolism. They include corrosives (e.g., strong acids and bases), acutely toxic substances (e.g., cyanides), irritants, carcinogens, embryotoxins, teratogens, mutagens, asphyxiants and allergens. Toxic effects can be acute causing immediate damage as the result of a single or short- duration exposure or chronic causing damage after repeated or long-duration exposure. Acute toxicity is measured by:

- LD_{50} (lethal dose) - expressed as dose (i.e., amount/body weight) of a substance that, when administered by a particular route of entry, has been shown to cause the death of 50% of a defined animal population. From a practical point of view, there's a wide range of LD50 and corresponding toxicities from super-toxic (LD_{50} of <5mg/kg) to practically nontoxic (>15g/kg)

- LC_{50} (lethal concentration) - a concentration of substance in air that, when administered by inhalation over a specified period of time has been shown to cause the death of 50% of a defined animal population

6.1.2 Routes of Entry

All entries begin with contact followed by penetration through various mechanisms. The main way chemicals enter the body is by:

- inhalation - respiratory tract
- ingestion - digestive tract
- skin contact - penetration
- eyes

6.1.3 Principles of Control

Known or suspected chemical hazards can be controlled at the source, along the pathway or at the worker.

<u>Control at the Source</u>
Controlling hazards at the source is the best method of hazard control. This can be done by using fewer hazardous chemicals therefore eliminating the use of the dangerous chemical. You can enclose the chemical therefore isolating it from the worker. The work process can be changed to eliminate worker

exposure. You may also reduce the amount of chemical you are using.

Along the Pathway
The second most effective way to control a chemical hazard is to control it along the pathway. This is done mainly through mechanical ventilation. The use of fume hoods in laboratories is a common example of control of the hazard along the pathway.

At the Worker
Control of the hazard at the worker is generally the least effective way to control a hazard. The uses of personal protective equipment and administrative controls like rotating workers through dangerous jobs are examples of control of the hazard at the worker.

6.1.4 Exposure Limits

The American Conference of Governmental Industrial Hygienists (ACGIH) annually revises lists of Threshold Limit Values (TLVs) and Short Term Exposure Limits (STELs) for common chemicals used in laboratories. The Canada Occupational Safety and Health regulations under the Canada Labor Code are to be amended to automatically incorporate the most up-to-date version of these occupational exposure limits.

- TLV - time-weighted average concentration for a normal 8-hour workday to which nearly all workers may be repeatedly exposed without adverse effect

- STEL - maximum concentration to which workers can be exposed for periods up to 15 min (such exposures should be limited to no more than four per day with periods of at least 60 min each between exposures; the total time-weighted exposure per day should not exceed the TLV value)

- Ceiling limit - the concentration which should never be exceeded

Exposure limits should be interpreted with caution and each situation should be individually assessed. They are not the absolute line between safe and dangerous concentrations but rather should be used as guidelines. Consideration should be given to the facts that there are no TLVs for mixtures of chemicals which might have synergistic or commutative effects. Further, because there is a wide variation in the way
people react to chemicals, a small percentage of workers may experience discomfort for some substances at concentrations at or below exposure limits. A smaller percentage still may be affected more seriously by the aggravation of a pre-existing condition.

It is best to try to avoid a toxic chemical by altering the work process or replacing the chemical with a less toxic one. Further, chemicals can often be purchased as prepared solutions to avoid exposures due to weighing, mixing, etc.

Read sections on Routes of Entry and Principles of Control along with the specific Safe Work Practices in this chapter for more information on reducing the risk of chemical exposure.

6.1.5 Transporting of Chemicals

Transporting chemicals in and between laboratories and stockrooms must reflect the potential danger posed by the chemical. Hand carried chemicals or chemicals carried on a cart must be placed in a secondary container to protect against breakage and spillage. Carts should be stable and have wheels large enough to negotiate uneven surfaces without tipping or stopping suddenly. Carts must also have a spill tray.

6.2 FLAMMABLE AND COMBUSTIBLE MATERIALS

Flammable materials readily catch fire and burn in air. Combustible materials must first be heated before they can burn. Flammable and combustible liquids themselves do not burn. It is the mixture of their vapors and air that burns. The vapors from nearly all flammable and combustible materials are heavier than air and can settle and collect in low-lying areas (e.g., sewers, trenches, basements). The vapor trail can spread far
from the liquid and if ignited can "flash back" to the liquid source. This can occur even if the ignition source and liquid are hundreds of feet or several floors apart.

6.2.1 Definitions

- Flashpoint - the lowest temperature at which the liquid gives off enough vapor to be ignited; the lower this temperature, the greater is the risk of fire; most common laboratory solvents have flash points lower that room temperature (e.g., acetone: -37^{0}C, ethyl alcohol: 12.8^{o}C, toluene: 4.4^{o}C, benzene: -11.1^{o}C) Flashpoints are intended to be used as guides only, not as fine lines between safe and unsafe.

- Flammable or Explosive Limits - A material's flammable or explosive limits also relate to its fire and explosion hazards. These limits give the range between the lowest and highest concentrations of vapor in air that will burn or explode. An example is gasoline. The lower flammable limit or lower explosive limit (LFL or LEL) of gasoline is 1.4%; the upper flammable limit or upper explosive limit (UFL or UEL) is 7.6%. This means that gasoline can be ignited when it is in the air at levels between 1.4 and 7.6%. A concentration of gasoline vapor in the air below 1.4% is too "lean" to burn. Gasoline vapor levels above 7.6% are to "rich" to burn. Flammable limits, like flashpoints however, are intended as guides and not as fine lines between safe and unsafe.

- Auto-ignition temperature - the temperature at which some materials self-ignite without a source of ignition, such as a spark or flame

- Spontaneous combustion - takes place when a substance reaches its auto- ignition temperature without the application of external heat (e.g.. Oily rags slowly react with oxygen creating heat; when the auto-ignition temperature is reached, the vapors ignite, causing a fire)

6.2.2 Safe Work Practices for Handling Flammable Substances

- flammable substances should be handled away from heat, sparks, open flames, electrical motors, and direct sunlight. Avoid soldering or welding in the vicinity of flammables.

- conduct work involving the release of flammable vapors in a fume hood

- use "approved" portable safety cans for carrying, storing and dispensing flammable liquids (safety cans have mechanisms to allow for automatic venting of vapors). Approved containers are from organizations such as ULC - Underwriters Laboratories Canada or CSA - Canadian Safety Association.

- approved non-reusable glass or plastic containers (i.e., the containers they are usually shipped in), holding no more than 5 litres, may be used to store and handle flammables; do not exceed the maximum container sizes specified by the National Fire Code(NFC).

- minimize quantities of flammable liquids in the laboratory to the supply necessary for normal operations; maximum storage out in the open laboratory is 300 L of flammable and combustible liquids of which not more than 50 L shall be Class 1 liquids; additional amounts must be stored in proper storage cabinets conforming
  to the requirements of the NFC (a flammable storage cabinet must not contain more than 500 L of flammable and combustible liquids, of which not more than 250 L's are Class 1 liquids)[1]

- keep containers closed when not in use

- do not store flammable and combustible liquids in standard refrigerators that contain many ignition sources; use only approved "explosion safe" non sparking refrigerators

- when dispensing flammables from metal storage containers to smaller metal containers, bond both containers to each other and ground the storage container to prevent the build-up and discharge of static charge. See Appendix 1 in this section for information on preventing static discharges during dispensing of flammable chemicals.

- clean up spills promptly to minimize the surface area of the spilled liquid and to avoid the risk of the vapor concentration exceeding the LFL; use absorbent materials specially designed for the particular chemical spilled (see Chapter 13 on Spills for more information)

- read the MSDS and supplier's label to know all the hazards for the flammable and combustible materials that you work with

- in addition to fire hazards, flammable and combustible materials can cause health problems through breathing the vapor/mist and eye or skin contact. Some are carcinogenic. Some are corrosive and many undergo dangerous chemical reactions if they contact incompatible chemicals such as oxidizers.

- wear proper protective equipment for the tasks you are performing.

- WHMIS warning signage of the dangers that these chemicals can cause must be put on every cabinet storing these chemicals.

6.3 CORROSIVE MATERIALS

The major classes of corrosives are strong acids (e.g., hydrochloric, sulfuric, nitric, chromic, acetic and hydrofluoric acids) and bases (e.g., ammonium hydroxide, potassium hydroxide, sodium hydroxide). Inhalation of vapors or mists can cause severe irritation and burns of the lining of the nose, throat, windpipe and lungs. In serious cases, this results in pulmonary edema, a build-up of fluid in the lungs that can
be fatal. These chemicals burn and erode the skin and are particularly damaging to the eyes, causing scars or permanent blindness.

Although most of the corrosives are liquids, such as strong acids and bases, there are also corrosives that are gases (ammonia) and solids (sodium hydroxide pellets). Some such as nitric acid are also strong

oxidizers so present additional risks and hazards, especially with respect to storage. Special measures need to be in place if dealing with perchloric acid in order to prevent explosions.

Corrosives can also damage or even destroy metal. When acids attack metals, flammable hydrogen gas is often given off. Some corrosive chemicals are also powerful oxidizing agents (perchloric, nitric and sulfuric acids) and present fire and explosion hazards.

6.3.1 Safe Work Practices for Handling Corrosive Materials

- avoid skin contact by always wearing appropriate gloves (i.e., of material resistant to degradation by the corrosive - see an attached chemical glove degradation guide)
- always wear eye protection when working with corrosives; chemical safety goggles are usually the most appropriate, however, a face shield may also be required to protect the face from splashes
- work in a fume hood where a possibility of inhaling corrosive vapors, fumes, dusts or mists exist; in some situations, respirators may be required for breathing protection
- inspect containers regularly and do not use containers susceptible to degradation by the corrosive; use safety carriers for transporting corrosives
- many corrosives generate large amounts of heat when mixed with water causing solutions to froth and boil; always add corrosives slowly to water when diluting; always use water at room temperature or below
- in the event of accidental contact with the skin or eyes, use eyewash stations and chemical deluge showers to flood the affected area for at least 15 minutes; always seek medical attention

6.4 OXIDISING MATERIALS

Oxidizing liquids and solids are substances that provide a source of oxygen or other oxygen-liberating substances(e.g., ozone, chlorine). These chemicals can be severe fire and explosion hazards. Most oxidizing materials do not burn themselves but produce flammable mixtures when combined with combustibles like paper, wood, flammable and combustible liquids, greases, waxes, plastics, textiles, hydrogen, sulphur compounds and ammonia compounds. They can result in fires when in contact with flammable and combustible materials and can increase the speed and intensity of a fire. They can cause substances which do not normally burn readily in air to burn rapidly. They can cause combustible materials to spontaneously catch fire without the presence of obvious ignition sources.

The degree of fire hazard when an oxidizer comes into contact with a combustible material depends on the stability of the oxidizing substance. The less stable, the greater the chance that it will react in a dangerous way.

6.4.1 List of Common Oxidizing Chemicals

Bromine, bromates, chlorinated isocyanurates, chlorates, chromates,dichromates, hydro peroxides, hypochlorites, inorganic peroxides, Ketone peroxides, nitrates, nitric acid, nitrites, perborates, perchlorates, perchloric acid, periodates, permanganates, peroxides, peroxyacids, persulphates

Organic peroxides provide both a source of fuel and oxygen and can catch fire easily and burn very rapidly and intensely. Some are dangerously reactive. They can decompose rapidly or explosively when exposed to slight heat, friction, mechanical shock or contamination with incompatible materials. Organic peroxides can also be strong oxidizing agents, resulting in fire if they contact combustible materials. Examples of organic peroxide include benzoyl peroxide, acetyl peroxide, methyl ethyl ketone peroxide and peroxyacetic acid.
Oxidizing materials may also be toxic or corrosive, causing burns or irritation to the skin, eyes, respiratory tract and other tissues. Corrosive oxidizers can attack and destroy metal.

The formation of peroxides on storage of solvents such as diethyl ether, tetrahydrofuran and dioxane are of most importance. Order such solvents in small quantities to be used within a few months. Test for the presence of peroxides (using test strips and colour reactions) if solvents are kept in storage and prior to disposal.

The National Fire Protection Association (NFPA) Code 430 (2000) "Code for the Storage of Liquid and Solid Oxidizers" classifies oxidizing materials according to their ability to cause spontaneous combustion and how much they can increase the burning rate.

6.4.2 Safe Work Practices for Handling Oxidizing Chemicals

- prevent direct contact of skin and eyes with oxidizing materials by using appropriate protective clothing and equipment
- read the MSDS on the chemicals you are going to use before you use them.
- where respirators are required, cartridges or canisters containing activated charcoal may not be acceptable for high concentrations of strong oxidizers such as vaporized hydrogen peroxide (self-contained breathing apparatus may be required)
- avoid or eliminate ignition sources (sparks, flames, hot surfaces) when working with oxidizing materials
- keep oxidizers away from flammable and combustible materials
- some oxidizers are incompatible with each other and may react violently together; always check the reactivity data and storage requirements
- dispense oxidizing materials carefully, using compatible equipment and containers.
- keep only the smallest amounts possible (not more than one days supply)in the work area
- do not return contaminated or unused oxidizers back to the original container
- be careful not to contaminate oxidizers with anything that can burn (wood, paper, clothing, leather shoes)
- follow the chemical manufacturer's directions for mixing oxidizers with water.
- store oxidizing chemicals in containers that the chemical supplier recommends. Normally these are the same containers that material was shipped in

- ensure that hoods, ducts, fans and air-cleaning devices, such as dust collectors, are made from materials compatible with the oxidizing agents.

- store oxidizing materials in areas that are labeled with suitable warning signs

- know the emergency spill response for oxidizing chemicals

6.5 DANGEROUSLY REACTIVE MATERIALS

Workplace Hazardous Materials information System (WHMIS) criteria define dangerous reactive liquids or solids as those that can:1. undergo vigorous polymerization, condensation or decomposition, 2. Become self reactive under conditions of shock or increase in pressure or temperature, 3. React vogorously with water to release lethal gas

Some dangerously reactive chemicals are very unstable and can react vigorously, even explosively, under mechanical shock or slightly elevated temperature or pressure. Materials in this category include concentrated hydrogen peroxide solutions, peroxides, dry picric acid and peracetic acid. Improper storage conditions have led to explosions of these materials in the laboratory. These materials may also produce dangerous gases
when mixed with incompatible materials. For example, potassium cyanide slowly releases hydrogen cyanide gas on contact with water. Some dangerously reactive materials undergo vigorous decomposition, polymerization, or condensation. Some peroxides vigorously decompose at room temperature and are only safe when refrigerated or diluted.

Some substances may not be dangerously reactive at the time of purchase, but may develop dangerous properties over a period of time. Compounds known to form highly reactive and explosive peroxides include picric acid and diethyl ether.

Dangerously reactive materials may also be corrosive, oxidizing, flammable, and toxic.

Read the MSDS carefully, paying special attention to the storage and handling requirements.

6.5.1 Safe Work Practices for Handling Dangerously Reactive Chemicals

- know the conditions under which the chemical can be handled and stored; know conditions under which it is unstable

- limit the quantities on hand to the minimum amount required

- always wear eye protection when working with reactive chemicals; when using materials harmful to the skin, wear protective gloves; wear respirators as required, cartridges containing activated charcoal may cause hazardous reactions (wear a self-contained breathing apparatus instead)

- metal contamination from spatulas may lead to explosive decomposition; use ceramic or wooden spatulas as specified by the supplier

- sources of heat, direct sunlight, moisture and elevated temperatures should not be permitted near these materials

- friction, grinding, and all forms of impact should be avoided

- inspect containers regularly for damage or leaks before handling them
- never return unused material to the original container
- glass containers with screw-cap lids or glass stoppers may present a hazard; polyethylene bottles with screw-capped lids are better; avoid using caps with cardboard liners for moisture-sensitive chemicals (airborne moisture can diffuse slowly through the liner); always store the material in the container in which it was shipped; if crystals are present around the screw cap, do not open, detonation may occur
- protect containers from light and impact or physical damage; keep vented containers (e.g., hydrogen peroxide) in an upright position
- take care when handling and transferring reactive materials; spills have caused serious accidents
- peroxides should be stored at low temperatures but not frozen (crystals of pure, very sensitive peroxide may form); follow the manufacturer's storage instructions (i.e., refrigerated in an "explosion safe" non-sparking refrigerator)
- dispose of reactive chemicals as specified by the supplier once the shelf life has expired
- never dispose of these chemicals or reactive wastes in ordinary garbage or down sinks or drains; proper disposal procedures for these products must be followed according to the supplier's advice; use hazardous waste collection and disposal companies
- empty containers may contain hazardous residues and must never be used for anything else, no matter how clean they may seem to be; treat them as dangerously reactive wastes
- dangerously reactive chemicals are potentially life threatening and can cause severe property damage
- read the MSDS carefully, paying special attention to the storage and handling requirements

6.6 COMPRESSED GASES

The three major groups of compressed gases stored in cylinders are: liquefied, non- liquefied and dissolved gases. Liquefied gases are gases which can become liquids at normal temperatures when inside cylinders under pressure. Examples include propane, carbon dioxide and nitrous oxide. Non-liquefied gases do not become liquid, even at very high pressures. Common examples of this group are oxygen, nitrogen and helium. Acetylene is the only commonly dissolved gas (dissolved in acetone).

In addition to the physical hazard presented by compressed gas cylinders, some present fire and explosion hazards. Flammable gases such as acetylene, propane and hydrogen can burn or explode. Cryogenic gases such as carbon dioxide and liquid oxygen can cause frostbite on contact. Some compressed gases are toxic while others, although inert, can displace enough air to produce oxygen deficient atmospheres.
Asphyxiant gases include argon, helium, nitrogen and carbon monoxide. Common corrosive gases include ammonia and hydrogen chloride. Cylinders containing oxidizers react with combustible materials, resulting in fire or explosion (e.g. nitrous oxide, liquid oxygen).

The following precautions should be followed when handling hazardous compressed gases:

6.6.1 Safe Work Practices for Using Compressed Gases

- In addition to the hazards posed by compression, compressed gases may be corrosive, flammable, highly reactive or toxic. Cylinders can explode if heated or damaged and can become missiles capable of penetrating walls.

- whether in use or not, always secure cylinders firmly in an upright position (i.e. clamp, anchor, or chain). Never leave a cylinder free standing.

- dragging cylinders can damage them; use specially designed cylinder carts; move cylinders with protection caps on

- check equipment for gas leaks at cylinder valves, regulators and connections; use soapy water or approved leak-test solutions such as SNOOP or electronic leak detectors

- use regulators designed for the contents of the cylinder; the regulator inlet threads should match the cylinder valve outlet threads; do not use a lubricant or tape to achieve a good seal; tighten regulators using the proper size wrench

- close the main cylinder valve and bleed residual pressure from the lines when the cylinder is not in use

- keep cylinders capped when not in use and in transit and securely chained or strapped to the wall

- store cylinders in a dry, well-ventilated area away from heat, ignition sources and clear of exit routes and fire exits; keep cylinders away from paint, oils or solvents.

- read the MSDS and know all the chemical, physical and physiological effects of the compressed gases you work with

- always check the label, not the cylinder color, to identify the gas

- keep them away from incompatible materials

- separate by at least 600cm (20 feet) or a fire wall, oxidizing and flammable and highly combustible gas cylinders

- never use a gas in an area where there is insufficient ventilation

- never bleed a cylinder completely empty; leave a residual pressure.

- store flammable gases away from all ignition sources
- the regulator should be closed before coupling. Do not over tighten the coupling nut from the regulator stem.

- a contingency plan for leaking cylinders should be defined and known to all laboratory personnel in areas where compressed gases are used.

6.7 STORING CHEMICALS IN LABORATORIES

The amounts of toxic, flammable, corrosive, unstable, or highly reactive materials permitted in laboratories should be limited to minimum working quantities and those specified in the NFC. Reserves must be stored in chemical storerooms or chemical storage buildings. The chemicals stored in the laboratory must be inventoried (with the name, quantity (i.e., amount typically on hand), location (i.e., room number), a
user/owner, and expiry date, if applicable), and unneeded items returned to storerooms or stockrooms. Inventories must be kept up-to-date.

Each class of chemical in the laboratory should have a designated storage place, accessible only to authorized laboratory workers. Storage cabinets should be designed and installed in accordance with NFC requirements. Chemicals stored on bench tops can easily be knocked over and chemicals stored in fume hoods can disrupt airflow. Care must also be taken to avoid exposure of chemicals to heat sources or direct
sunlight and to observe precautions regarding proximity of incompatible substances.

Containers must have legible WHMIS labels. This can be either a supplier label or workplace label. Any container that is unlabelled should be treated as containing hazardous materials. Arrangements may have to be made for special testing to determine contents of the container. An up-to-date MSDS must be available for each product. Consult section VIII of the MSDS for specific storage requirements.

6.7.1 Safe Work Practices for Storing Chemicals in Laboratories

- the maximum quantity of flammable and combustible liquids set out in the NFC must be followed (300 L in open laboratory areas of which not more than 50 L are flammables or the supply necessary for normal operations); additional amounts must be stored in flammable storage cabinets conforming to the requirements of the NFC

- flammable storage cabinets must not hold more than 500 L of flammable and combustible liquids, of which not more than 250 L are Class 1 liquids; there is a limit of three cabinets/lab fire compartments; grounding of cabinets is advisable, especially when metal containers are stored inside; venting of cabinets may be
  hazardous (fire could be carried through the ducting to another location or vapors could ignite causing flashback), however, for health and safety reasons, venting is recommended when storing toxic flammables; always ensure that lids are tightly secured.

- the maximum allowable container sizes for flammable and combustible liquids specified by the NFC must be followed (5 L for flammable liquids or in Underwriters Laboratories (UL) approved safety containers of not more than 25 L)2

- special cabinets are recommended for storage of more than 8 L of volatile or liquid corrosives; cabinets should be resistant to the material being stored (i.e., specially coated surfaces or polypropylene)

- storage cabinets for oxidizers are recommended whenever more than 25 L or kg of volatile or liquid oxidizers or liquid organic peroxide formulations are being stored; they are not generally needed for the majority of the solid inorganic oxidizers; cabinets should be made of non-porous, non-oxidizable material (i.e., not unprotected wood)

- substances producing noxious vapors and volatile toxicants must be stored in properly ventilated cabinets

- storage cabinets should have trays or catch basins of sufficient capacity to prevent contents from escaping

- highly toxic materials must be stored in locked cabinets

- provide for a separate storage area for reactive substances that are unstable; consideration for storage should be made on a case-by-case basis to provide for protection from changes in pressure, temperature, friction, light exposure, water vapor, physical shock or sound waves
- glass containers should be protected from falling, collisions, impact and physical damage

- store larger containers and corrosives on lower shelves to minimize the extent of splashing or spillage in the event that a container falls and breaks; store dangerously reactive chemicals below shoulder height

- shelves supporting chemicals should be equipped with edge guards to prevent containers from sliding off; the shelving is to be non-combustible, corrosion resistant, strong enough for the load and securely attached to walls and floors

- storage areas and cabinets should be adequately ventilated; ventilated cabinets must comply with 4.2.10.6 of the NFC.

- impermeable catch trays, compartments, devices and secondary containers should be used to contain spills should a container break or leak

- use only approved "explosion proof" non-sparking refrigerators; ordinary refrigerators should be labeled as "not suitable for the storage of flammable liquids"

- label all storage cabinets, refrigerators and other storage areas clearly with appropriate warnings (e.g., Flammable liquids - keep fire away, Warning - Corrosives, Warning - chemical storage, Warning - Toxic substances in use)

6.7.2 Storing Chemicals in Storerooms and Storage Buildings

Chemical storerooms and storage buildings must be designed and maintained in accordance with applicable local standards and codes. Recommendations for safe use and operation of these facilities will be discussed. An operational protocol specific to the layout and the materials stored in each chemical storage facility must be developed.

6.7.3 Safe Work Practices for Storing Chemicals in Storerooms

- All the safe work practices outlined for chemical storage in laboratories also apply to dedicated storage facilities. In addition, the following practices must be considered:

- storage facilities must be kept locked and have access restricted

- the site plan and up-to-date inventory must be posted at the main entrance to the facility

- all controlled products must have WHMIS labels; there are to be no unlabelled containers in the chemical storage facility

- a binder or binders containing up-to-date MSDS for controlled products stored in the facility must be readily available (kept outside of the storage rooms for easy access during an emergency)

- all required personal protective clothing and equipment must be available for general use (e.g., decanting materials into another container) and for emergency procedures (e.g. spill, leaks); protective clothing and equipment should be kept outside of the storage rooms to allow for easy access during emergencies

- staff must be trained in the procedures to follow when accessing and working in the facility and in the event of a spill or leak

- safety eyewashes and deluge showers must be available and located outside of storage rooms. See Section 2 - Safe Use of Laboratory Equipment for more information

- fire extinguishers should be available - See Section 2 - Safe Use of Laboratory Equipment for more information

- arrangements should be made with the local Fire Department to visit the facility so that they will be aware of your fire emergency needs

- keep the amount of oxidizing materials in storage as small as possible

- inspect the storage area regularly for any deficiency including damaged or leaking containers and poor housekeeping

- signage should be posted outside the chemical storage room warning of the hazards inside the room

- it is advisable that when transferring large volumes of solvents to have a second person available in case of an emergency

6.8 CHEMICAL COMPATIBILITIES

The storage requirements for chemicals within the laboratories are quite diverse, however, all storage of chemicals must conform to required codes and legislation. There are specific storage requirements for pesticides, corrosives, oxidizers, acids, reactive chemicals, flammables, etc. The areas where chemicals may be stored include laboratories, chemical storage rooms, chemical storage buildings, barns and greenhouses. In all of these areas, the utmost care must be exercised to ensure that proper chemical storage policies and procedures are developed and maintained.
See Appendix 2 for a list of chemical incompatibilities.

6.8.1 Incompatible chemicals

Extreme care must be exercised to ensure that incompatible chemicals cannot accidentally come in contact with each other. Such contact could result in a serious explosion or the formation of substances that are highly toxic or flammable. The distance between containers depends on the properties of the substances. In general, consider the consequences of two containers simultaneously breaking or leaking; if their

contents can mix, then they are stored too close together. One must also consider the possibility of a shelf collapsing and the contents of all containers mixing. Segregation of chemicals into different reactivity classes is the first step.
As a preliminary segregation, the following groups can be segregated:

- **Flammables** - (e.g.; Acetone, Benzene, Cyclohexane, Ethanol, Ethyl Acetate, Ethyl Ether, Gasoline, Hexane, Isopropyl Alcohol, Methanol, Propanol, Tetrahydrofuran, Toluene, Xylene) Separate from oxidizing acids and oxidizers, keep away from sources of heat, sparks, ignition

- **Acids** - separate from caustics, cyanides, sulfides; oxidizing acids (e.g. nitric and sulphuric) are segregated from organic acids (e.g. formic and acetic), flammable and combustible materials

- **Caustics** - separate from acids

- **Oxidizers** -(eg;Calcium Hypochlorite, Ferric Chloride, Iodine, Nitrates -Salts of, Peroxides -Salts of, Potassium Ferricyanide, Sodium Nitrite, Bromine, Hydrogen Peroxide, Nitric Acid, Perchloric Acid, Chromic Acid) Reacts violently with organics, separate from flammable and combustible materials; segregated from reducing agents (e.g. zinc, alkaline metals, formic acid)

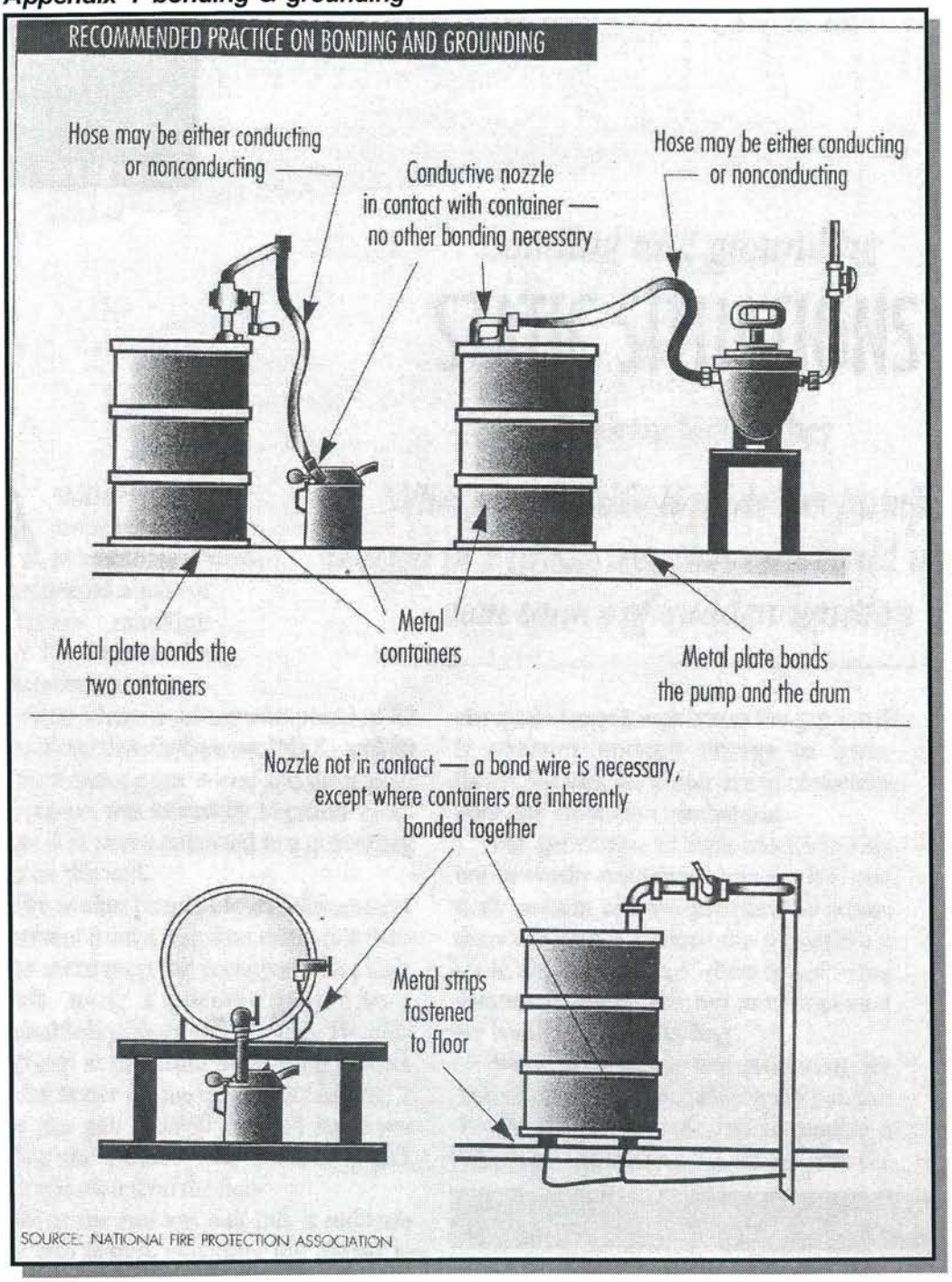
- **Water reactive chemicals** - separate from any potential water source

Within any given category of this preliminary segregation, there may still exist incompatible combinations. The reactivity of each chemical must be checked to verify its compatibility with others stored in the same group. Always consult the reactivity section of the MSDS for a list of incompatible materials.

6.8.2 - Incompatible Chemical Resource Guide

It is mandatory that all laboratories have a hard copy and/or electronic copy of a guide to chemical incompatibilities resource that is readily available to all staff.

Appendix 1 bonding & grounding



Appendix 2 Chemical Incompatible list

Incompatible Chemicals in storage and in reactions

Acetic Acid- with chromic acid, ethylene glycol, hydroxyl containing compounds, nitric acid, perchloric acid, permanganates peroxides e.t.c
Acetone-with concentrated nitric and sulphuric acid mixtures etc
Acetylene – with copper tubing, halogens (bromide, chlorine, fluorine, and iodine) mercury, silver and their compounds etc
Alkali Metals- with carbon dioxide, carbon tetrachloride, chlorinated hydrocarbons waster etc
Ammonia, anhydrous- with calcium hypochlorite, halogens(bromide, chlorine, fluorine, and iodine) , hydrogen flouride, mercury etc
Ammonium Nitrate – with acids, chlorates, flammable liquids, metal powders, nitrates, sulfur, finely divided organic compounds and combustibles etc
Aniline – with hydrogen peroxide, nitric acid etc
Bromine – with ecetylene. Ammonia, butadiene, butane, hydrogen, sodium carbide, turpentine, metal powders etc
Carbon (activated charcoal) – with calcium hypochlorite, oxidizing agents etc
Chlorates – with acids, ammonium salts, carbon, metal powders, sulfur, finely divided organic compounds and combustibles etc
Chlorine – with acetylene, ammonia, benzene, and other petroleum fractions, butadene, hydrogen, sodium carbide, turpentine , metal powders etc
Chlorine dioxide –with ammonia, hydrogen sulfide, methane, phosphine etc.
Chromic acid-with acetic, alcohol, camphor, glycerin, naphthalene, turpentine, flammable liquids etc.
Copper- with acetylene, hydrogen peroxide, etc.
Cyanides – with acids, alkalis, etc.
Flammable Liquids – with ammonium nitrate, chromic acid, halogens (bromine, chlorine, fluorine, and iodine), hydrogen peroxide, nitric acid, sodium peroxide etc.
Hydrocarbons – with chromic acid, halogens (bromine, chlorine, fluorine and iodine), sodium peroxide etc.
Hydrogen Peroxide – with aniline, copper chromium, iron, most metals, nitro methane, flammable liquids, combustible materials etc.
Hydrogen Sulfide – with fuming nitric acid, oxidizing gases etc.
Iodine – with ammonia, acetylene, etc.
Mercury – with acetylene, hydrogen, fulminic acid, etc.
Nitric acid – with acetic acid, aniline, carbon (activated), chromic acid, hydrocyanic acid, hydrogen sulfide, organic compounds that are readily nitrated, etc.
Oxalic acid – with mercury, silver etc.
Oxygen – with grease, hydrogen, oils, flammable materials etc.
Perchcloric Acid – with acetic anhydride, alcohol, bismuth and its alloys, flammable and combustible materials, etc.
Phosphorus Pentoxide – with water.
Potassium Permanganate – with benzaldehyde, ethylene glycol, glycerin, sulfuric acid, etc.
Silver – with acetylene, ammonium compounds, oxalic acid, tartaric acid, etc.
Sodium – with carbon dioxide, carbon tetrachloride, water, etc.
Sodium Peroxide – with acetic anhydride, glacial acetic acid, benzaldehyde, carbon disulfide, ethyl acetate, ethylene glycol, furfural, glycerin methanol, any oxidizable chemicals, reducing agents etc.
Sulfuric acid – with chlorates, perchlorates, permanganates, water, etc.

Reproduced from: Chemical Safety in the Laboratory. 1994. S.K. Hall (ed.). CRC Press, Florida

7.0 JOB HAZARD ANALYSIS AND SAFE WORK PRACTICES

There is a need for a standardized way of evaluating risks and developing safe work practices for the tasks performed by employees in the ILRI Research Platform. This section will be a useful tool to help complete Risk Assessments and Job Hazard Analysis for specific tasks.

7.1.1 Employees:

- must read and follow the job hazard analysis(JHA) and safe work practices(SWP)
- if requested, must participate in the development of a JHA/SWP for the tasks they perform

7.1.2 OHS committees and representatives:

- responsible for reviewing JHA/SWP

7.1.3 Employer:

- must use a systematic approach to review existing Standard Operating Procedures and Protocols(SOPs) and ensure they contain realistic and measurable occupational safety components. A Job Hazard Analysis and/or corresponding Safe Work Practices must be completed when the standard documents do not adequately identify safety components
- must designate a person(s) are identified to develop and maintain the JHA/SWP.
- responsible to ensure that tasks are reviewed for their potential risk and to help prioritize JHA development, a simple Risk Analysis (see Section 3.2) must be completed
- must ensure that the OHS committee and other interested parties are allowed a chance to comment on the JHA/SWP
- ensure use of completed JHA/SWP to train employees, to develop workplace inspection checklists and as a resource in hazardous occurrence investigation
- to ensure that the JHA/SWP are reviewed as per the requirements of the this chapter.

7.2 WHAT IS A JOB HAZARD ANALYSIS

One way to increase the knowledge of hazards in the workplace is to conduct a job hazard analysis on individual tasks. **A job hazard analysis (JHA) is a procedure which helps integrate accepted safety and health principles and practices into a particular operation**. The last stage of a JHA is a SWP. SWP is a set of guidelines that describes the safest way to perform a task and is developed based on the hazards identified in the JHA.

In a JHA, each basic step of the job(or task) is examined to identify potential hazards and to determine the safest way to do the job. Other terms used to describe this procedure are job safety analyses and job hazard breakdown.

The terms "job" and "tasks" are commonly used interchangeably to mean a specific aspect of work for example sample preparation or autoclaving. The word "job" is used throughout this section, but the words function or task could be used to have the same meaning. The critical point is that all the steps of

the job/function/task are analyzed for hazards.

7.2.2 What are the benefits of doing a Job Hazard Analysis?

Initial benefits from developing a JHA will become clear in the preparation stage. As safety and health awareness is raised. The analysis process may identify previously undetected hazards and increase the job knowledge of those participating. Additionally, it can be an opportunity to improve communication between workers and supervisors and promote acceptance of safe work procedures.

The completed JHA and safe work practices must be used for;

- training new employees,
- in the development of workplace inspection checklists and,
- as a tool during the hazardous occurrence investigations

7.3 THE FIVE BASIC STEPS OF A JHA

Five basic stages in conducting a JHA are:

- selecting the job to be analyzed
- breaking the job down into a sequence of steps
- identifying potential hazards
- determining preventive measures to overcome these hazards
- communicating the information to others

7.3.1 Selecting the Job to be Analyzed

- Which jobs require a hazard analysis? It would not be realistic to assume that all jobs in the laboratories should be subjected to a JHA. The task of performing and keeping the JHA current requires considerable time and effort. So, given that it will be impossible and unnecessary to analyze each and every task, consider the following factors to begin:

- hazard occurrences frequency and severity: are there jobs where accidents occur frequently or where they occur infrequently but result in disabling injuries

- the potential for severe injuries or illnesses: are the consequences of an accident, hazardous condition, or exposure to harmful substance are potentially severe

- are there newly established jobs: due to lack of experience in these jobs, hazards may not be evident or anticipated

- modified jobs: are there new hazards may be associated with changes in job procedures

- infrequently performed jobs: are workers at greater risk when undertaking non routine jobs, would a JHA provides a means of reviewing hazards

- jobs with frequent work interruptions due to technical difficulties

- jobs where employees are required to work alone

7.3.2 Simple Risk Analysis

The factors above will help to create a prioritized list of "jobs" in the workplace. For each job on the list, a simple risk analysis must be completed to determine which of them require a JHA.

The risk analysis allows for a methodical, quantitative assessment of the jobs. JHAs for jobs with the highest risk of a hazardous occurrence should be written first (e.g. jobs with the highest total score in the example below)

Example: Risk Analysis Worksheet

Risk Analysis Location : Additives and Chemical Contaminants Unit,
Analysis by: _____**Date**: _____**Reviewed by**:_____

Identification of Tasks	Frequency of task	Probability of harm with the existing controls in place	Severity	Total score	Is a JHA/SWP required to be completed
1. Removing samples from upright freezer	4	2	2	16	No
2. Sample preparation - can opening, blending, food processing, homogenizing	4	3	2	24	No
3.Handling and working with solvents	5	3	3	45	Yes
4.Heating solutions on hot/stir plate	5	3	3	45	Yes
5.Aspirating solvent with pipette	4	2	2	12	No
6.Connecting and disconnecting compressed gases to regulators	3	3	4	36	Yes

RISK ANALYSIS LEGEND -
Frequency of task (exposure)- 1= Less than once a year, 2= Once a year, 3= Once a month, 4= Once a week, 5= Daily
Probability - 1= Remotely possible, 2= unlikely, 3= Probable in time 4= Likely to occur immediately, 5= Certain
Severity - 1= No injuries occur, 2= Minor reversible illness or injury to humans, 3= Major reversible illness or injury to humans, 4= Causes severe or critical injury/irreversible harm, 5= Death/catastrophic

Action Required - Multiply the three numbers (Frequency, Probability x Severity). If the total score is 30> a job hazard analysis and safe work practices are required. Safety should be incorporated into relevant SOPs

*NOTE: Tasks with a score of <30 can still have a JHA completed after others with a >30 score are completed.

See (Appendix 1 - Blank Sample Risk Analysis Worksheet)

7.3.3 What methods are used to collect information for a Job Hazard Analysis?

Now that you have determined your list of what tasks require a JHA performed, here are two methods to use when collecting information for a JHA.

Observation - A method used to develop a JHA by observing a worker actually perform the job. The major advantages of this method are that it does not rely on individual memory and, that the process itself prompts recognition of hazards. For infrequently performed or new jobs, observation may not be practical.

Group Discussion - With this approach a group of experienced workers and supervisors complete the analysis through discussion. An advantage of this method is that more people are involved allowing for a wider base of experience and promoting a more ready acceptance of the resulting work procedure. Members of the joint occupational safety and health committee should participate in this process also.

7.3.4 Breaking the Job into a Sequence of Steps (Basic Steps) 1

After a job has been chosen for analysis, the next stage is to break the job into steps. A job step is defined as a segment of the operation necessary to advance the work.

- Care must be taken not to make the steps too general, thereby missing specific steps and their associated hazards. On the other hand, if they are too detailed, there will be too many steps. A general rule is that most jobs can be described in less than ten steps. If more steps are required, you might want to divide the job
  into two segments, each with its separate JHA, or combine steps where appropriate.

- Each step is recorded in their correct sequence. Any step which is out of order may miss potential hazards or introduce hazards which do not actually exist. Make notes about what is done rather than how it is done.

- Each step is started with an action verb.

- Watching the worker is the best way to prepare this part of the analysis, i.e. listing the steps. The observer is normally the immediate supervisor but a more thorough analysis often happens by having another person, preferably a member of the joint occupational health and safety committee, participate in the observation. Key points are less likely to be missed in this way.

- To strengthen full cooperating and participation, the reason for the exercise must be clearly explained. The JHA is neither a study of a worker's efficiency in disguise, nor an attempt to uncover individual unsafe acts. The job, not the individual, is being studied in an effort to make it safer by identifying hazards and
  making modifications to eliminate or reduce them. The worker's experience can be important in making improvements.

- The job should be observed during normal times and situations.

- When completed, the breakdown of steps should be discussed by all the participants (always including the worker) to make sure that all basic steps have been noted and are in the correct order.

See (Appendix 2 for an example of the "Sequence of Steps" completed)

7.3.5 Identifying Potential Hazards or Accidents

Once the basic steps have been recorded, potential hazards must be identified at each step. At this stage, no attempt is made to solve any problems which may have been detected.

Evaluate each step to determine if the following hazards are present:

- Physical
- Biological & Botanical

- Ergonomic
- Psychological
- Chemical
- Psycho social

Clearly identify the hazard on the JHA worksheet. Again, all participants should jointly review this part of the analysis.

See Appendix 2 for an example of the "Potential Accidents or Hazards" completed)

7.3.6 Developing Safe Work Practices

The final stage in a JHA is to determine ways to eliminate or control the hazards identified. The safe work practices developed must be realistic and measurable to be effective.

Controlling the hazards in order of preference are:

- **Eliminate the hazard** -This is the most effective measure. These techniques should be used to eliminate the hazards:
    - Choose a different process
    - Modify an existing process
    - Substitute with less hazardous substance
    - Modify or change equipment or tools

- **Contain the hazard** - If the hazard cannot be eliminated, contact might be prevented by using enclosures, machine guards, or other similar devices; improve the environment by increasing ventilation,

- **Revise work procedures** - Consideration might be given to modifying steps which are hazardous, changing the sequence of steps, or adding additional steps (such as locking out energy sources).

- **Reduce the exposure** - These measures are the least effective and should only be used if no other solutions are possible. One way of minimizing exposure is to reduce the number of times the hazard is encountered. The use of appropriate personal protective equipment may be required. To reduce the severity of an accident, emergency facilities, such as eyewash stations, may need to be provided.

In listing the preventive measures, use of general statements such as "be careful" or "use caution" should be avoided. These are not measurable statements.

Using paper 8.5 x 14" landscape format will give you more room to enter information and there may be enough room to put all the safe work practices on the one sheet. However, there may not be enough room on the JHA form to identify all the safe work practices. The safe work practice information can be on an additional document that is referenced on the JHA safe work practice section.

See Appendix 2 for Completed JHA & SWP example

7.3.7 - Communicating the Information to Others

The final stage of the JHA process involves using the completed JHA to improve existing standard operating procedures and employee training. As mentioned previously it is a tool that can also be used in developing workplace inspection checklists and as a resource in the investigation of hazardous occurrences.

7.4 MAINTENANCE OF JHA DOCUMENTS

The JHAs/SWPs documentation, records and records management must comply with Sections, 1.7 and 1.8 of this manual. Revision of the JHAs and SWPs will occur;

- when steps required to complete the task(s) or the nature of the task(s) changes
- when changes to legislation, standards and other reference documents occurs
- a minimum of every three years.
- a review of the JHA/SWP after a hazardous occurrence occurs to an employee.

APPENDIX 1 - Blank Risk Analysis Form

Risk Analysis Worksheet
Risk Analysis Location : _____ Analysis by:_____ Date:_____
Reviewed by

Identification of Tasks	Frequency of task	Probability of harm with the existing controls in place	Severity	Total score	Is a JHA/SWP required to be completed

RISK ANALYSIS LEGEND -
Frequency of task (exposure)- 1= Less than once a year, 2= Once a year, 3= Once a month, 4= Once a week, 5= Daily
Probability - 1= Remotely possible, 2= unlikely, 3= Probable in time 4= Likely to occur immediately, 5= Certain
Severity - 1= No injuries occur, 2= Minor reversible illness or injury to humans, 3= Major reversible illness or injury to humans,
4= Causes severe or critical injury/irreversible harm, 5= Death/catastrophic

Action Required - Multiply the three numbers (Frequency, Probability x Severity). If the total score is 30> a job hazard analysis and safe work practices are required. Safety should be incorporated into relevant SOPs

*NOTE: Tasks with a score of <30 can still have a JHA completed after others with a >30 score are completed.

Appendix 2 - Sample Completed Job Hazard Analysis Form

Job Hazard Analysis Worksheet
Task: Perform chemical analysis on fish and fish products, **Date**: September 6, 2000 **Date**: September 6, 2000
Analysis By: Chemistry Staff **Reviewed By**: R. Jones **Approved by**: G. Brown, P. Wood

Sequence of Steps (*Note: observe/interviewed/record worker performing each step, start each step with a verb*)	**Potential Accidents or Hazards** (*physical, biological, botanical, ergonomic, psychological, chemical, psycho social*)	**Safe Work Practices (SWPs)** (*Note: the preventative measures identified must be achievable and measurable*) additional pages can be used for SWPs
1. Receiving and moving fish in large tote (up to 80 lbs)	Arm, shoulder & back strain, damage to foot	Wear safety boots. Divide fish in smaller boxes. Lift tote with help from another person. Follow Safe Lifting Practices as outlined in Laboratory Safety Manual Ergonomics Chapter. Use trolley to move. If load reaches 45kg> and lifting is required you must follow Part XIV Manual Materials Handling COHS Regulations
2. Cutting, blending and grinding fish and shellfish	Cutting finger or hand with sharp knife or cleaver, fingers cut by cutter or grinder blades	Wear protective mesh glove. Do not force knife through frozen fish or shell. Follow safety instructions with grinder and cutter when feeding fish through
3. Filleting fish	Slicing finger or hand with sharp knife	Learn filleting technique, wear hand protective glove. Follow **Safe Work Practice for Filleting Fish** 1. **Safety equipment to be worn** - Laboratory lab coat or apron, protective mesh glove (for cutting). 2. **Prepare fish for filleting** - Fish to be filleted vary in size: - sunfishes or yellow perch which are less than 0.5 kg.,. - carp which can weigh as much as 10-12 kg, - eels which are more than 2 feet long. They are usually frozen. It is important to thaw fish thoroughly so that the filleting knife can cut through easily. Use thaw tanks in the Chemistry Sample Preparation Room whenever possible (fish may be too large to fit in). Rinse fish to reduce slime. 3. **Filleting a round-bodied fish** - 1. Place fish on the cutting board. Hold fish with gloved hand with fish facing away from you. 2. Use a sharp, thin-bladed knife to cut along the back of the fish, from head to tail, such that the knife is cutting away from you.. 3. Make a second cut just behind the gills, down to the backbone. Holding the knife at a slight angle, cut along the bone to free the back side of the fillet. It is better to cut a little shallow than deep. Peel

		back the free meat, then cut fillet away from the rib cage. Again make sure the knife is cutting away from you. 4. If more meat is required, turn fish over and repeat above steps for second fillet. 5. To skin, grasp fillet by the tail end, skin side down. Holding the knife at a slight angle, cut the meat free. Make sure cut away from gloved hand or body 4. **Filleting a small fish (bass, crappie**) - 1. Lay the fish on the cutting board. Grasp the fish's mouth, take small fillet knife and position it just behind the side fin. Slice downward about a half inch, keeping the rear of the knife blade up (watch your fingers!). Be careful not to cut into the fish's backbone. 2. Turn the knife blade towards the tail and continue cutting, staying on top of the back and belly fins. You'll feel resistance as you cut through the rib cage. Be careful not to cut into the backbone. It is better to cut shallow and avoid the bones. Continue cutting until the fillet is off. 3. To skin, grasp fillet by the tail end, skin side down. Holding the knife at a slight angle, cut the meat free. Make sure cut away from gloved hand or body
4. Handling and working with toxic reagents	Reagent can be absorbed through skin	Wear gloves, lab coat, safety glasses
5. Handling and working with volatile reagents	Reagents may cause irritation to eyes and skin	Wear gloves, lab coat, safety glasses Follow Safe Work Practices identified in Sections 6.2-6.5 of the ILRI Laboratory Safety Manual when handling & working with chemicals
6. Handling and working with corrosive reagents	Reagents can cause skin burns, damage clothing	Wear gloves, lab coat, safety glasses. Follow Safe Work Practices identified in Sections 6.2-6.5 of the ILRI Laboratory Safety Manual when handling & working with corrosive reagents
7. Digesting samples with strong acids.	Concentrated acids are extremely corrosive, burn skin, destroy clothing..	Work in the acid resistant fume hood. Wear gloves, lab coat, safety glasses, face shields. Follow Safe Work Practice for Using Concentrated (conc.) Acids 1. **Safety equipment to be worn** Gloves, lab coat and safety glasses are to be worn at all times when handling conc. acids. Face shield must be worn when specified in the procedure. 2. **Transport and storage** - Conc. acids, including perchloric, sulphuric, nitric, acetic, phosphoric, must be transported safely on trolley or cart when received and brought to storage cabinets in the laboratory. Individual glass bottles (usually 2 L size) should be taken out of shipping carton and put in the acid storage cabinets under the fume hood. When transporting individual bottle of conc. acid, bottle safety carrier, which can contain all the acid in case of bottle breakage, must be used Note: Some conc. acids are available in plastic container. 3. **Filling dispenser bottle or making dilution** - When 2 L size bottle of conc. acid is taken from storage cabinet and opened to fill dispenser bottle (1 L size) or pour into graduated cylinder for dilution, operator must wear face shield or use face shield of fume hood. The operation must be carried out in the

		fume hood with the fan running on high speed. 4. **Dispensing acid** - The dispenser must be sitting firmly on the counter surface in the fume hood. Containers like digestion tube, conical flask, are brought to the dispenser and acid is dispensed into the container. The dispenser must not be held by hands and brought to the containers for dispensing. 5. **Inspection of dispenser** -The operation of the dispenser must be checked thoroughly every time it is re-filled with acid. The plastic cap must be inspected for integrity and tight fit. If there are signs of wear, parts should be replaced and if necessary the dispenser should be replaced. 6. **Review the ILRI Laboratory ILRI Safety Manual Sections 2 & 3**,- Safe Work Practices and other operational manuals. Check that safety practices have been adhered to. Propose improvements to safety procedures. Attend safety training courses
8. Extracting samples with organic solvents, evaporating solvent extracts	Vapor can damage eyes. Solvents are toxic and have accumulative effect. Absorption through inhaling vapor or skin contact.	Work in the fume hood, under canopy or exhaust arms. Wear solvent resistant gloves, lab coat. Follow Safe Work Practice for Using Solvents below 1. Safety equipment to be worn - Solvent resistant gloves, lab coats and safety glasses are to be worn when handling 4 litre (L) bottles of solvent. 2. Extracting sample with solvent - The blending of sample and solvent mixture using a blender or Polytron homogenizer and the subsequent filtering operation must be done in the fume hood. 3. Flash evaporating solvent extracts - Solvent extracts are evaporated using rotary flash evaporators. An exhaust arm must be over the area to prevent accumulation of solvent vapor. 4. Transport and storage - When a shipment of solvents arrives, cartons of 4 X 4 L are to be stored in the designated Solvent Storage. These cartons should be placed on the platform off the floor against the side wall and stacked to no more than 3 high. Once a carton is opened, individual bottles should be stored on the steel shelves. Bottle safety carrier or carts must be used in the transport of 4 litre size bottle of solvents from the Solvent Storage to the laboratory or from lab to lab. The carrier is design to hold the content of the bottle in case the bottle breaks. In the laboratory, 4 L size solvent bottles should be stored in a solvent storage cabinet under the fume hood. 5. Filling dispenser bottle - The filling operation should be carried out in the fume hood with the fan running on high speed. 6. Dispensing solvent - Dispensing of solvent should be done in the fume hood or under an exhaust arm. 7. Rinsing and drying of glassware with solvent - This operation must be done in the fume hood. The spent solvent is to be collected and deposited in a waste container in the fume hood. 8. Disposal of waste solvent - a) Waste solvents may be collected as halogenated and non-halogenated for the purpose of disposal. The non-halogenated solvents are collected and stored in special 5 gallon metal waste containers. When these are full, they are transported (using trolley or cart) to the Solvent Storage room. b) The non-halogenated solvents are poured into a 45 gallon waste solvent drum for

		disposal by contract company. Be sure to connect grounding wires between the 5 gal container and the drum when pouring. c) The halogenated solvents are collected in 4 litre bottles and transported to the solvent storage room. They are poured into a 5 gal waste can, marked for halogenated solvents, which is disposed off by the company. d) Read and comply with SOP - 06-345-13 Waste Disposal
9. Connect & disconnect compressed gases to instruments	High pressure gas can puncture skin, break glassware resulting in injury	Learn how to handle compressed gas safely. Follow **Safe Work Practice Section 6.6.1 of the ILRI Laboratory Safety Manual on Compressed Gas Safety**
10. Operate vacuum oven	High vacuum may cause glass trap to break, resulting in flying glass injury	Put tapes on glass trap to reduce potential of flying glass. ear gloves, lab coat, safety glasses.
11. Heating solutions on hot plates	Hot surface and spilled solution can cause burn	Wear thermal gloves or handle glassware with tongs. Wear lab coat, safety glasses
12. Filling distilled water carboys (up to 60 lbs) from Sterilization Room and transport to lab	Back and neck injury can result from improper lifting	Lift carboy with help from another person. Fill carboy to half full. Fill carboy on trolley and transport to lab
13. Moving cylinders of compressed gases to and from laboratory.	Dropped cylinder can cause bodily injury	Wear safety boots. Use proper cart for transport; capped and secure cylinder at all times. Follow Safe Work Practice Section 6.6.1 of the ILRI Laboratory Safety Manual on Compressed Gas Safety
14. Transport organic solvents to and from storage	Dropped bottle can cause bodily harm, spilled solvent produce large amount of toxic vapor	Follow Safe Work Practice for Using Solvents - See Point# 8 above
15. Operate LKB electro focusing equipment	High voltage may cause electrical shock	Wear rubber gloves. Ensure work bench is dry. Put up warning sign in front of equipment
16. Using instruments and	Exposure to radioactive	For Electron Capture Devices review the manufacturers instructions. Please follow Safe Work Practices

Charm Test kits which contain radioactive materials	substance	outlined in the ILRI Laboratory Safety Manual, Radiation Chapter, Section 8.3 Electron Capture Devices For Charm Kits review manufacturer's handling instructions. Please also follow; 1. There should be no pipetting by mouth. 2. There should be no eating or use of cosmetics while radioactive materials are being handled. Ingestion is the greatest health threat during this time. 3. Wash hands thoroughly after handling radioactive materials. 4. Wipe up spills immediately and thoroughly. 5. Solid waste contaminated with [14] or [3H] may be put into the normal trash after removing or blacking out all radioactive labels. 6. Liquid waste contaminated with [14C] or [3H] may be put into the sanitary sink drains and flushed with copious amounts of water.
17. Operate computer	Eye fatigue, wrist and arm injury	Make sure computer and work station are set up properly. Learn proper posture and keyboard technique.

8. 0 RADIATION SAFETY

The International Livestock Research Institute (ILRI) has a consolidated license from Radiation Protection Board. (RPB) ILRI has three uses of radioactive material that require a license. These uses are: 1. Open sources of radioisotopes in laboratory studies, 2. Fixed Gauges with a sealed source of nuclear activity and 3. Electron Capture Devices which also have a sealed source of nuclear activity. This section of the Laboratory Safety Manual, Radiation Safety, will give basic minimum guidelines to be followed for each type of use pattern.

All areas using radioisotopes will be inspected by RPB. Failure to comply the RPB regulations and action items identified in the inspection report may result in cancellation of the license.

8.1 LICENSES, REGULATION AND INFORMATION

All users of radioactive material must be registered on a license issued by the Radiation Protection Board (RPB). The license outlines a set of conditions that must be followed for the use and disposal of the prescribed radioisotopes. In addition, all RPB regulations and regulatory guides must be adhered to. These area available at http://www.health.go.ke/radiation-board.htm This includes the following:

8.2 DUTIES FOR A EOHSO (RADIATION SAFETY OFFICER) AND EOHS TECHNICAL ASSISTANT

8.2.1 EOHSO (Radiation Safety Officer)

EOHSO has the following duties and responsibilities:

- the overall responsibility for all the Radiation Protection Board licenses issued to ILRI.
- qualified to be a Radiation Safety Officer by completing a training course that meets the RPB requirements.
- Programs for Workers Involved in Licensed Activities with Nuclear Substances and Radiation Devices, and with Class II Nuclear Facilities and Prescribed Equipment.
- to monitor and audit all licenses and permits on a yearly basis at ILRI to ensure they are compliant with the RPB
- to monitor and approve all training programs at ILRI to ensure they are compliant with the RPB
- to provide advice on matters relating to the use of radiation devices, radioisotopes and their disposal in Biotechnology
- to ensure all RPB licenses and employee training programs are kept current
- to complete and submit to the RPB the Annual Compliance Report
- issues copy permits to ILRI facilities identified in the RPB license.
- will perform a yearly review of radioactive materials purchased at ILRI

- has the ability to suspend work under the permit if conditions identified under the Permit are not met.

- responsible for the renewal of the license and any required changes to the license

- being familiar with and keeping a copy of the relevant RPB regulatory documents (outlined above) and site license

- ensuring all RPB regulations, policies, license & permit conditions are adhered to by auditing the work procedures and policies

- developing specific radiation safety protocols specified by the license; the protocols must be reviewed by the Institutional Biosafety committee and the Institute of Nuclear Science – Nairobi University (trainer for radiation safety for ILRI)

- ensuring all users are trained in the safe use, storage and disposal of radioisotopes and are appropriately familiar with the radiation safety protocols, RPB regulations and license conditions

- obtaining dosimetry services as required

- ensuring that all radioactive material must get approval before they are ordered.

- authorizes internal permits for workers using radioisotopes

- monitoring all inventories, contamination test results and dosimetry records

- developing emergency procedures to be followed in the event of an accident or spill

- investigating and reporting all accidents, spills, hazardous incidents and dosimetry results above RPB specified levels

- has the ability to suspend work under the permit if conditions identified under the permit are not met.

- designates in writing if a worker is a Nuclear Energy Worker (NEW) as per the requirements of Radiation Protection Board. The EOHSO can also revoke in writing the NEW designation if exposure is less than 1mSv per year.

8.2.2 Environment Occupational Health & Safety Technician (Radiation Safety Technician)

The duties of the Radiation Safety Technician will include:

- to be a liaison with the EOHSO to help monitor and ensure the requirements of the consolidated license and permits are being met and in the completion of the Annual Compliance Report.

- to arrange for leak testing of the unit as required by legislation

- to ensure the RPB License and the ILRI Permit to use Electron Capture Devices (ECD) and Fixed Gauges are posted and to audit compliance to the conditions of the ILRI Permit.

- to maintain an inventory of sealed sources, records of disposal and employee training.

- to meet the training requirements outlined in section 8.3 and 8.4

8.3 ELECTRON CUPTURE DEVICES

- Servicing Limitations - The license does not authorize the licensee to dismantle electron capture detectors.

- Storage - The licensee shall: a) ensure that when in storage radioactive nuclear substances or radiation devices are accessible only to persons authorized by the licensee; b) ensure that the dose rate at any occupied location outside the storage area, room or enclosure resulting from the substances or devices in storage does not exceed 2.5 microSV/h; and c) have measures in place to ensure that the dose limits in the Radiation Protection Regulations are not exceeded as a result of the substances or devices in storage. The licensee shall post and keep posted, in a readily visible location at the place the device is stored, a legible sign that indicates the name or job title and the telephone of the person, who can be contacted 24hrs. a day, who can initiate the accident procedure referred to in the license.

- Labeling - Sealed sources must be marked with a radiation warning symbol, and the activity and name of radioactive material involved. Gas Chromatographs containing a radioactive substance must be clearly and durably labeled with radiation warning sign, activity, and the name of the radioactive material involved.

- Testing - Leak tests shall be performed on sealed sources, by a RPB.
- The frequency for leak testing shall be,
  every 24 months for each sealed source continuously in storage,
  every 12 months, where the sealed source or shielding is located in a radiation device
  every six months, where the sealed source or shielding is not located in a radiation device

- Permit - The Permit will be issued by the Radiation Protection Board. All conditions of the Permit must be complied with. A copy of the ILRI authorization Permit is posted in the room where the radiation device is used. (See Appendix 2 - Sealed Source Radiation Device Permit)

- License - The RPB license will be sent by the Radiation Protection Board to the EOHSO. All conditions of the license must be complied with. A copy of the RPB license must be posted near where the ECD is used.

- Training- All users of Electron Capture Devices shall be trained on the:
  1. general operations and procedures of the radio isotope lab
  2. explanation of license & permit requirements, responsibilities
  3. discussion on the very low radioactive source in the device.
  4.Document that this training has occurred.

8.4 FIXED GAUGES

ILRI has a sealed radiation source which is located in the caesium room which is located next to the new office building opposite the tick unit. The following conditions must be followed:

- Emergency Contact - a readily visible and legible sign that indicates the name or job title and the telephone number of a person who can initiate the accident procedure referred to in this license who can be contacted 24hrs. shall posted on or near any radiation device.

- Storage - The licensee shall: a) ensure that when in storage radioactive nuclear substances or radiation devices are accessible only to persons authorized by the licensee; b) ensure that the dose rate at any occupied location outside the storage area, room or enclosure resulting from the substances or devices in storage does not exceed 2.5 microSV/h; and c) have measures in place to ensure that the dose limits in the Radiation Protection Regulations are not exceeded as a result of the substances or devices in storage.

- Record Requirements - The licensee ensure that a copy of the prescribed records and operating instructions, specific to the location of use, are maintained at the location of use.

- Permit - The Permit will be issued by the RPB. All conditions of the Permit must be complied with and must be posted in the room where the radiation device is used.

- License - The RPB license will be sent by the EOHSO to the laboratory. All conditions of the license must be complied with. A copy of the RPB license must be posted near where the Fixed Gauge is used.

- Leak Tests -Except for gaseous sources and sources of tritium, leak tests must be performed according to RPB guidelines on all sealed sources containing more than 50MBq (1.35 mCi) of all radioactive substance.

  The frequency of the leak testing shall be the same as those identified in section 8.3.

8.5 OPEN SOURCE RADIOISOTOPE USE

Currently one ILRI laboratory uses open sources of radioisotopes .

8.5.1 Safe Work Practices When Using Open Sources of Radioisotopes in a Basic Level Laboratory

A basic concept to working safely with radioisotopes is keeping exposures as low as reasonably achievable (ALARA). This can be achieved by three different means: TIME (the magnitude of the dose is directly related to the duration of the exposure), DISTANCE (radiation intensity decreases the further away from the source) and SHIELDING. Although safe working procedures vary with each isotope, the following precautions are essential:

- radiation warning signs must be posted at the entrance to all areas where radioisotopes are used or stored,

- specific standard operating procedures must be developed and reviewed by the site radiation safety officer

- Permit - The use of permits is necessary in a radiation safety program to ensure access to nuclear materials is controlled and that only authorized trained people are working with the radioactive materials. The Permit will be issued by the EOHSO. All conditions of the Permit must be complied

with. A copy of the ILRI authorization Permit is posted in the room where the radioisotopes are used. See Appendix 1 - Radioisotope Permit & Conditions

- License - The RPB license will be issued by the National EOHSO to the laboratory. All conditions of the license must be complied with. A copy of the RPB license must be posted near where the radioisotopes are used

- no person shall work with radioisotopes without the proper training as per 8.5.2

- working efficiently reduces your exposure time. Post a copy of your protocol nearby for reference and, before you begin, assemble everything you will need

- you should know the types and energies of emitted radiations, the potential for external exposure, the half life, the annual limit on intake, and how to detect contamination for the radionuclides used

- A copy of the poster must be displayed in each laboratory; the name and telephone number (at home and extension at work) of the EOHSO must appear on the poster

- containers holding radioactive material and equipment used to manipulate radioactive material must be clearly labeled as radioactive; sealed sources must also be labeled

- work with radioisotopes should be confined to as small an area as possible; the defined area must be clearly labeled as radioactive (e.g., use radioactive tape to mark off benches and equipment)

- use absorbent paper with plastic backing on work surfaces and change it after each experiment

- use appropriate SHIELDING (32P - at least " plexiglass; 125I - lead); conventional lead shielding should not be used with high-energy beta emitters, e.g.32P, due to increased bremsstrahlung hazard (Br58)

- work in a fume hood when handling volatile radioactive solutions; isotopes must not be stored in fume hoods; fume hoods used for work with radioactive materials must comply with the special design criteria outlined in the WHO Biosafety Guideline.

- wear appropriate gloves when handling radioisotopes (note: external ring badges must be worn under the gloves); hands must be washed and surveyed after
completion of the experiment and removing gloves

- wear also a laboratory coat and closed-toe-shoes when working with unsealed radioactive materials

- avoid spreading contamination; consider using aerosol resistant pipette tips

- look for contamination with frequent monitoring of hands, surfaces and equipment. Always monitor your hands, shoes, clothing when you complete your protocol

- any cuts or abrasions on the hands or other exposed skin should be covered with waterproof bandages

- always maximize the DISTANCE between you and the radiation (e.g., use tongs and forceps to handle materials not your hands, step away from sources while doing calculations or waiting for a

reaction to finish)

- always minimize the TIME exposed to the radiation; leave sources within their containers as much of the time as possible while working

- monitor incoming shipments of radioactive materials for leakage (see RPB requirements on - Identifying & Opening Radioactive Packages; the delivering carrier and supplier must be notified if contamination is discovered

- all losses or thefts of radioactive materials must be reported to the EOHSO and RPB.

- staff must be trained in the procedures for dealing with radioactive spills and other accidents. See the section 8.11 Handling Radioactive Spills & ILRI- Spill Procedures for more information

- radioisotope purchase requisitions, together with a current inventory of each radioisotope being requisitioned should be submitted to the EOHSO (to confirm that the possession limits of the license are not being exceeded)

- pregnant employees should contact their EOHSO to discuss issues relating to working with radioisotopes as soon as they realize their pregnancy

8.5.2 Training

All persons handling radioactive materials must be trained in the specific radioisotopes and procedures they will be using.

Original Training
The original training course and materials, whether they are developed by a consultant, outside sources or by ILRI staff must:

- comply with the Regulatory
- and the Radiation Protection Act (1982)
- and be approved by the EOHSO

BI - Annual Refresher
Refresher training is required for all persons handling radioactive materials and shall include as a minimum the following elements:

- a review of the Standard Operating Procedure for the radioactive substance(s) being used
- read the Radiation Safety Data Sheet for radiation sources being used

additional resources that can be used to supplement the above training include:

- view the Safety in the Research Laboratory video titled, Radionuclide Hazards.

After completion of the training, documentation must be kept outlining the date the training took place, participants name and course topics.

8.5.3 Properties of Selected Nuclides

Radionuclide	Radiation Characteristics	Use & Precautions	Detection & Measurement
Chromium 51 ^{51}Cr	X-Ray Gamma and Auger Electrons Half Life 27.7 Days	Disposable gloves & lab coat should be worn when handling ^{51}Cr. Use of lead shielding is required when handling mCi quantities. Remote handling devices (tongs etc.) should be used when handling mCi amounts. Read MSDS on 51Cr for more information.	Swipe testing counting with a Geiger Muller Tube or Liquid Scintillator
Tritium ^{3}H	Beta particle Half Life 12.26 Years	Disposable gloves & lab coat should be worn when handling ^{3}H Read MSDS on ^{3}H for more information	Swipe testing counting with a Liquid scintillator
Indium ^{111}In	Gamma & X-Rays Half Life 2.83 Days	Use tools to indirectly handle unshielded sources and potentially contaminated vessels; avoid direct hand contact Use lead shielding and syringe shields to minimize exposure. Normal precautions for handling radioactive materials should be observed. Read MSDS on ^{111}In for more information	Liquid scintillation Counting

Note: always refer to the information sheet supplied with each shipment of a particular radioisotope for specific characteristics (e.g., half-life) of that isotope. Some properties may vary between manufacturers and lot numbers.

8.5.4 Personnel Monitoring

Monitoring persons for radiation exposure must be carried out according to the license and RPB Regulatory requirements.

Dosimetry services are available through RPB as follows:

National Radiation Protection Board,
Kenyatta National Hospital Grounds
Hospital Road
P O Box 19841 -00200
Nairobi
Tel: +254 (20) 2714558.
Fax: +254 (20) 2714383.
Email: rpbkenya@nrbnet.co.ke

Application forms must be filled out by the EOHSO and forwarded to RPB at least three weeks prior to the date when dosimeters are required. The wearing schedule and position, and name list instructions must be adhered to.

- a dosimeter must be assigned to a specific wearer and worn for the scheduled period prescribed by RPB
- dosimeters are routinely collected and submitted to the RPB for monitoring purposes every last Friday of the month.
- records of dosimetry readings for each wearer must be kept on file
- dosimeters must be stored away from radioactive sources, heat, sunlight or moisture when not in use; they must not be worn /taken off the premises
- training should include a review of the Proper Care and Use of Personal Dosimeters
- the wearer and RPB must be notified when the dosimetry result for that person exceeds the limits outlined in Sections 13 & 14 Radiation Dose Limits of the RPB Radiation Protection Regulations
- the cause and circumstances contributing to that result must be investigated by the EOHSO and the report submitted to RPB and Institutional Safety Committee within 21 days of becoming aware that the dose limit has been exceeded as per the Radiation Protection Regulations

8.6 ENVIRONMENTAL MONITORING- OPEN SOURCE USE

Monitoring of work surfaces and storage areas for possible contamination (fixed or removable) must be carried out as required by the license. A monitoring program must be maintained and kept on file for up to three years.

- surface contamination checks must be carried out at least weekly
- a diagram of the work area must be made showing benches, sinks, doors, etc. and at least 10 numbered test areas (see The Site Radiation Report); areas tested should include bench tops, floors, sink and taps, pipette handles, centrifuges and centrifuge bowls, door handles, soap dishes, etc.)

- wipe testing is the acceptable method for detection of loose surface contamination; such testing is isotope and location specific; suitable wipes are commercial swipes, filter papers, and cotton tip applicators

- a calibrated survey meter should be used in conjunction with wipe tests to detect loose and fixed contamination over a broader area (they may detect contamination missed by the wipe test); they may or may not be isotope specific
- records of checks must be kept on file for three years (see attached sample record form)

- for any wipes with at least twice the counts of the background wipe, the location must be immediately decontaminated with detergent and water taking care not to spread the contamination; the location must then be retested to ensure that the removable contamination has been eliminated

- consult your license for specific limits for non fixed surface contamination (for normally accessible working surfaces where isotopes are used or stored, this is usually 0.3 Bq/cm2 of alpha activity and 3 Bq/cm2 of beta or gamma activity, averaged over an area of 100 cm2)

- in addition to routine checks, areas must be surveyed after any spill or leak, when work with radioisotopes is completed, and before maintenance or removal of equipment that may have come into contact with radioactive material

8.7 CONTROLLED ACCESS TO NUCLEAR SUBSTANCES & DEVICES

Access to radioactive materials is controlled from the time of acquisition until disposal. When not in use or not under the direct supervision and control of an authorized worker, nuclear substances and radiation devices must be secured in a locked area, room or enclosure.

8.8 RECORD KEEPING AND INVENTORY

(1)Every licensee shall keep the following records:

(a) a record of the following information in respect of any nuclear substance in the licensee's possession that is referred to in the license:

(i) the name, quantity, form and location of the nuclear substance,
(ii) where the nuclear substance is a sealed source, the model and serial number of the source,
(iii) where the nuclear substance is contained in a radiation device, the model and serial number of the device,
(iv) the quantity of the nuclear substance used, and
(v) the manner in which the nuclear substance was used;

(b) a record of the name of each worker who uses or handles a nuclear substance;

(c) a record of any transfer, receipt, disposal or abandonment of a nuclear substance, including
(i) the date of the transfer, receipt, disposal or abandonment,
(ii) the name and address of the supplier or the recipient,
(iii) the number of the license of the recipient,

(iv) the name, quantity and form of the nuclear substance transferred, received, disposed of or abandoned,
(v) where the nuclear substance is a sealed source, the model and serial number of the source, and
(vi) where the nuclear substance is contained in a radiation device, the model and serial number of the device;

(d) a record of the training received by each worker; and

(e) a record of every inspection, measurement, test or servicing performed by the licensee in accordance with the Act, the regulations made under the Act or the license.

(2) Every licensee shall retain a record referred to in paragraph (1)(d) for the period ending three years after the termination of employment of the worker.

(3) Every person who is required to keep a record referred to in paragraph (1)(e) shall retain the record for the period ending three years after the expiry date of the last license that was issued to the person in respect of the nuclear substance.

8.9 STORAGE

The storage of radioisotopes must conform to the requirements outlined in the license. This includes the following:

- storage areas must be accessible only to personnel authorized by the license
- a radiation warning sign must be affixed to all areas where radioactive materials are stored (including refrigerators and freezers); the sign must include the name and phone number (at home and extension at work) of the EOHSO
- each storage container must be labeled with a radiation warning symbol and an itemized list of the contents
- surface contamination checks must also be conducted in storage areas
- leak test are required for sealed sources in storage areas

8.10 WASTE DISPOSAL

All radioactive substances must be disposed of as:

- in the condition(s) stated in the license
- radioisotopes sent out for disposal must be done using a facility possessing an appropriate RPB and National Environmental Management Authority (NEMA) Waste Facility Operating License
- all waste containers must be labeled with a radioisotope warning label, all isotopes and their scheduled quantities, and date (i.e. the last time waste was added to the container); store waste containers in a radioactive storage area as described above
- inventory sheets must be filled out when disposing of radioactivity (this includes spill clean up materials); include the quantity (i.e. radioactivity), the type (i.e. solid, liquid) and disposal method

(decay, sewage, regular garbage, licensed disposal company)

- radioactive material contaminated with a biological organism must be treated to destroy that organism (care must be taken to protect autoclaves from volatile radioactives). Procedures must be approved by the National Radiation Safety Officer

- scintillation cocktails that are aqueous based are preferred (solvent based cocktails must be treated as chemical waste); aqueous-based cocktails may still require dilution to ensure radioactivity is below legislated levels

8.11 PACKAGING AND TRANSPORTATION

Employees shipping and receiving nuclear substances must ensure they meet the requirements of the Packaging and Transportation of Nuclear Substances Regulations as well the pertinent sections of the Transportation of Dangerous Good Regulations (TDGR) relating to Class 7 Radioactive Substances

If a decision is made to no longer use radioisotopes at a work location, decommissioning of the room shall occur. Compliance with the requirements of the RPB license section on decommissioning is critical. The EOHSO must notify the RPB of the intent to decommission a room. The following checklist shall be complied with when decommissioning a room.

- compliance with RPB license conditions on decommissioning

- non fixed contamination does not exceed 0.3Bq/cm2

- provide wipe test results and mapping of areas tested (dated & signed)

- provide a copy of your work record indicating the last date of use and the statement that all work ceased after that date

- all devices and substances transferred - provide documentation of firm that has removed the devices and or substances and their final destination

- all radiation warning signs have been removed or defaced

- if applicable, dosimeters returned

- location where laboratory records will be stored

- keep a record of decommissioning for review by the RPB and notify Institute Environment Occupational Health & Safety committee when work is completed.

APPENDIX 1 **ILRI LABORATORY RADIOISOTOPE PERMIT**

Permit No:

Permit Holder: Phone Number No:

Laboratory Room Number Where Work With Radioisotopes Will Occur:

Emergency Contact Person Relating to This Permit:

Environment Occupational Health & Safety Officer & Phone #:

Permit Time Period:

Person(s) Approved For Work With Radioisotopes:

Name	Position	Isotopes	Dosimetry

Radioactive Prescribed Substance:

Radioisotope	Use limit/Open source	Sealed source activity	Type of device

Radioisotope Permit Conditions (by signing Permit Holder agrees the following conditions will be met)

1. Only trained persons as per 8.4.2 of the ILRI Laboratory Safety Manual shall work with radioisotopes.

2. All conditions of the RPB license and this permit for the radioisotopes/sealed sources being used must be complied with.

3. All pertinent sections of the ILRI Laboratory Safety Manual, Section 8 - Radiation Safety must be read before the permit is issued.

4.The Safe Work Practices For Using Radioisotopes must be followed when performing radioisotope work

5. Internal Standard Operating Procedures for using radioisotopes must be followed.

_____ _____

signature/date/ permit holder signature/date/EOHSO

APPENDIX 2

SEALED SOURCE RADIATION DEVICE PERMIT

Permit No:

Permit Holder: Phone Number No:

Emergency Contact Person Relating to This Permit:

Radiation Safety Assistant - Phone #:

Permit Time Period:

Person(s) Approved to Work with Radiation Device:

Model and serial	Maximum activity	Use location	Storage location

Radiation Device Conditions (by signing Permit Holder agrees the following conditions will be met)

1. Only trained persons as per 8.3 of the ILRI Laboratory Safety Manual shall work with radiation devices.

2. All conditions of the RPB license and this permit for the radiation devices being used must be complied with.

3. All pertinent sections of the ILRI Laboratory Safety Manual, Section 8 - Radiation Safety must be read before the permit is issued.

4.The Safe Work Practices For Using Electron Capture Devices must be followed.

5. Internal Standard Operating Procedures for radiation devices must be followed.

_____

signature/date/EOHSO

_____

signature/date/ permit holder

9.0 WORKPLACE INSPECTIONS

Workplace inspections are a critical component of a hazard prevention program. This section of the manual has been designed to help you complete an effective, planned workplace inspection that will meet the requirements of Kenyan, ILO and ISO 18000 requirements.

9.1 PURPOSE OF A WORKPLACE INSPECTION

The purpose of a workplace inspection is to identify hazards that could endanger the health or safety of anyone in the workplace and ensure actions that appropriated action is taken when an actual or potential hazard is identified. It can also be used to verify if established procedures are being followed as well as identify training needs. An inspection achieves its purpose by seeking answers to four questions:

- Is a hazard or potential hazard present in the workplace?
- Is any worker or other person exposed or likely to be exposed to the hazard?
- Has anyone suffered injury or a health effect as a result of this exposure, or is anyone likely to do so?
- Are established procedures being followed?

Action can then be taken to control or remove the hazard in order to prevent work-related accidents, disease or injury.

9.2 FREQUENCY OF INSPECTION AND WHO PERFORMS THEM

Inspections must be completed at regular (quarterly) intervals by EOHS Office staff, the Safety representative member and a designated member(s) of the health and safety committee in a workplace.

- This should be in compliant with the Local , ILO and ISO 18000 requirements and guidelines.

9.3 FOUR STAGES OF INSPECTION

An effective inspection is a procedure made up of four stages:

- Preparation;
- Inspection;
- Review and Reporting;
- Follow-up

9.3.1 Preparing for an Inspection

To be effective, inspections should be planned and laid out in advance. Effective planning for an inspection will include reviewing available information, and assembling inspection tools as well as other preparations.

Pre-Inspection Information

Pre-inspection information is specific information about work processes, hazards and controls that are present in the place to be inspected. This information will help the inspection team to concentrate on the items most likely to need attention. Four types of data are important:

- Workplace Layout: What goes on where and when, and what materials are used? This involves the use of diagrams, maps, processes, list of chemicals, hazard evaluation (physical, ergonomic,

biological, chemical).

- Standards: What legal regulations, laboratory standards, employer rules and safe work practices apply to the processes and equipment used in the work area?

- Controls: What controls, emergency procedures and protective equipment are used there?

- Problem Indicators: What concerns have been reported about this area that may indicate potential hazards? Past hazardous occurrence data is often helpful in determining areas of concern. There also may be health monitoring programs in place.

Inspection Tools

Proper tools will help the person doing the inspection to ensure that all relevant items are examined during the inspection and that observations of these items are properly recorded.

The most critical inspection tool is the use of a **checklist**. A checklist should be used as your standard of measure for compliance to legislation, operating standards and safe work practices and other information collected during your pre-inspection. The items in the checklist must be measurable and realistic. An example of a laboratory checklist is included in **Appendix 1**. This checklist may be used as a guide in developing a checklist for your laboratory.

Other inspection tools that can be brought along during the inspection for reference purposes are: a copy of the Kenyan, ILO and ISO 18000 requirements, other pertinent standards such as the emergency shower/eyewash and fire extinguisher standards, maps that show equipment location, and Heating Ventilation & Air Conditioning Systems (HVAC) schematics, may also be useful.

A pen, camera, clipboard and possible light, temperature and noise meters may be used during the inspection process. Use of a recording form to identify deficiencies will be discussed later.

Planning

The review of pre-inspection information provides the basis for planning the inspection. A number of other questions must be answered during the inspection planning phase:

Who will participate in the inspection?

How long will it take?

Have the necessary arrangements been made to ensure entry to the work area?

How will the inspection be organized?

Where will it begin, what parts of the work area will be visited, and in what order?

This stage of inspection planning is also the time to make sure all required tools have been prepared and assembled and are ready for use.

9.3.2 Conducting a Physical Inspection of the Workplace

The object of the inspection is to conduct a systematic examination of any thing or any procedure that might pose a hazard to the health or safety of any person in the workplace. Techniques involved in workplace inspection include:

- talking with workers and supervisors about any concerns and points of view; sufficient time should be allowed to gather their opinions.

- a visual inspection of the workplace for contraventions to the legislation, standards and safe work practices.

- use of a systematic approach; a common method is to inspect the floor, walls, ceilings and then any interior equipment, machinery, cabinets or work surfaces.

Patterns in health and illness symptoms or problems in the operation of equipment will not be readily apparent to the people conducting the inspection but they may be revealed by workers or supervisors who are familiar with them. Workers and supervisors can also report whether the conditions at the time of the inspection are typical or normal.

Information about the quality and suitability of training may also emerge from talks with workers and supervisors. Because of their knowledge and experience, they are often the source of useful suggestions or concrete proposals for health and safety improvements. Personal attitudes and human relations sometimes contribute to the existence or continuation of a hazard and knowledge of these factors can only be learned from those in the work area.
Ergonomic concerns can also be identified by talking with workers and observing them work.

Newly hired or transferred employees should not be ignored. Often they are able to pick up on potential hazards that have gone unnoticed or unidentified by their more experienced colleagues.

Recording
The "Comments" column, beside each item of the Laboratory Checklist, should be used to record all deviations, deficiencies or hazards identified during the inspection. Additionally any other hazard identified during the inspection but not in the checklist currently, should be written at the end of the checklist to be included the next time the checklist is revised.

9.3.3 Review and Reporting

Review, writing the report, recommendations and follow up
Those who participated in the inspection must review their findings together as soon as possible after the inspection.

All hazards identified shall be reported on the ILRI Research Platform **workplace inspection form** (Appendix 2). The following information should be included on the form;

- Location of the hazard

- Identification of the hazard

- Hazard rating – **A**- fix within 24 hours, **B-** fix within 7 days, **C** – fix within 30 days

- The name of the "responsible person" i.e. the person responsible to correct the hazard, this is usually the supervisor of the area in which the hazard was found

- Remedial or corrective action; what was done, what date was it done and by whom

The form should be sent as soon as possible to the person(s) responsible identified on the form. If for some reason this person is not a supervisor, the supervisor should also be copied on the inspection report. The person(s) are responsible for notifying the inspection team in writing or by email once the corrective action has been taken to resolve the hazard.

9.3.4 Ensuring follow up action

The report shall be reviewed and the form signed off at the ILRI OHS committee meeting to document that the review took place. The review should focus on ensuring all hazards identified have been corrected as required by the hazard rating given. The workplace inspection report should stay on future OHS committee meetings agendas until all outstanding items have been addressed.

Environment Occupational Health & Safety Office is responsible for ensuring follow up action has occurred on items identified on the workplace inspection form. If the above process fail to achieve action the section Director can be contacted for help in resolving hazards identified in the workplace inspection form. The report should also be posted (hard copy/ electronically) in the workplace for the information of workers and supervisors.

Appendix 1

ILRI Laboratory Workplace Inspection Standard Checklist

NOTE: The ILRI Workplace Inspection Standard Checklist is a physical examination of the worksite to uncover any occupational safety and health hazards. This document is not intended to be a comprehensive audit of your OHS program nor a definitive list of all possible hazards in your workplace.

1) **Safety Communication**
2) **Fire and Emergency Plans and Equipment**
3) **General Safety**
4) **First aid/CPR**
5) **Office and Laboratory Ergonomics**
6) **General Lab Safety**
7) **Personal Safety and Protection**
8) **Respiratory Protection**
9) **Chemical Safety, Chemical Spill Kits & WHMIS**
10) **Biological Hazards**
11) **Radiation Safety**
12) **Workshop Safety**
13) **Cryogenics Safety**
14) **Gas Cylinder Safety**
15) **Office Safety**

General

1.0 SAFETY COMMUNICATION			
	Item	**Y/N/NA**	**Comments**
	Safety Board		
1.1	Is there a safety notice bulletin board? (it could be electronic as long as everyone has access to it)		
1.2	Are the following posted on your Safety notice board: a) The ILRI OHS Policy b) names, work locations, contact numbers of all members of the Safety representatives committee c) minutes of the Safety representatives committee d) names, work locations, phone numbers of personnel trained in First Aid and/ or CPR e) a reference to the laboratory safety manual (i.e. where it is located) f) copy of the building emergency evacuation plan g) contact number for Employee Assistance Program		
2.0 FIRE AND EMERGENCY PLANS AND EQUIPMENT			
	Item	**Y/N/NA**	**Comments**
2.1	Have contingency plans for emergency procedures including fire, been prepared for the workplace and is it posted?		
2.2	Is the emergency lighting operable and checked monthly?		
2.3	Is the fire extinguisher operable and checked monthly?		
2.4	Are emergency evacuation drills held once a year as a minimum?		

2.5	Are all the fire extinguishers checked yearly by an outside competent company for their condition, appropriate location and type?		
2.6	Is there signage identifying the location of the fire extinguishers?		
2.7	Have a Emergency Warden been appointed for your building and is the list current?		
2.8	Have all the Emergency Wardens been trained in the use of fire extinguishers?		
2.9	Are signs conspicuously posted at all entrances to fire hazard areas?		
2.10	Has the local fire department been made aware of hazardous products or agents in your building?		
2.11	Are all fire exists unobstructed?		
2.12	Is there a copy of the emergency evacuation plan posted on each floor?		
2.13	Is the list emergency contact numbers for Fire, Police and Ambulance posted?		
2.14	Is there a location outside the building with the map of the facility and a list/location of hazardous substances or does the fire department keep it at there work site?		
2.15	Are all emergency eyewash stations (attached to plumbing) operated, checked and signed off weekly that they are operating and are clean?		
2.16	Are all Are all emergency eyewash stations (not attached to plumbing) being maintained according to manufacturer's instructions?		
2.17	Are emergency drench hoses operated, checked and signed off weekly that they are in working condition?		
2.18	Are emergency showers inspected, signed off and operated weekly to ensure they are		

	operable?		
2.19	Are all emergency showers/drench hoses/eyewash stations kept free of obstructions		
2.20	Are emergency showers in accessible locations that require no more than 10 seconds to reach?		
3.0 GENERAL SAFETY			
	Item	**Y/N/NA**	**Comments**
3.1	Are stairways equipped with handrails?		
3.2	Are stairways, aisles, walkways kept free and unobstructed?		
3.3	If any door, when opened, extends into an aisle or passageway, is the floor suitably marked to indicate the area of hazard created by opening the door?		
3.4	Do all traffic doors have a see through panel?		
3.5	Where there is danger of people walking through glass doors or partitions, are there marks or decals placed on glass?		
3.6	Are passageways and travel areas free of any storage that may endanger the safety and health of persons?		
3.7	Are all electrical rooms kept free of storage of any kind of material?		
3.8	Are switches and other devices controlling the supply of electricity (i.e. panel board) operated by only specific authorized personnel?		
3.9	Has the location of all circuit breaker panels been appropriately identified to allow for shut off during emergencies?		
3.10	Are portable electrical tools and appliances grounded?		

3.11	Are all flexible power codes in good condition?		
3.12	Are steam, hot water pipes and all other hot surfaces that can cause bodily harm either guarded, or covered and are they identified with signage?		
3.13	Are all ramps, walkways, stairs or safety landings fitted with railings?		
3.14	Are all exterior stairways, walkways, ramps, passageways, roofs and canopies kept clean?		
3.15	Are elevating devices (elevators, escalators, or other devices for moving passengers or freight)) inspected and tested every 12 months?		
3.16	Are all areas adequately illuminated according to Local, ILO & ISO 18000 Lighting requirements?		
3.17	Are loading dock areas maintained clutter free of deliveries?		
3.18	What procedure is in place to control the movement of trucks while in the loading dock? (e.g. dock locks tire wedges, lighting system) Is it working?		
3.19	Are all sanitary facilities and personal service rooms cleaned at least once every 24 hours?		
3.20	Are personal service rooms used for any type of storage?		
3.21	Is soap (or equivalent) provided adjacent to each wash basin		
3.22	Are the hand drying facilities operable/available?		
3.23	Are all designated lunch rooms physically separated or isolated from the possibility of contamination from hazardous substances?		
3.24	Does the building temperature remain in the acceptable range of 20º-26ºc during working		

	hours?		
3.25	Is waste and scrap metal removed from the workplace as often as required by the legislation or by laboratory guidelines?		
3.26	Are the HVAC diffusers clean?		
3.27	Is the practice of drinking beverages around electrical machinery (i.e. photocopier, computer) discouraged?		
3.28	Are pressure vessels inspected once a year and are records kept of the inspection?		
4.0 <u>FIRST AID/CPR</u>			
	Item	**Y/N/NA**	**Comments**
4.1	In a workplace where at least four employees are working at any time, is there at least one first aid attendant (holder of basic first aid or standard first aid certificate)		
4.2	Is there a current list of first aid attendants, the expiry date of their certificates, and is it posted?		
4.3	Is every attendant's First Aid and CPR certificate current?		
4.4	Is someone responsible to arrange for training and ensure it is kept up to date?		
4.5	Is an up-to-date list of emergency telephone numbers available at each employees workstation		
4.6	Is the first aid treatment book being completed each time first aid is administered?		
4.7	Are the first aid kits/stations/rooms:		
	a) available and accessible during all working hours?		
	b) inspected monthly, its contents maintained and a list of what shall be in the kit available next to the kit?		

	c) clearly identified by a conspicuous sign?		
4.8	Are the locations of first aid stations and first aid rooms posted on the emergency plan map?		
4.9	Has the name of the person responsible for the maintenance of the first aid room and/or first aid kits been posted on the door of the first aid room and/or first aid kit?		

5.0 ERGONOMICS

	Item - Office Workstation Recommendations	**Y/N/NA**	**Comments**
5.1	Chair ➢ a backrest shaped to support lower back and is adjustable a seat that curves downwards at the front end ➢ a seat that is adjustable in height and angle ➢ a stable five leg base ➢ adjustable and removable arm supports ➢ arm rests which do not prevent the chair from being drawn up to the desk or interfere with natural movement ➢ non-slip breathable fabric on the seat		
5.2	Keyboard and tray ➢ adjustable tray for height and tilt ➢ allows worker to use keyboard with arm at 90 degree angle at elbow ➢ wrist rest available		
5.3	Mouse and tray ➢ mouse is on the same level and as close to the side of the keyboard as feasible ➢ hand is kept at elbow level when using the mouse		
5.4	Workstation ➢ adjustable in height ➢ footrest available for workers who cannot reach the ground with their feet ➢ document holder at eye level next to computer screen, adjustable and movable ➢ computer monitor - adjustable screen position, brightness, contrast		

	➢ monitor is adjustable so that workers eyes are just below top of the screen with head up. ➢ Viewing distance is 30 to 60 cm Screen is 90 degrees to a window		
Manual Lifting			
5.5	Have employees who manually lift more than 10 kg received training in the safe method of lifting and carrying?		
5.6	Have employees required to manually to lift or carry loads weighing in excess of 45 kg, received written instructions from the EOHS Office?		

Lab Areas

6.0 GENERAL LAB SAFETY			
	Item	**Y/N/NA**	**Comments**
6.1	Are items not in use stored so as not to interfere with the current work space and work being performed?		
6.2	Are "Laboratory" refrigerators correctly labeled to clearly state their use and that no food/lunches are to be stored there?		
6.3	Are there staff performing an unsafe work practices such as eating/drinking and/or applying cosmetics in the laboratory?		
6.4	Are proper pipetting techniques used and the practice of oral pippeting not allowed?		
6.5	Are items stored such that heavy items are stored below shoulder height and off the floor (where feasible).		
6.6	Are change rooms provided where it is necessary for employees to change from street clothes to work clothes for safety or health reasons?		

6.7	Is the change room and clothing and storage area in good house keeping?		
6.8	Is a separate container used for the disposal of glassware at all times?		
6.9	Is broken glass disposal container labeled as such and sealed?		
6.10	Are hypodermic needles and syringes disposed off safely, in a puncture proof container identified for that purpose?		
6.11	Are these containers being disposed of according to the pertinent provincial and federal legislative requirements of the province your lab is in?		
6.12	Are there any other hazardous wastes and are they being properly contained and disposed off according to pertinent federal and provincial legislation?		
6.13	Are wastes properly contained? (e.g. reusable items properly disinfected, biohazard wastes in covered containers, impenetrable sharps containers available and used)		
6.14	Are electrical cords to lab equipment free of damage which may produce a spark hazard?		
6.15	Do walk-in freezers, fridges, incubator, etc have a back up emergency release mechanism?		
6.16	Do all staff using walk-in freezers, fridges, incubator, etc know how to open emergency release in the event the main door latch fails?		
6.17	Where equipment is equipped with UV bulbs, are appropriate warning signs posted and UV protective eyewear/shields used?		
6.18	Are the following posted at the entrance to each lab, as appropriate: - biohazard warning sign		

	- radiation warning sign - hazard listing (WHMIS symbols) - where there is an extensive list of chemicals in use at the worksite it is acceptable to post the chemical hazard classes present and have the detailed list available nearby the entrance to the worksite (e.g. in the worksite MSDS binder, if that is located nearby).		
6.19	Are gas lines labeled?		
6.20	Is the location of gas shut off valves known and marked?		
6.21	Do employees with long hair have it tied back?		
6.22	Is safety training for work procedures provided to each employee (work with equipment tools, machinery lab techniques, hazardous material)?		
7.0 Personal Protective Equipment (PPE) and Protection			
	Item	**Y/N/NA**	**Comments**
7.1	For the hazards identified and used in the laboratory, is the appropriate personal protective equipment provided and used by each employee? Check MSDS and Scales of Entitlement for "appropriate")		
7.2	Does the footwear worn in the lab have closed toes and heels?		
7.3	Are lab coats being worn in the lab?		
7.4	Are lab coats and PPE worn exclusively in the designated laboratory area?		
7.5	Is the PPE cleaned and inspected as per manufacturers requirements and is this documented?		
7.6	Are gloves used adequate to protect against the hazards identified?		

7.7	Is the location of PPE easily accessible to employees?		
7.8	Is the appropriate training provided for your personnel in the correct use of PPE as required by legislation and other Standards?		
7.9	Have supervisors and co-workers been made aware of the people who wear contact lens in the labs?		
Lab Areas **8.0 Respiratory Protection**			
	Item	**Y/N/NA**	**Comments**
8.1	Do you have documented Respiratory Protection Program in place?		
8.2	Do the respirators provide adequate protection for the specific hazard and concentration of the contamination?		
8.3	Has a health evaluation of the prospective user been made to determine physical and psychological ability to wear the selected respiratory protective equipment?		
8.4	Are respirator users identified as such on their medical surveillance/hazard identification forms and evaluated annually?		
8.5	Are users trained in proper respirator use, cleaning and inspection? Has training been documented?		
8.6	Has each employee been assigned his/her own face piece?		
8.7	Has a fit test (qualitative and quantitative) been performed and documented?		
8.8	Are workers prohibited from wearing respirators in contaminated work areas when they have facial hair or other characteristics		

	that may cause face seal leakage? (applicable to respirators that require a complete face seal).		
8.9	Is respiratory protection worn at all times during exposure to respiratory hazards?		
8.10	Are respirators properly cleaned and disinfected after each use when different people use the same device, or as frequently as necessary for devices issued to individual users?		
8.11	Are respirators inspected before and after each use and during cleaning?		
8.12	Are users trained in inspection techniques?		
8.13	Are respirators stored away from dust, sunlight, heat, excessive cold, moisture or damaging chemicals?		
8.14	Are respirators stored so as to prevent them from deforming?		
8.15	Are Self Contained Breathing Apparatus (SCBAs) inspected weekly for gas pressure and documented?		
8.16	Is "emergency use" respiratory protective equipment inspected monthly and documented?		
Lab Areas **9.0 Chemical Safety**			
	Item	**Y/N/NA**	**Comments**
9.1	Are warning signs conspicuously posted where chemicals are stored, handled, or used in a workplace?		
9.2	Are work surfaces non-porous and easily cleaned?		
9.3	Are volatile chemicals used away from heat producing apparatus?		

9.4	In a laboratory where cyanide compounds are used, are antidotal cyanide kits available for use by qualified personnel?		
9.5	Are laboratory workbench areas uncluttered? (if cluttered, specify if condition is due to poor housekeeping or chronic lack of laboratory space.)		
9.6	Where flammable liquids are dispensed from metal containers, is static grounding and/or bonding provided?		
9.7	Do you have a regular house keeping program in place (e.g. annual lab cleaning, daily cleaning so benches are free of chemical or sample debris etc.)?		
9.8	To the extend that is possible are dangerous substances/dangerously reactive material in a workplace limited, to the quantities required for use or processing in the workplace in one workday?		
9.9	Are reagent bottles stored back from edge of shelving?		
9.10	Are reagent bottles returned to their storage place immediately after use?		
9.11	Are there documented chemical waste disposal procedures in place in your building?		
9.12	Are all laboratory chemical spill kits complete and current for all chemical hazards identified?		
9.13	Are employees trained in spill clean up procedures?		
	Fumehoods		
9.14	Are fumehoods tested yearly according to WHO guidelines and internationally acceptable Standards?		
9.15	Is the face velocity of the fume hood verified before commencing work?		

9.16	Are all materials stored at least 15cm in the hood?		
9.17	Are only materials and equipment being used currently stored in the fume hood? (The fume hood should not be used as a storage area.)		
9.18	Around fumehoods, are electrical leads, switches and sockets inspected regularly to spot possible insulation damage or corrosion?		
9.19	Is there an alarm system installed warning users of incorrect face velocities or abnormal airflow conditions?		
9.20	Are ether containers that do not contain preservative regularly checked for the formation of peroxides?		
9.21	Are ether and other peroxide containers labeled with date opened?		
9.22	Are explosion-proof refrigerators used to store highly volatile or reactive chemicals?		
9.23	Are all liquid chemicals in larger than litre size bottles stored in appropriate cabinets?		
9.24	If poisonous materials are being used are the appropriate antidote kits available?		
9.25	Are approved safety containers used for the handling and dispensing flammable liquids?		
	Storage		
9.26	Is a current inventory list of all chemical substances and agents in stock maintained for each laboratory?		
9.27	Are the quantities of chemicals stored in the laboratory within the NFC and NFPA requirements? (Minimize quantities of flammable liquids in the laboratory to the supply necessary for normal operations; maximum storage in an open laboratory is 300 L of flammable and combustible liquids of		

	which not more than 50 L may be flammable; additional amounts must be stored in proper storage cabinets conforming to the requirements of the NFC; a flammable storage cabinet must not contain more than 500 L of flammable and combustible liquids, of which not more than 250 L are flammable liquids)		
9.28	Do all chemicals have WHMIS labels; there are to be unlabelled containers anywhere in the laboratory including the chemical storage facility?		
9.29	Check that all required personal protective clothing and equipment is available for general use (e.g. decanting materials into another container) and for emergency procedures (e.g. spills, leaks); protective clothing and equipment should be kept outside of the storage room to allow for easy access during emergencies		
9.30	Chemical storage facilities are kept locked and have access restricted?		
9.31	Do all storage places for chemicals display appropriate warning signs?		
9.32	Are chemicals being stored according to their compatibilities? ➢ store acids separated from caustics (bases), cyanides, sulfides ➢ store oxidizing acids (e.g. nitric, sulphuric) separate from organic acids (acetic) ➢ store caustics (bases) separately from acids		
9.33	Are dangerously reactive material (e.g. concentrated hydrogen peroxide solutions, peroxides, dry picric acid, peracetic acid, potassium cyanide, diethyl ether) stored away from flammables, combustibles, heat and ignition sources in appropriate containers?		
9.34	Are oxidizing materials stored away from heat, ignition sources and flammable or combustible materials?		

9.35	Are oxidizing materials stored separately from reducing agents?		
9.36	Are liquids and large volumes of chemicals being stored on the bottom rows of the shelves?		
9.37	Is the material in the fridge/freezer neatly stored and properly labeled?		
9.38	Are chemicals known to degrade to dangerous explosives with age (i.e. picric acid) carefully monitored?		
9.39	Are pesticides stored in separate locked areas according to provincial storage regulations?		
9.40	Are poisonous materials stored in a secure area?		
9.41	Do the shelves supporting chemicals have edge guards?		
9.42	Are the shelves non-combustible, corrosion resistant, strong for the load and securely attached to walls and floors?		
9.43	Is there a program in place to regularly monitor old chemicals and dispose off those not used within a set period of time?		
	Flammable Substances		
9.44	Are ordinary refrigerators used for chemical storage free of flammable liquids?		
9.45	Are ordinary refrigerators labeled: "NOT SUITABLE FOR THE STORAGE OF FLAMMABLE LIQUIDS"?		
9.46	Are flammable substances stored away from ignition sources?		
	Corrosive material		
9.47	Are there spill grays under all corrosive chemicals		
9.48	Where vapors, fumes or dusts exist using		

	corrosive chemicals, is a fume hood being used?		
9.49	Is personal protective equipment being used when handling corrosive chemicals? (corrosive resistant gloves, eye goggles/face shield)		
	Chemical Spill Procedures		
9.50	Does your unit have materials readily available for cleaning up:		
	a) flammable liquid spills		
	b) corrosive liquid spills		
	c) mercury spills		
	d) pathogenic spills		
9.51	Are personnel trained in emergency spill response procedures?		
9.52	Is the emergency spill protocol for chemical, pathogenic and/or radioactive spills posted in your work area?		
9.53	Does your facility have a Chemical Emergency Response Team (C.E.R.T) in place? (not mandatory, depends on the facility)		
9.54	Do staff know who the members of your building chemical spill response team are and where to contact them?		
9.55	Is the procedure for how to activate the C.E.R.T. posted in your area?		
9.56	After spill occurs is the spill team notified of restocking the required materials?		
9.57	Are all laboratory employees aware of Chemical Spill Procedures for their laboratory areas?		

	WHMIS		
9.58	Have all employees been trained in WHMIS such that they knowledgeable of the WHMIS pictograms, understand warning information on labels and can find information in an MSDS.		
9.59	Is the 3 year policy on MSDS known?		
9.60	Have MSDS been obtained for each chemical now in use? Are they being requested for any new chemicals purchased?		
9.61	Is the MSDS information current? (i.e. MSDS is not older than 3 years)		
9.62	Are supplier containers properly labeled?		
9.63	Are worker-filled containers properly labeled?		
9.64	Is training on the hazards of the material being handled provided to the employee before they start using the chemical?		
9.65	Is an MSDS binder easily accessible to all employees at the workplace?		
9.66	Are inventory lists of all hazardous material established/or in the process of being established?		
Lab Areas **10.0 BIOLOGICAL HAZARDS**			
	Item - Level 2	**Y/N/NA**	**Comments**
10.1	Is biohazard warning signage is posted at the entrance to the worksite (risk level, special provisions/conditions for entry if any, agent(s) present, contact person(s) identified?		
10.2	Have all persons met specific entry requirements (immunization) and been advised of the potential hazards in the laboratory?		
10.3	Are all employees' work practices monitored to ensure they are performing their ob safely?		

10.4	Is it policy to take base-line seroconversation values for new employees, and conduct employee medicals on a yearly basis?		
10.5	Has all laboratory staff read the pertinent sections of the ILRI Laboratory Safety Manual and the laboratory specific safe work practices.		
10.6	Is the personal protective equipment standard for laboratory (gloves, lab coats, safety glasses) being implemented by lab workers and visitors?		
10.7	Are food and drinks for consumption being stored outside pf the laboratory?		
10.8	Are all procedures with a high potential for creating infectious aerosols or when high concentrations of an infectious agent are used, being performed in biologically safety cabinets?		
10.9	Have the biologically safety cabinets been certified on an annual basis according to CSA Z3 16-95? Does the certification sticker indicate the date of next certification and to what standards the tests were performed?		
10.10	Before any work is initiated in a Biological Safety cabinet, is the airflow checked?		
10.11	Are pieces of equipment inside a Biological Safety cabinet raised on stands to ensure that the air flow is not blocked?		
10.12	Is all work in the BSC be done at least 15 cm inside the BSC?		
10.13	When rotating or moving equipment is functioning in a Biological Safety cabinet, is it prohibited to perform any other manipulations in the cabinet?		
10.14	Are mechanical pippeting devices being used for all pippeting procedures?		

10.15	Where possible, are capped, leak proof tubes and bottles used when working with and storing infectious agents?		
10.16	Are all infectious agents transported in unbreakable, leak proof containers capable of being decontaminated?		
10.17	Are there written protocols outlining decontamination of work surfaces, spills and wastes, and are these protocols implemented?		
10.18	Are foot, knee or automatically controlled sinks available and used where required?		
10.19	Are all specimens of unknown status autoclaved or incinerated?		
10.20	Is all equipment exposed to infectious agents decontaminated before servicing?		
10.21	Are all spills and accidents which result in exposures to infectious materials immediately reported, recorded and cleaned up?		
10.22	When manipulating infectious material, is the worksite covered with a disinfectant soaked towel? Is this towel autoclaved after use?		
10.23	Are procedures performed in a manner that minimizes the creation of aerosols?		
10.24	When transferring infectious material from pipette to petri dish or bottle, is the liquid released as close as possible to the receptacle, or allowed to run down the wall, never from a height?		
10.25	Are magnetic stirring bars added before the liquid, instead of dropped in after the liquid is measured into the receptacle?		
10.26	Are centrifuges equipped with safety cups to reduce aerosol production?		
10.27	For high speed blenders, are screw-cup bowls used instead of plastic cup bowl?		

10.28	Are inoculating loops cooled before they are inserted into a liquid culture?		
10.29	Lab staff have been trained in how to safely work with and dispose of organisms and contaminated items (documented)?		
10.30	Are work surfaces disinfected at the end of a work session?		
10.31	Are MSDS available on the biological organisms used at the lab?		
	Level 3 - in addition to the above:		
10.32	Are dedicated solid front lab clothing and personal protective equipment worn in the lab?		
10.33	Is clothing removed before leaving the lab area?		
10.34	Are personal effects not stored in the lab area?		
10.35	Aerosol proof safety heads or cups must be used for centrifugation – are they being used?		
10.36	Are centrifugation heads/cups are removed only in a biological cabinet?		
10.37	Are effective disinfectants are available at all times?		
10.38	Are written protocols posted, outlining operational protocols, waste disposal, disinfection procedures and emergency response procedures?		
10.39	Is medical surveillance of staff is carried out as appropriate for the next agent?		
10.40	Is the facility recertified annually?		
10.41	Are all floor drains filled with disinfectant?		
10.42	Is laboratory clothing decontaminated before being sent to the laundry?		
10.43	Are all containment perimeter walls, floors and		

	ceilings impermeable to all liquids and gases?		
10.44	Are all penetrations through these walls, ceilings and floors sealed?		
10.45	Are entrances to lab posted with a biohazard sign, a list of infectious agents, name and phone number of responsible person and entry requirements?		
10.46	Do personnel who enter rooms housing infected animals wear appropriate respiratory protection?		
10.47	Are magnehelixes checked regularly to ensure that rooms are maintained under negative pressure?		
10.48	Are all vacuum lines protected with hepa filters and/or disinfectant traps?		
10.49	Are all operations with bio-hazardous substances conducted inside a biological safety cabinet (BSC) or other approved engineering controls?		
10.50	Are all infected small animals housed using appropriate primary containment systems?		
10.51	If UV lights are used are they cleaned to ensure they are free of dust?		
10.52	Does documentation and safe work practices exist clearly identifying that UV lights are only used when staff are not working in the room?		
10.53	Are employees trained in the hazards of working with UV radiation?		
10.54	Are non-dedicated eye glasses being disinfected at the containment barrier?		
10.55	Do employees change from street clothing into dedicated laboratory protective clothing?		
10.56	Are access doors locked when not in use?		

Lab Areas **11.0 Radiation Safety**			
	Item - general	**Y/N/NA**	**Comments**
11.1	Is a copy of the radioisotope license and ILRI permit prominently displayed where radioactive materials or devices are used, conditions of the license being followed and id the license current?		
11.2	Are all conditions of the radioisotope license conditions for the transfer or disposal of radioactive material or devices adhered to?		
11.3	Are inventories of radioactive material (open and sealed sources) maintained?		
	Sealed Source (Electron Capture Detectors, Fixed Gauges)		
11.4	Is there a designated Radiation Safety Assistant at the facility who, along with the EOHSO, assures compliance with the license requirements?		
11.5	Are leak tests performed on sealed sources as prescribed by the condition of the radioisotope license?		
11.6	Are sealed sourced marked with a radiation warning symbol, and the activity and name of radioactive material involved?		
11.7	Are gas chromatographs containing a radioactive substance must be clearly and durably labeled with radiation warning sign, activity and the name of the radioactive material involved?		
11.8	Are the employees trained according to Section 8.3/8.4 of the Laboratory Safety Manual?		
	Laboratory Studies (open sources)		
11.9	Are radiation warning signs posted at the entrance to all areas where radioisotopes are		

	used or stored?		
11.10	Does the person/s working with radioisotopes have a Radioisotope Permit, as per 8.5.1 of the Laboratory Safety Manual which is issued by the EOHSO?		
11.11	Are all employees, visitors and students given the required radiation safety training before beginning work with isotopes as per 8.5.2 of the Laboratory Safety Manual?		
11.12	Are appropriate dosimeters being worn when required by the radioisotope license?		
11.13	Is a copy of your protocol nearby for reference?		
11.14	Are all purchase orders for equipment containing radioisotopes signed by the EOHSO prior to purchase?		
11.15	Is a copy of the RPB poster titled "Radioisotope Safety - Basic Laboratories" displayed in each laboratory?		
11.16	Are dose records kept for all workers working in designated labs?		
11.17	Are fridges, freezers and other radioisotope storage facilities lockable and marked with appropriate signage?		
11.18	Do fridges, freezers and inventory sheets affixed to them with phone numbers for emergency contact personnel?		
11.19	Are containers holding radioactive material and equipment used to manipulate radioactive material clearly labeled as radioactive?		
11.20	Are radiation warning signs posted at the entrance to all areas where radioisotopes are used or stored, including sealed sources (e.g. gamma cell irradiation, bio waste tanks)?		
11.21	Is work with radioisotopes confined to as small an area as possible; the defined area must be		

	clearly labeled as radioactive (e.g. use radioactive tape to mark off benches and equipment)?		
11.22	Is shielding appropriate to the radioactive material being used? (^{32}P - at least 3/8" plexiglass; ^{125}I – lead) Conventional lead shielding should not be used with high-energy beta emitters, e.g. ^{32}P, due to increased bremsstrahlung hazard (BR58).		
11.23	Are employees wearing gloves when handling radioisotopes? (Note: external ring badges must be worn under the gloves) Are hands washed and surveyed after completion of the experiment and removing gloves?		
11.24	Are staff trained in the procedures for dealing with radioactive spills and other accidents?		
11.25	Are losses or thefts of radioactive materials exceeding 10 SQ reported to the RPB within 24 hours of discovery?		
11.26	Are staff minimizing their time exposed to the radiation by leaving sources within their containers as much of the time as possible while working?		

12.0 Workshop Safety

	Item	**Y/N/NA**	**Comments**
12.1	Do all portable tools used by employees meet CSA Standards?		
12.2	Are the sides of loading docks and ramps not used for loading fitted with side rails, curbs or side edges?		
12.3	Are portable ramps and dock plates:		
	a) clearly marked to indicate maximum safe load?		
	b) installed so that they cannot slide or move when used ?		

12.4	Are machines that require guards equipped with them?		
12.5	Are workshops kept neat and in good order?		
12.6	Are aisles kept free of trip hazards and well lighted?		
12.7	When working around machinery with moving parts is long hair tied back, jewellery removed and snug fitting clothing worn?		
13.0 Cryogenics Safety			
	Item	**Y/N/NA**	**Comments**
13.1	Is a training program in the use of cryogenic fluids/dry ice in place?		
13.2	Are cryogenic fluids stored in a well ventilated area?		
13.3	Is cryogenic personal protective equipment provided (protective gloves, aprons, face protection) for all employees handling cryogens?		
13.4	Are warning sign posted to identify cryogen storage area?		
13.5	Are staff aware of the oxygen depleting ability of cryogens?		
13.6	If large quantities of cryogens are being used or transferred, is a protocol developed including the use of personal and area alarms in place?		
13.7	Are staff instructed not to accompany a full cryogen tank in an elevator?		
14.0 Gas Cylinder Safety			
	Item	**Y/N/NA**	**Comments**
14.1	Has all you staff received training in the use of gas cylinders?		
14.2	Are gas cylinders transported by cart?		

14.3	Are valve protection carps securely in place on cylinders not in use or being transported?		
14.4	Are gas cylinders retested every 5 years to comply to Kenyan standards?		
14.5	Are empty cylinders identified as such?		
14.6	Are gas cylinders properly and clearly labeled?		
14.7	Do all gas cylinders requiring two stage regulators have them?		
14.8	Are storage areas fitted with cylinder racks and/or brackets securely fastened to the wall?		
14.9	Are full and empty cylinders stored separately?		
14.10	Are employees aware of these cylinder handling procedures?		
14.11	Are compresses gases stored away from ignition sources?		
14.12	Are oxidizing and flammable gas cylinders kept at least 3m apart?		

15.0 <u>OFFICE SAFETY</u>

	Item	**Y/N/NA**	**Comments**
15.1	Are carpets smooth without bumps?		
15.2	Are the aisles/stairs clear and not blocked?		
15.3	Are all the lights working and adequate for the task performed as per the Kenyan Standard?		
15.4	Are all extension cords located as not to cause a trip hazard?		
15.5	Is electrical wiring, fixtures properly concealed and there is no overloading of outlets as per the Electric Code		
15.6	Are all electrical and computer cords in good working condition and kept at east 30 cm from baseboard heaters?		

15.7	Are there ground faults on electrical outlets located near water sources?		
15.8	Are cabinets level and anchored to wall or floor or have counter weight to prevent them from falling?		
15.9	Is the safety interlock working and only one drawer of a filling cabinet can be opened at one time?		
15.10	Are the heaviest items being stored on the bottom shelves of filling cabinets to reduce tip hazard?		
15.11	Are shelves being maintained in a manner that will not cause items to fall off shelf or protrude off shelf as to pose a hazard?		
15.12	Are spillable liquids stored on lower shelves (less than 1m)?		
15.13	Are the ventilation diffusers clean?		
15.14	Is the photocopier located in a separate area away from employees?		
15.15	Is a copy of the MSDS for the toner available near the copier?		
15.16	Do all office employees have a list readily available, of emergency telephone number including a list of all employees trained in first aid?		
15.17	Paper cutters: are they inspected to ensure guillotine-type cutting blades are kept in closed down position when not in use?		
15.18	Do all chairs and stools with castors have a five castor base?		
15.19	Is all furniture in good repair, i.e. there is no broken or defective furniture?		

Appendix 2 - WORKPLACE SAFETY/ENVIRONMENT INSPECTION RECORDING FORM Page -----of ------

Date of Inspection: (yy/mm/dd) ----------

Inspection location: ----------

Copies for action given to: ----------

Inspection Team: ----------

Class A – A condition or practice likely to cause permanent disability, loss of life or body part, and/or extensive loss of structure, equipment or material. **Correct within 24 hours**.

Class B –A condition or practice likely to cause serious injury/illness, and/or non-disruptive property damage that is disruptive but less severe than in Class A. **correct within 7 days**

Class C – A condition or practice likely to cause minor, non-disabling injury/illness, and/or non-disruptive property damage. **Correct within 30 days.**

Inspectors Observations					**Remedial Action Taken**		
Item # & Location	**Class of Hazard A/B/C**	**Description and brief analysis**	**Hazard/Non Compliance**	**Responsible Person/ Section Manager**	**Action Taken**	**Completion**	
						Date	**By**

Reviewed by Safety Representatives Committee ---------- Date ----------

10.0 HAZARDOUS OCCURANCE REPORTING POLICY AND PROCEDURES

The ILRI Research Platform will ensure that all hazardous occurrences and significant near misses are reported, recorded, and investigated in accordance with requirements identified in the Kenyan Labor Code, and the Kenya Occupational Safety and Health Regulations. This chapter complies with the requirements of the ILRI EOHS Policy. This section does not deal with the completing of worker compensation forms or Return to Work Programs.

These procedures apply to all hazardous occurrences in the ILRI Research Platform that result in injuries, occupational illnesses, fires, damage to material resources, environmental spills, incidents/ near misses and all other incidents that disrupt normal work procedures with a potential for causing an accident.

These procedures incorporate the minimum requirements of the Kenya Occupational Safety and Health Regulations, ISO 18000 standards on Hazardous Occurrence Investigation, Recording, Reporting and apply to all employees of ILRI Research Platform and persons contracted to work for ILRI, using ILRI facilities, under a collaborative agreement with outside sources.

10.1 OBJECTIVES

- to provide managers, supervisors, OHS Committees and representative, Lab Area Coordinators and employees with procedures to facilitate the reporting, recording, and investigation of workplace hazardous occurrences.
- to identify the roles and responsibilities of EOHS Office, managers, supervisors, EOHS Committee members and representatives, and employees, with respect to hazardous occurrences reporting, recording, and investigating.
- to use the information collected through the reporting procedures to produce annual statistical and analytical reports to set priorities in hazardous occurrence prevention programs.
- to provide a guide in how to investigating an accident.
- to provide a "tip sheet" for completing the ILRI Hazardous Occurrence Investigation Report Form.

10.2 DEFINITIONS

Accident: An undesired event that results in harm to people, damage to property or loss to process.1

Hazardous occurrence: An unexpected or unplanned event where personal injury or property damage has or could have occurred. This includes the definitions of accident, incident, near miss, occupational illness or injury and environmental spills/releases.

Hazardous occurrence investigation: is the determination of the facts of a hazardous occurrence by inquiry, observation, and examination and an analysis of these facts to establish the causes of the hazardous occurrence and the measures that must be adopted to prevent its recurrence.2

Incident/near miss: an unexpected event that did not cause injury or damage, but had the potential to. It is a "significant near miss" where the loss potential would be significant that would trigger the use of the Hazardous Occurrence Reporting Form & Procedures.

Occupational illness: Any disease, abnormal health condition or disorder caused by exposure to environmental factors or substances associated with the work, and which includes acute and chronic illnesses or diseases which may result from inhalation, absorption, ingestion, or direct contact with a substance.

Occupational injury: Any bodily injury (such as a cut, fracture, sprain, amputation, etc.) which results from a work accident or from exposure involving a single incident in the work environment.

Occupational health & safety committees (OHS) and representatives A workplace committee whose membership represents the interests of management and employees in matters concerning workplace safety and health.
A Safety and Health Representative is an employee who has been appointed to represent employees in matters concerning workplace safety and health.

For the purposes of this document, unless otherwise stated, whenever the term OHS committees are used, it is understood to include Safety and Health Representatives.

Recurrence: This term is used when an employee must become absent after his/her return to work, as a result of the original injury.

Work injury: Any injury, disease, or illness incurred by an employee in the course of employment.

10.2.1 Types of Work Injuries

Minor or Non-disabling: Any work injury for which first aid or medical treatment is provided and there is no lost time beyond the day of injury.

This category can be broken down into two subcategories:

- **Minor First Aid:** an injury for which an employee may seek treatment from a health nurse or first aid attendant.

- **Minor Medical Aid**: an injury where an employee seeks treatment from a hospital, doctor, or chiropractor. The employee may be away from work for the remainder of the day.

Disabling injury: an injury where an employee seeks professional medical care and loses time from work beyond the actual day of the accident.

10.3 ROLES & RESPONSIBILITIES

10.3.1 Employees:

- must report all hazardous occurrences, however seemingly minor, to a supervisor or Safety Representative.

- must follow prescribed safety procedures as established by ILRI.

10.3.2 OHS committees and representatives:

- responsible for keeping adequate records and reviewing reports of workplace hazardous occurrence investigations.
- must participate in hazardous occurrence investigations.
- may be involved in establishing programs for the prevention of hazardous occurrences in the workplace.

10.3.3 ILRI

- responsible for the prevention of hazardous occurrences in their area of responsibility by identifying hazards & ensuring adherence to prescribed safety procedures.
- ensuring that first aid or medical aid is available and provided to injured employees.
- responsible for investigating hazardous occurrences in their area of responsibility, and ensuring that the necessary reports are completed and forwarded to the proper authorities, as identified in the "Procedures" section Hazardous Occurrence Investigation, Recording and Reporting.
- responsible for the prevention of workplace hazardous occurrences and keeping record of such.
- responsible for appointing someone to investigate a workplace hazardous occurrence; usually this is the supervisor or Safety Representative who has a knowledge of the work procedures and safety requirements where the hazardous occurrence occurred.
- responsible for establishing safety procedures to be followed by employees.
- responsible for ensuring that employees are made aware of the prescribed safety procedures.
- responsible for ensuring first aid facilities are available as prescribed by Department of Occupational Safety and Health - Kenya,.
- responsible for ensuring that documentation of hazardous occurrences is reported to the proper authorities, and within the prescribed time frame, as identified in the "Procedures" section.
- ensure that all people involved in the hazardous occurrence team are trained in how to perform a hazardous occurrence investigation.
- Notify the ILRI EOHSO when a significant hazardous occurrence occurs.

10.3.4 ILRI EOHSO

- provides advice and training on the implementation of this policy and procedure.
- develops, monitors, evaluates this module to ensure it meets legislative requirements
- through Safety Representatives, is responsible for investigating serious hazardous occurrences.
- monitors all hazardous occurrences at ILRI and produces statistical and analytical reports on such.

10.4 HAZARD OCCURANCE PROCEDURE

All hazardous occurrences, however seemingly minor, must set into motion the recording, reporting, and investigation system.

10.4.1 Procedure

1) When a hazardous occurrence occurs, it is important to determine if there are injuries. Injured employees should receive the required first aid or medical attention immediately to minimize the severity of the injury and promote the recovery of the injured person. Should the employee need to be transported to a medical facility, transportation is to be provided by ILRI.
   Necessary steps must be taken to prevent a recurrence of the hazardous occurrence.

2) Managers must ensure that a qualified person or persons are appointed to carry out an investigation. This is usually the supervisor of the area where the hazardous occurrence occurred since he/she would be familiar with the work and the nature of the work done by the injured employee; the Safety Representative EOHS Office staff should be represented on the investigation team.

3) The supervisor must ensure that the EOHS Office is notified of the hazardous occurrence as well as the name(s) of the investigator(s). Staff of the EOHS Office shall participate in the investigation.

4) The ILRI Hazardous Occurrence Investigation Report Form must be used to report all hazardous occurrences.
5) The form is completed by the supervisor and is sent to the EOHS Office for review. The EOHSO must sign the form. The original is kept on file at the laboratory where the accident occurred. These forms are discussed at the Institutional and Safety representatives committees.

6) In the case of a fatality or serious injury, managers must ensure that the scene of the hazardous occurrence is not disturbed unless authority is given by Ministyr of Labour, Department of Occupational health & Safety, Kenya Police, or disturbance must be limited to the extent necessary to: save a life, prevent an injury, or relieve human suffering in the vicinity; maintain an essential public service; or prevent unnecessary damage to or loss of property.

7) The supervisor is responsible for ensuring that the corrective action and the root causes of the hazardous occurrences are followed up on and acted upon.

10.4.2 Human Resources and Social Development Reporting Requirements

8) When a hazardous occurrence (including a motor vehicle hazardous occurrence) involves:

- a disabling injury to an employee,
- a loss of consciousness as a result of an electric shock, toxic atmosphere or oxygen-deficient atmosphere,
- the implementation of rescue, revival, or other similar emergency procedures, or a fire or an explosion,

It must be reported **within 14 days** after the hazardous occurrence to HR office.

10.4.3 Fatalities and Other Serious Hazardous occurrences:

9) Where a hazardous occurrence results in:

- the death of an employee,
- a disabling injury to two or more employees,
- an explosion,
- damage to a boiler or pressure vessel that results in fire or the rupture of the pressure vessel or boiler; or
- a free fall of, or damage to, an elevating device that renders it unserviceable,

The EOHSO or his/her designate, will report the hazardous occurrence, as soon as possible but not later than 24 hours after becoming aware of the hazardous occurrence, to HR office.
This type of hazardous occurrence must be fully investigated by a Human Resources Office.

10.5 A GUIDE ON HOW TO PERFORM A HAZARDOUS OCCURANCE INVESTIGATION

A hazardous occurrence investigation that is properly and efficiently carried out and is followed by prompt remedial action, addressing the immediate, basic and root causes is an effective method of reducing hazardous occurrences. It is important to note that the severity of loss determines the extent of the investigation.

A hazardous occurrence investigation has two purposes: to determine why the hazardous occurrence happened by identifying all work-related facts associated with it; and, to subsequently modify work conditions and procedures to prevent a similar occurrence. The supervisor responsible for the work must be totally committed to the hazardous occurrence investigation process. These guidelines are based on that premise.

10.5.1 Responsibilities

ILRI is responsible for ensuring that work hazardous occurrences occurring within its jurisdiction are investigated, recorded and reported, the causes determined and appropriate measures taken to prevent similar occurrences. It is also the responsibility of the institute to ensure that all investigation team members are trained in hazardous occurrence investigation procedures.

A team approach to the investigation of the hazardous occurrence is recommended. A team will consist of a minimum of one supervisor and one Occupational health & safety Office staff member and a Safety committee representative.

10.6 THE INVESTIGATION TEAM

10.6.1 The Supervisor

The supervisor, by the nature of his or her position and its inherent responsibilities, possesses a detailed knowledge of the work and the conditions under which it is done and is the appropriate person to undertake the hazardous occurrence investigation. Primary responsibility for investigation should, therefore, rest with the supervisor. Acceptance of this responsibility by each supervisor, combined with a personal commitment to the time and effort involved in such investigations, is required if the program is to operate effectively. The supervisor's responsibility extends beyond determining the cause of the hazardous occurrence and includes exercising supervisory responsibilities to ensure that proper remedial action is promptly taken.

10.6.2 ILRI EOHSO

Where appropriate, the ILRI EOHSO can offer guidance in coordinating a hazardous occurrence investigation. The EOHS0 cannot be expected to provide technical advice on every operation or to take the place of the responsible supervisor concerning the detailed work operation or procedures. The EOHSO can, however, often help to determine the cause of a hazardous occurrence, as a result of general knowledge and experience with similar hazardous occurrences and their causes.

In case of potentially serious or serious hazardous occurrences the EOHSO must become more actively involved in the investigation.

10.6.3 Technical Specialist

A technical specialist may be utilized when investigating hazardous occurrences involving highly technical processes.

10.7 THE INVESTIGATION

10.7.1 Purpose of Investigation

The primary purpose of the hazardous occurrence investigation is to establish the causes as quickly as possible through the identification and examination of all information associated with the hazardous occurrence. The ultimate purpose is to make the required changes in the work conditions, procedures, and program standards that will eliminate or reduce the risk of a similar occurrence.

Fact-finding only

The investigation should be undertaken in a constructive spirit. It is not a fault finding exercise, and irrespective of the causes determined or the involvement of various personnel, the occasion should not be used for apportioning blame. In establishing the existence of human error, such actions should be dealt with objectively.3

10.7.2 Planned Approach to Investigations

The degree of the hazardous occurrence investigation should be determined by the loss potential of the hazardous occurrence.

The Investigation Team must receive training on the following sequence of actions involved in investigating hazardous occurrences.

A planned approach should incorporate the following sequence of actions:

1 the initial response

2 collecting evidence & information

3 analysis and identification of causes

4 developing corrective & remedial action plans

5 report findings

6. evaluation the effectiveness of the corrective action

7. make changes for continuous improvement

10.7.3 The Initial Response

Steps involved in the initial response which is 1st stage of a hazardous occurrence investigation response include:

- taking control at the scene
- ensure first aid & emergency services
- control secondary hazardous occurrence scenes
- identify sources of evidence
- preserve evidence
- determine loss potential
- notify appropriate managers

10.7.4 Collecting Evidence & Information

This is an overview of the 2nd stage of the hazardous occurrence investigation which involves four parts. They are:

- **Position evidence** - This involves utilizing photos, sketches or video cameras to capture the location of the evidence.

- **People evid**ence - this involves interviewing people who were involved with the hazardous occurrence or might have knowledge of facts that may have contributed it to the hazardous occurrence occurring. Interviewing is an art and interviewers should receive training on how to conduct a proper hazardous occurrence investigation interview.

  Proper interview techniques are important. Normally, for example, it is well to remind the person being interviewed of the constructive purpose of the investigation. The investigator should do everything reasonable to put the person at ease and should never appear hostile. Ask the person what happened and try not to interrupt. When more information is needed, it is usually better not to pose direct questions but to ask for clarification of key points. Also ask any pertinent questions required to complete the hazardous occurrence investigation report.

- **Parts evidence** - includes the examination of what parts may have contributed to the hazardous occurrence occurring.

- **Paper evidence** - includes the examination of such things as training records, maintenance logs & records, work schedules, procedures and practices relating to the hazardous occurrence being investigated.

10.7. 5 Analysis and identification of causes

The 3rd stage of a hazardous occurrence investigation involves the analysis stage; determining what the losses were, what the contact was that resulted in a hazardous occurrence occurring, immediate causes, basic causes and determining the underlying root causes.

10.7.5.1 The 4 W's Analytical Method[4]

The 4 W's analytical method expands on the traditional investigation questions of who, what, where, when, how, and why?

The 4 W's thinking is highly compatible with the following Loss Control method and can be used to navigate deeper into the Hazardous Occurrence root causes. The following are just a few examples of how this type of questioning can be expanded.

Who were all the people involved in the Hazardous Occurrence scenario?

We usually have a victim, but there are also supervisors, managers, witnesses, co- workers, trainers, emergency responders, and human resource people to name a few. What were their qualifications? What role did, each play? Who assigned the work? Provided orientation? Who ensured the worker was capable of doing the job? Did the victim have any personal or medical problems that contributed to the outcome?

What tools, equipment, and materials were involved in the process?

Were they defective in any way? Were guards available and used? Were the right tools and equipment provided for the job? What about the job itself. What were the hazards? Did safe procedures exist? Was orientation and training provided?

Where did this happen?

Did the location interfere with the usual work procedures? What impact did the environmental factors of heat, cold, or darkness play? Did workers take shortcuts because of these?

When did this happen?

Specifically, did the particular part of the workday impact the Hazardous Occurrence ? Were shift schedules or overtime a factor? What else was happening in the area at the time of the Hazardous Occurrence ?

How did the Hazardous Occurrence take place?

This is asking us to think about the immediate accident causes. What changes to the work process were introduced before the Hazardous Occurrence? What happened immediately before, during, and after the accident?

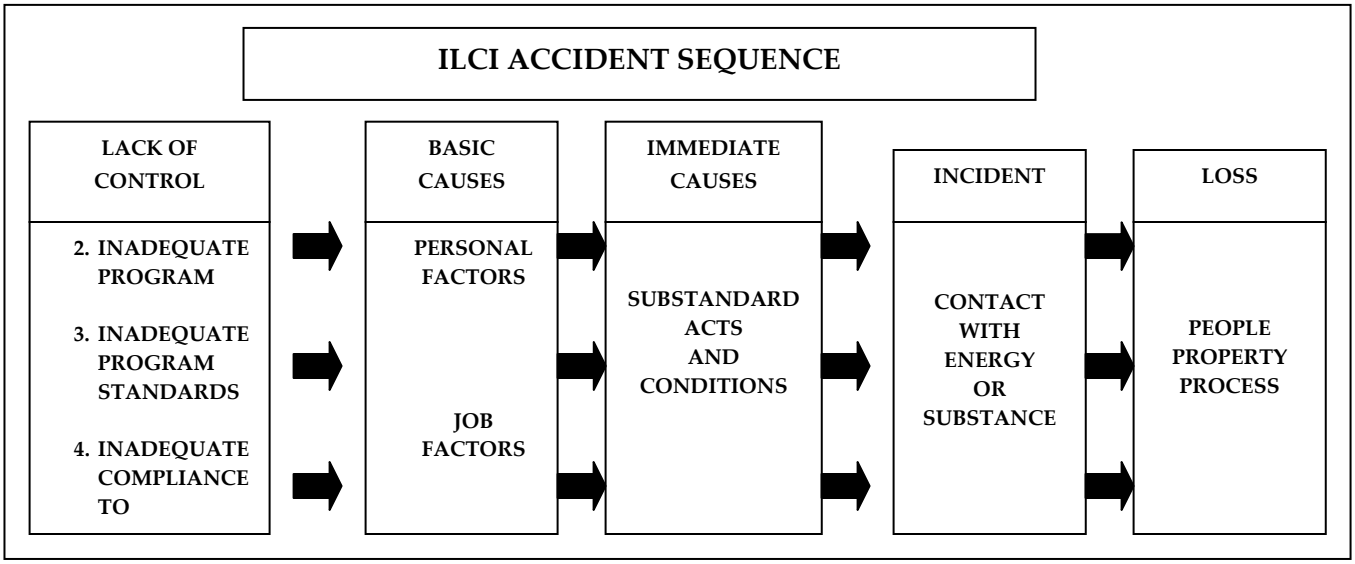
Why did this Hazardous Occurrence happen?

Who + When + Where + What + How = WHY

Ask why each event in the Hazardous Occurrence scenario happened. Putting the why question in front of all the questions you have asked up to now will help determine the basic causes of the Hazardous Occurrence. From there you can determine what root cause might have produced them. Ask the why questions until you run out of answers.

10.7.5.2 The International Loss Control Institute Hazardous Occurrence Sequence.[5]

Follow the chart and information below to identify the root causes behind the Hazardous Occurrence.
Loss - What was the loss that occurred? Was there an injury, illness, part of body harmed, property/process damage?



Contact - What were the sources of energy or substances when the hazardous occurrence first occurred? Some of the **contact categories** could include; Struck against, struck by, caught in, caught on, caught between, slip, fall on same level, fall to below. Possible energy sources are: Electricity, heat, cold, radiation, caustics, noise, toxic substances, knives, floor and other sources.

Immediate Causes are the immediate, measurable and visible causes that occurred and contributed to the hazardous occurrence occurring? There are two broad categories of immediate causes. They are substandard conditions and substandard actions. See the tip sheet on how to complete the Hazardous Occurrence Investigation Report.

Basic Causes are the underlying causes that cannot be immediately seen or measured that may have contributed to the hazardous occurrence occurring and can be broken down into two categories. They are job factors and personal factors. See the tip sheet on how to complete the Hazardous Occurrence Investigation Report.

Root Causes/Lack of Control - After the investigation team has determined what were the immediate and basic causes of the hazardous occurrence, they will then perform the last part of the analysis stage of the investigation. The team will look at what deficiencies in the Occupational health & safety program exist (the root causes/lack of control). The employer will determine the corrective & remedial action plans.

10.7.6 Developing corrective & remedial action plans

The 4th stage of the investigation occurs once the causes of the hazardous occurrence have been identified. Developing corrective & remedial action plans is the responsibility of the supervisor, supported where necessary by the investigation team. They must prescribe the action that must be taken, based on the findings of the investigation, to rectify the hazard or reduce the risk of a similar hazardous occurrence.

The corrective and remedial actions taken must be obtainable, measurable, realistic and specific. The corrective action will be the action that addresses the hazard immediately. The remedial plan will be the action that addresses the underlying root causes of the hazardous occurrence.

The corrective action and plan must have the person(s) named to address the hazard and time frames in which the hazard and program deficiencies will be corrected by.

10.7. 7 Report Findings

The 5th stage is to report the findings from your hazardous occurrence investigation. The Hazardous Occurrence Investigation Report must be completed by the supervisor investigating the hazardous occurrence. Below is a "TIP" sheet on how to complete the hazardous occurrence form. No person should be blamed on the hazardous occurrence form for the hazardous occurrence occurring and phrases like "Use more common sense" are avoided.

The form must be sent to EOHS Office. The EOHS Safety Representatives committee must also review the hazardous occurrence form at their next safety meeting

10.7.8 Evaluation of the effectiveness of the corrective action

The 6th stage is for the employer to review the corrective actions taken to ensure they have actually controlled the root causes that were identified. The EOHS Office shall document that this review has taken place.

The EOHS Safety Representatives committee shall also review the corrective and remedial actions at future meetings to help ensure the required actions have been implemented and are controlling the hazards.

10.7.9 Make changes for continuous improvement

The final stage is for the ongoing review of the EOHS program at the local and institutional level to ensure it is current and identifies changes needed to improve the program. This can be accomplished by review of hazardous occurrence reports, workplace inspections and Institutional EOHS audits to identify trends.

10.8 TIPS ON HOW TO COMPLETE THE ILRI HAZARDOUS OCCURANCE INVESTIGATION REPORT FORM

NOTE: *(It is important to note there is no room on the form for witness, or for the injured employee, to Take comments. Additional information can be stapled to the Form and submitted*)

Type of Hazardous Occurrence ☐

Mark off the correct box. **Use the "Other" category to report Near Miss/Incident Reports** or Environmental spills or leaks.

Type of Injury ☐
MINOR OR NON-DISABLING: Any work injury for which first aid or medical treatment is provided and there is no lost time beyond the day of injury.
This category can be broken down into two sub-categories:

Minor First Aid: an injury for which an employee may seek treatment from a health nurse or first aid attendant.

Minor Medical Aid: an injury where an employee seeks treatment from a hospital, doctor, or chiropractor. The employee may be away from work for the remainder of the day.

DISABLING INJURY: an injury/illness where an employee seeks professional medical care, and loses time from work beyond the actual day of the accident.

Section A - 1 to 8 - Injured Employee Information

The information required in Section 1 to 7 is straightforward.
The information needed in Section 8 is your complete laboratory location.

Section B - 9 to 19 - Hazardous Occurrence

In **Section 9** the complete name and number of the establishment and the exact location of where the hazardous occurrence/incident has taken place is required.

Remember in **Section 12** to attach a Witness statement if there was a witness to the hazardous occurrence. They do not have to give their names.

Section 17 - Nature and Extent of Injury

Extent of Injury Body Part Affected

1. Fracture	14. Eyes	26. Stomach
2. Broken bone	15. Ears	27. Buttock
3. Bruise	16. Head	28. Leg
4. Sprain	17. Neck	29. Ankle
5. Strain	18. Shoulder	30. Foot
6. Concussion	19. Back	31. Toe
7. Headache	20. Arm	32. Other_____
8. Dizziness	21. Elbow	
9. Laceration	22. Chest	
10. Nausea	23. Wrist	
11. Vomiting	24. Hand	
12. Burn	25. Finger	
13. Other _____		

Occupational Illness

Please specify _____

Section - 20 to 21 Investigation of Accident

Section 20 - Sequence of Events
In a narrative form please explain in the sequence of events that occurred leading to the hazardous occurrence. Feel free to attach additional paper if there is not enough space on the hazardous occurrence form. You may also want to include the initial contact factors that occurred.

Initial Contact Factors

Type of Contact	Contact With
1. Struck against	11. Heat
2. Struck by	12. Cold
3. Caught in	13. Radiation
4. Caught on	14. Caustics
5. Caught between	15. Noise
6. Slip	16. Chemical _____
7. Fall on same level	17. Knives
8. Fall to below	18. Sharps
9. Overexertion	19. Floor
10. Electricity	20. Biological Exposure_____
11. Contact with	21. Other_____

Section 21 - Causes of Hazardous Occurrences

21. a) Mechanical/Physical and/or Environmental Conditions

Pick at least one Cause from each category if applicable.

IMMEDIATE CAUSES

1. Inadequate guards or barriers
2. Inadequate or improper protective equipment
3. Defective tools, equipment, or materials
4. Congestion or restricted action
5. Inadequate warning system
6. Fire or explosion hazards
7. Poor housekeeping
8. Hazardous environmental conditions
9. Noise exposures
10. Radiation exposures
11. High or low temperatures exposures
12. Inadequate or excess illumination
13. Inadequate ventilation
14. Defective fume hood

BASIC CAUSES

1. Inadequate leadership/supervision
2. Inadequate engineering
3. Inadequate purchasing
4. Inadequate maintenance
5. Inadequate tools/equipment
6. Inadequate work standards
7. Wear and tear
8. Abuse or misuse

21. b) Human Factors

Pick at least one Cause from each category if applicable.

IMMEDIATE CAUSES

1. Operating equipment without authority
2. Failure to warn
3. Failure to secure
4. Not following safe work practices
5. Making safety devices inoperable
6. Removing safety devices
7. Using defective equipment
8. Using equipment improperly
9. Failing to use personal protective equipment
10. Improper loading
11. Improper placement
12. Improper lifting
13. Improper position or task
14. Servicing equipment in operation
15. Horseplay
16. Under the influence of alcohol and/or other drugs
17. Improper testing methodology

BASIC CAUSES

1. Inadequate capability
2. Lack of knowledge
3. Lack of skill
4. Stress
5. Improper motivation

SECTION D 22 to 25 - Preventive Action

Section 22 & 23 - Corrective Action and Date of Implementation
Please ensure that this section is completed, the person(s) identified to perform the corrective action and the date for implementation of the corrective action is entered on the form.

Section 24 - Investigation Team
There must be at least one supervisor and one safety representative committee member and EOHS Saff on the investigation team. The investigation team must sign and date the form after completion of the report.

Section 25 - OHS Committee Review
It is **IMPORTANT** that the hazardous occurrence form be taken to the safety representatives committee meeting where the committee will review it and add their comments to the form. It must be signed by the Chair of the safety committee. The supervisor and EOHS Ofice shall ensure recommendations have been acted on. The original form is kept at the EOHS Office and a copy with the area Supervisor.

Section E Management Review
If there is a hazardous occurrence that results or could result in a disabling injury or significant near miss, the Deputy Director General – Research (DDG – R) will review the hazardous occurrence form, sign it and make comments on the investigation team findings section of the form. The DDG - R will look at the root causes identified, and controls that have been put in place to prevent reoccurrence of this hazard.

Appendix 1

HAZARDOUS OCCURRENCE INVESTIGATION REPORT

Hazardous Occurrence

☐ Injury ☐ Explosion/Fire ☐ Loss of consciousness ☐ Threats ☐ Emergency Procedures ☐ Other(specify)

Type of Injury

☐ Non-disabling ☐ Minor - First Aid ☐ Minor - Medical Aid ☐ Disabling ☐ Fatal

A - INJURED EMPLOYEE INFORMATION

1. Name		2. Sex ☐ Male ☐ Female	3. Date of Birth Y/ M/ D
4. Classification	5. Occupation	6. Time in this type of work Years Months	7. Safety training received in this task ☐ Yes ☐ No

7a. Specify type of safety training received and date of training

8. Regional Office	Address	Telephone No

B HAZARDOUS OCCURRENCE

9. Hazardous Occurrence Location of	10. Regular Duties	11. Supervisor

12. Witness(es)	13. First Aid Treatment ☐ Yes ☐ No

14. First Aid Attendant	15. Date and Time of Accident Y/M /D	16. Date and Time Reported/ Y/M /D

17. Nature and extent of injury (State part of body affected)

18. Property /Material Damage

Nature and extent (vehicles, spectacles, tools, equipment etc) Cost

19. Contact Person

C - INVESTIGATION OF ACCIDENT

20. Sequence of events leading to accident

(Fully identity equipment, tools, materials, etc, that may have contributed to the accident)

21. cause(s) of Accident

(a) Mechanical, physical, and /or environmental conditions

(b) Human factors (unsafe act)

D - PREVENTIVE ACTION

22. Corrective and preventive measures, planned or recommended

23. Date of implementation Y/M /D

24. Investigator – Investigation Team

	Name	Title	Signature	Date (Y/A MM D/J)
1				
2				
3				

25. OHS Committee Review	Comments / Observations
☐ Yes ☐ No	

Signature - Employee co-chairperson	Signature - Management co-chairperson

E - MANAGEMENT

Comments / Observations

Name	Title	Signature	Date(Y M D)

11.0 SHIPPING BIOLOGICAL MATERIALS

This section outlines the:

- minimum training requirements for the shipping of "exempt animal specimens", "biological specimens " and "infectious substances ". The section applies to ILRI Research Platform when they ship these substances to other laboratories.

This section does not pertain to the submission of dangerous goods that are biological material shipped as part of the Animal Health Program from ILRI employees to the Laboratories. For information on shipping those specimens from the field, please speak to the biological services unit.

11.1 TRAINING REQUIREMENTS

11.1.1 Employees Who Ship "biological specimens " and "infectious substances "

Training is required for anyone who ships "biological specimens " and "infectious substances " under the Transportation of Dangerous Goods Regulations.. The training must be specific to those categories of materials that are being shipped and the mode of transport that is to be used (road, air, marine). The training content shall cover as a minimum:

- **classification** - names, class(es), product identification numbers and packing groups(if applicable) of dangerous goods normally encountered on the job;
- **shipping documents** - what documents are required and how to complete it properly
- instructions for the correct **labeling** and required safety marks;
- **proper packaging** (means of containment) of dangerous goods - (in the case of Class 6.2 Infectious substances, Category A, UN2814, UN2900 this would include packing instructions 602 and Type 1A and for biological substances category B, UN3373, packing instructions 650 and Type 1B);
- the implications of mixed loads, and the need for segregation of incompatible dangerous goods;
- procedures to follow if an infectious substance or radioactive materials are lost, stolen or misplaced;
- procedures to follow in case of an Accidental Release as per Reporting Requirements Part 8 of TDG regulations; and
- the ILRI 24 hour emergency number and spill response plan

11.1.2 Employees Who Are "Receivers/Shippers" of Infectious Substances

Training is required for people receiving dangerous goods. This training for employees shall cover thoroughly:

- identification of placards, labels, signs, numbers and other safety marks, what they mean, and when and where to display them;
- control and emergency features for all handling equipment used in the day-to- day activities of the job;

- cafe practices for the loading and stowage of dangerous goods;
- selection and use of the proper means of containment for the dangerous goods[1]

11.1.3 Training Material

All training material that is developed internally or by an external delivery organization, should be reviewed by the ILRI National TDG Coordinator to ensure it meets the requirements of the Transportation of Dangerous Goods legislation

11.1.4 Training Certificates & Frequency

A training certificate expires

- 24 months after its date of issuance for transport by aircraft; and/or
- 36 months after its date of issuance for transport by road vehicle, railway vehicle or ship,

The training certificate must be issued by the employer, signed by the employer's representative and signed by the employee. The training card must be carried by the employee and a copy of their training record kept on file. (hardcopy or electronic)

12.0 PESTICIDE SAFETY

The persistence of pesticides (fungicides, herbicides and insecticides) in the environment and their chronic hazards (e.g., build up in fatty tissue) are of major concern. In addition to being toxic, pesticides may be corrosive, flammable or explosive.

Special precautions are necessary for the transport, storage, mixing, application and disposal of these chemicals. Agricultural Association of Kenya (AAK) regulates all pesticides which are used, sold or imported into the country.

Pesticide use in the ILRI Research Platform is varied and includes:

- pesticide standards for analytical chemistry purposes for determining pesticide levels in produce and animals.
- pesticides used in greenhouses and field work
- pest control inside facilities or around building foundations.
- pesticide treated seed analysis and herbicide bioassays in the seed lab (ADDIS).

Each facility in which pesticides are used, handled, stored or disposed shall ensure the manufacturer's instructions as detailed on the pesticide label, on a material safety data sheet or other manufacturers' literature is readily available in the workplace and is followed.

Where, for research purposes or otherwise, deviations from the manufacturer's instructions are required, an application for use in the manner specified shall be obtained before proceeding with such use.

Detailed written procedures regarding the safe use, handling, storage, transportation and disposal of such pesticides, including circumstances where the employee may be required to work alone, are developed in consultation with the local OHS Committee, prominently displayed in the workplace and explained to all employees concerned.

Pesticides used for pest control shall be used, handled, mixed and disposed by approved persons.

When pest control is contracted out, contractors shall be certified or licensed in accordance with the applicable requirements; the provisions of the Integrated Pest Management Program shall apply.

12.1 SAFE WORK PRACTICES FOR HANDLING TREATED SEED IN THE LABORATORY

- all treated seed samples received in the lab are identified as "treated" on the sample container and supporting documentation and worksheets. Samples are contained in a plastic bag (or over pack) and sealed. Sub-samples for other tests are labeled as treated seed

- samples awaiting analysis are stored in a designated room/area with adequate ventilation. Following analysis, samples are stored in a seed sample storage room prior to disposal

- read the Material Safety Data Sheet for the seed treatment used before the work begins

- protective clothing (lab coat and gloves) must be worn at all times when handling treated seed

- all mixing and dividing procedures shall be carried out in the fume hood
- all other test procedures for treated seed including analysis shall be carried out in a designated room/area with adequate ventilation
- ensure the work area and equipment is clean and equipment and work surfaces contaminated with pesticides must be decontaminated with soap and water after completion of tasks
- wash hands and equipment with soapy water after completion of work
- discard gloves in designated disposal bins
- food or beverage must not be stored or consumed in the area where treated seed is being handled or stored

12.1.1 Procedure for Removal of Seed Treatment Using Water and Ethanol

The following points hall be used where at the discretion of the analyst, an accurate analysis cannot be conducted because of the seed treatment.

- follow requirements outlined in the sop for the safe handling of treated seed samples
- after removal of seed treatment from the seed, the waste water shall be discarded in a designated waste container
- read the Material Safety Data Sheet for Ethanol before the procedures for removal of the seed treatment begins work begins

12.2 HERBICIDE BIOASSAYS SAFE WORK PRACTICES

- a lab coat and disposable gloves must be worn for all steps of the herbicide bioassay process (solution preparation, aliquoting solution, planting, evaluating)
- the MSDS for a specific herbicide must be read by the analyst/technician prior to handling the herbicide
- a spill kit should be located nearby to clean up spills if required
- herbicide solutions must be prepared in a fume hood
- alliquoting solution, planting, and evaluating of herbicide bioassays must be conducted in the fume hood; the exception is aliquoting solutions, planting, and evaluating Roundup bioassays which may be conducted without special ventilation measures, because Round Up toxicity is very low
- use a pipetting device and pipettes to aliquot smaller volumes of herbicides, do not pipette by mouth, to prevent spillage, pipettes should not be left in flasks
- designated pipettes may be reused for the use with the same herbicide only
- pipettes to be disposed should be placed in container for broken glass disposal
- excess herbicide solutions must be disposed of as hazardous waste, not flushed down the drain

- water used to rinse/clean equipment that contained herbicide solutions of high concentrations must be disposed of as hazardous waste

- tools and replicate containers for herbicide testing should be dedicated for use with herbicide bioassay testing only

- clearly mark a germination chamber for herbicide bioassay testing. Clean chamber with soap and water after use if it is to be used for germination testing

- wash, with soap and water, all tools and replicate containers following each use. Wipe all bench areas used with soap and water when work is completed

- food or beverage must not be stored or consumed in the area where herbicide bioassays are being conducted

12.3 PESTICIDE HANDLING IN ANALYTICAL LABORATORY

The safe work practices identified in Section 6 - Chemical Safety and the requirements of Section 5 - WHMIS must be followed when using pesticides in a laboratory environment.

12.4 PESTICIDE USE- OUTDOOR & GREENHOUSE POSTING OF SIGNAGE

Warning of treatment using pesticides 24 hours prior to application. However, it is recognized that under certain unforeseen weather conditions, spraying operations may have to be initiated on short notice; under these circumstances, the 24-hour pre application posting requirement may not be possible, but warnings must nonetheless be posted prior to pesticide application.

If Signs are put up, they shall contain the following wording: WARNING - PESTICIDES USED, The sign shall also contain a warning pictogram that alerts the public not to touch or walk on treated plants or area, and the following: date of application; name of pesticide used; PCP registration number; reason for application; telephone number for information, and safe re-entry date.

12.5 REDUCING THE RISK OF PESTICIDE EXPOSURE

12.5.1 Integrated Pest Management (IPM) Principles for field and greenhouse work

- IPM involves: a) identifying pests; b) determining the cause and source of the problem; c) knowing the pest's life cycle, behavior and effects on its host, and the most vulnerable period of its life cycle; d) monitoring pest activities and effectiveness of control or management

- IPM requires knowing and using available methods, such as: a) approved biological controls including: parasitic and predatory insects, and host-specific pathogens, b) maximizing a plant's health and minimizing its susceptibility to pest infestations by crop rotation, moisture control, planting techniques; c)
  genetic selection, i. e., choosing resistant species and varieties of plants, d) mechanical controls, e.g., trapping cultivation, physical barriers, e) the use of pesticides which are of relatively low toxicity to human and animal populations, and of low persistency in the environment, e.g., insecticidal soap; and f) the use

of conventional pesticides in a prescribed manner.

12.5.2 Substitution

The least toxic of pesticides recommended for control of a pest or an alternate acceptable control method shall be used whenever control or management of a pest is required. Pesticides known or suspected of being human carcinogens shall not be utilized except under restricted procedures, and such use shall be conducted by a trained person.

12.5.3 Isolation

Potentially hazardous pesticide operations should be isolated from either the worker or the worker isolated from the operation. Isolation techniques that should be considered include but are not limited to the following:

- positive pressure tractor cabs with filtered air supply;
- conducting pesticide operations when the fewest number of employees are in the area;
- isolation chambers for research application of high concentrations of toxic pesticides; and
- enclosing pesticide transfer points in handling facilities and using automated equipment for the application of pesticides.

12.5.4 Safe Work Practices - When mixing and handling pesticides:

Before mixing and using pesticides, all employees involved shall be trained in accordance with the provincial and federal legislation for their area. Measuring, mixing, and loading pesticides is the most hazardous stage of pesticide use.

- all persons handling pesticides must be trained, qualified and certified; know the chemical, physical and toxicological properties of the pesticides to be used
- read the label and safety data sheet for special instructions on personal protection required and for special procedures
- wear the appropriate face, skin and respiratory protection (e.g., chemical resistant footwear, apron and gloves, face shield and safety goggles, and where necessary, a respirator)
- practice good personal hygiene (e.g., washing hands after handling pesticides)
- conduct mixing operations carefully in a dedicated area to avoid spillage when opening the container (place the open container on a stable surface where it will not tip over) during pouring (use a funnel) and mixing (use the proper implement, to stir, add slowly to prevent splashing)
- avoid dust creation when mixing wettable powders
- scales, measuring cups, mixing pails, and other equipment used in these operations shall be used only for pesticides. Equipment shall be cleaned by trained employees and returned to locked storage area when not in use

12.5.5 Safe Work Practices - When applying the pesticide:

- know how to properly use the application equipment; be licensed if required; wear the required personal protective and safety equipment
- application equipment shall be selected, calibrated, operated, and maintained in accordance with established procedures to ensure employee safety and health and uniform application to target area and to prevent contamination of non target area
- check equipment, transfer lines, hoses or connectors and seals to ensure they are in good working order
- post required signage before applying pesticides
- spray only when the hazard of contaminating adjacent areas by drift is limited (no or very low wind conditions)
- use largest droplet size possible; keep nozzles and equipment clean; release sprayer pressure completely prior to examining system
- reserve equipment for the application of herbicides exclusively for that purpose
- keep unauthorized people and animals out of the treatment area during pesticide application
- clean/decontaminate protective equipment immediately after each use; clean out application equipment
- rinse emptied containers and dispose according to provincial/local requirements

12.5.6 Transporting Pesticides

- Pesticides shall be transported in a separate compartment from the driver and passengers, and shall not be transported in the same compartment containing animals, food, animal feed, clothing, household furnishings, or other personal items.
- All pesticides being transported shall be inspected to ensure the integrity of containers, and be placed in the vehicle in a safe manner to avoid tipping, spilling, or leaking.
- All pesticide containers shall have the original label intact. A list of pesticides being transported, with a copy of the labels, shall be kept by the driver. Vehicles transporting pesticides shall be posted with a warning sign as follows: **WARNING - PESTICIDES - ATTENTION**

12.5.6.1 Safe Work Practices - when transporting pesticides, include the following points:

- inspect containers for defects and to ensure that lids are on securely
- secure containers from movement to prevent accidental spillage; protect glass containers from impact (e.g., use form-fitting, foam-lined shipping packages) and paper or cardboard containers from rain and moisture
- never transport pesticides in the passenger compartment of any vehicle; never transport pesticides along with food or feed

- do not allow anyone to ride where pesticides are present (e.g., back of a truck)
- do not transport pesticides on platforms of wood or other absorbent materials (spill cleanup and decontamination is almost impossible)

12.5.7 Safe Work Practices - when storing pesticides include the following points:

- pesticides should be stored in a locked, designated area (i.e., storage cabinet, room or building) away from work areas; storage facility design (location, ventilation, plumbing, building materials) must meet applicable provincial and local regulations
- pesticides shall be stored in compliance with the National Building Code, the National Fire Code, the (where applicable), and other requirements.
- to the extent possible, quantities of pesticides purchased and stored shall not exceed the needs of one season in accordance with a pest management program
- storage cabinets and rooms shall be vented to the outside with controlled access to avoid unauthorized use
- shelving shall be secure and impervious; and no higher than 1.7m unless specifically designed for safe access above eye level
- post warning signs at the entrance to storage areas
- store pesticides in their original containers with a clearly legible label
- inspect containers regularly for leakage, corrosion or damage; transfer damaged containers to new containers clearly labeled with the pesticide name, concentration and PCP number
- keep amounts stored to a minimum; store pesticides on shelves, not the floor; store liquid pesticides below shoulder level and glass containers on lower shelves
- store pesticides away from heat and sunlight; separate incompatible chemicals (e.g., combustible pesticides and oxidizers, some pesticides and water, pesticides and corrosives, some pesticides and metals); store herbicides away from other pesticides
- Spill-control material appropriate to the pesticides in storage shall be maintained at the storage site. Ensure personnel are trained in proper clean up procedures.
- maintain records of the amounts on hand and amounts and dates of removal and use

12.6 DISPOSAL OF PESTICIDES

During disposal procedures, all possible precautions shall be taken and training must be provided to ensure that the safety and health of employees are not at risk and that the environment is not contaminated. Waste disposal shall be conducted in accordance with the manufacturer's directions on labels, and all provincial and federal regulations.

13.0 SPILLS

An effective hazard prevention program will reduce the chance of a spill occurring in the workplace. It is still imperative that a proactive spill mitigation and clean-up section be part of any ILRI Laboratory Safety Program.

All spills must be reported by the employee to the supervisor. The supervisor must investigate the spill and complete the ILRI Hazardous Occurrence Investigation Form.

Below are the minimum standards to follow in the case of a chemical, pesticide, biological and radioactive spill.

13.1 BIOLOGICAL SPILLS

Biological Spills are almost all unique; each spill will have a different agent, location, volume, dispersion etc. The following points should be considered as guidelines and be adapted to deal with your specific spill.

13.1.1 Level 2 Pathogens Spills in a Biological Safety Cabinet (BSC)

- leave the BSC in operation
- assemble clean-up materials and don appropriate protective clothing (including gloves)
- clean-up of the spill should be initiated as soon as possible
- cover spill with paper towels and apply disinfectant effective against the microorganisms present; begin at the edge of the spill and work slowly towards the centre; gentle flooding action will avoid creating aerosols
- pour disinfectant through perforated grills into a catch trays beneath if spilled material has gone through
- allow sufficient contact time for disinfection (at least 20 minutes, depending on the disinfectant and microorganisms present)
- use forceps to pick up any broken glass or sharps and place in a puncture- resistant container; wipe up spill and place all materials in an autoclave bag inside the cabinet in a container suitable for autoclaving
- items in the hood at the time of the spill must be thoroughly cleaned with a disinfectant and/or by autoclaving, prior to removal from the BSC
- protective clothing should be placed in bags and autoclaved prior to disposal or laundering, wash hands with disinfectant soap
- wipe inside of the cabinet with disinfectant and allow BSC to run for 10 minutes prior to resuming work
- report the incident to your supervisor
- swab the contaminated area and items in BSC to verify that disinfection was successful

13.1.2 Level 2 Pathogens Spills in an Open Area within the Laboratory

- hold breath and vacate area; warn others to leave

- mark off area using barricade tape or warning signs to prevent others from entering
- if the spill splattered your face, flush your eyes or wash face as necessary
- remove contaminated clothing and place in bag for autoclaving; if footwear has been contaminated, take care not to track contamination into clean areas before removing; take a shower if necessary
- seek medical attention if necessary
- advise laboratory supervisor and seek assistance from spill response team and/or biosafety officer if needed
- depending on location of spill (i.e. inside a containment lab or in a common hallway) and building ventilation, further evacuation of employees may be necessary
- wait at least 30 minutes to allow aerosols to settle before re-entering area
- don appropriate protective clothing (respiratory protection, long sleeved gown/coveralls with tight fitting wrists, gloves, boots) and assemble spill response materials
- cover spill with paper towels and apply disinfectant effective against the microorganisms present to begin at the edge of the spill and work slowly towards the centre; gentle flooding action will avoid creation of aerosols
- allow sufficient contact time for disinfection (at least 20 minutes, depending on the disinfectant and microorganisms present)
- use long forceps to pick up broken glass or sharps and place in a puncture- resistant container; wipe up spill and place all materials in an autoclave bag and suitable container
- items in the vicinity of the spill must be thoroughly cleaned with a disinfectant and/or by autoclaving

- Protective clothing should be placed in bags and autoclaved prior to disposal or laundering; clothing and equipment that cannot be autoclaved should be thoroughly decontaminated by disinfection.
- swab the contaminated area and items in the vicinity of the spill to verify that disinfection was successful

13.2 CHEMICAL SPILLS

The key to mitigating losses in the event of a chemical spill is to have a standard operating procedure developed for responding to a chemical spill in your workplace. If a spill occurs, the responder (s) will know what procedures to follow for the specific chemical (s) involved in the spill.

13.2.1 Chemical Spill Training

The Laboratory area coordinator shall take the Chemical Spill Course. This course consists of:

- understanding a MSDS from a spill response perspective

- the importance of vapor pressure in assessing hazards
- completing a Spill Risk Assessment Worksheet
- knowing the general spill response procedures
- practicing chemical spill clean up

All persons handling chemicals must be trained in spill response.

13.2.2 Chemical Spill Risk Assessment

It is recommended that a "Spill Risk Assessment" performed for the chemicals in their laboratories. A blank "Spill Risk Assessment" worksheet is included in Appendix 1.

Since some ILRI Research Platform laboratorie use many chemicals, it may be impractical to develop a Spill Risk Assessment for each chemical. Laboratories may choose to develop a checklist or method to prioritize to evaluate which chemicals need a Spill Risk Assessment. **Frequency of Use, Volume Used and Hazardous Properties of the Chemical** are three possible evaluation criteria that may help to group similar chemicals for a single Spill Risk Assessment, or identify chemicals that do not need a full assessment.

The completed assessments should be the foundation of your Chemical Spill Response SOP.

13.2.3 Minor Laboratory Spill General Response Procedures *

* Minor Spill Definition - the spill of a chemical substance that due to its toxicity, location and size is able to be cleaned up using existing spill control supplies in the laboratories without causing harm to the employee(s) cleaning up the spill. Please remember the size of the spill is only one factor in the decision process regarding who should respond to the spill clean up.

A. Identify Scope of the Problem

- **Potential losses** - human loss potential, exposure to you and others, environmental and property damage, assess the situation for personal safety (e.g. is it is unsafe to stay? Then vacate the area and warn others. If someone is injured seek medical attention)
- **personnel decontamination** - to remove contamination from the body, an emergency shower and/or eye flushing at an eyewash station should last at least 15 minutes
- **identification** - the location, quantity, type of spilled material and type and condition of container should be recorded for use at a later time or by other emergency responders
- **Site conditions** - floor drains, HVAC systems, potential ignition sources and other possible chemical reactions. Depending on location of spill (i.e., inside lab or in a common hallway) and building ventilation, further evacuation of employees may be necessary

B. Considerations (before taking action)

- **Expertise** - Do I have skills and knowledge to safely clean up the spill according to SOPs? Should I call in emergency personnel? Can I evaluate the possible health hazards, protective equipment required etc.?
- **Equipment** - Do I have the specific spill clean-up kits in enough quantities? Do I have adequate personal protective equipment to perform the clean-up?
- **Resources** - Consider consulting the laboratory supervisor, National Laboratory Safety Advisor, local emergency personnel. Do you have access to the Spill Risk Assessments and MSDS for particular chemical(s) spilled?

C. Remedial Actions

- notify your LAC
- Don appropriate personal protective clothing and assemble spill clean up materials (solvents - acids - caustics - mercury - spill kits); obtain a quantity sufficient to absorb an entire spill. **NOTE**: Your own laboratories procedures may state that there must be two people involved in the clean up.
- identify the area of the spill with barricade tape or other signage to prevent others from entering
- where possible, turn off all sources of ignition including hotplates, burners etc; consider turning off the power supply
- contain the spill using pillows as dykes to prevent further spreading, cover drains
- apply neutralizers/absorbents slowly starting at spill perimeter, working inward; NOTE: that there may be a considerable amount of heat and potentially hazardous bi- products produced given off as a result of the reaction between clean-up chemicals and the spilled chemicals
- use long forceps to pick up broken glass and place sharps in a puncture-resistant container
- pH kits can be used to determine whether neutralization of a spill is complete
- if appropriate, wash affected area thoroughly with water after clean-up (consult MSDS)
- remove contaminated clothing and place in bag for disposal; if footwear has been contaminated, take care not to track contamination into clean areas before removing
- waste clean-up materials may be packaged and disposed of as hazardous waste unless completely neutralized; non-disposable clean-up materials should be decontaminated and washed prior to reuse

13.3 PESTICIDE SPILLS

Each ILRI laboratory using pesticides should have a spill contingency plan. The plan should comply with the Code of Good Practice for Handling, Storage, Use and Disposal of Pesticides. At minimum, the plan should explain: how to prevent spills, who to contact if there is a spill, how to contain and clean-up the spill, identify critical or sensitive locations (e.g. rivers, drainage points) and specify how often the plan will be updated.

Regularly review First Aid Procedures for pesticides spilled onto skin or splashed into eyes. Review pesticide label information before using a pesticide. As with all controlled products, you must have MSDS information for each pesticide used at your facility.

Post emergency phone numbers by each telephone and at the pesticide storage area printed large enough so they are easy to read. Include phone numbers for the Poison Control Centre, a doctor, Fire/Police/Ambulance (911), and Provincial Emergency Program (PEP).

Compile a list of pesticide company emergency phone numbers. Pesticide labels have an emergency phone number(s) on them. Read your pesticide labels and record the PCP Act numbers, the company name, and the pesticide name. In an emergency it may take too long to find phone numbers on the labels or the labels may be damaged. Keep these phone numbers in the spill contingency plan and spill kits.

Design the mixing area to contain spills. Consider installing a containment pad for potential spills in the mixing and loading areas.

13.3.1 Spill Cleanup kit(s)

Keep a spill cleanup kit in a vehicle when transporting pesticides, in the pesticide storage area, and at the mixing and loading areas. A spill cleanup kit can be purchased from some farm supply stores or can be made from easily obtainable items. A pesticide spill cleanup kit should contain:

- personal protective equipment (e.g. unlined gloves, rubber boots, a respirator, protective eyewear, disposable coveralls)
- Dry absorbent material such as sawdust, vermiculite, dry coarse clay, kitty litter, commercial absorbent, newspapers or paper towels.
- Lime chlorine bleach or washing soda to decontaminate spill areas
- A broom and a scoop or shovel to pick up the contaminated material
- A container with lid (e. g 20L pail or heavy duty garbage bag) to contain the contaminated waste; this container can also be used to store the spill kit items prior to use.
- A felt pen to write the name of the spilled pesticide on the container
- A list

13.3.2 Dealing with a pesticide spill

Act quickly. The sooner the spill is controlled, the less damage it can cause.

- Protect yourself against pesticide exposure. Put on personnel protective gear including chemical resistant gloves and disposable coveralls. If a respirator is normally used when applying the pesticide, wear a respirator to clean up the spill. Do not smoke, drink or eat during clean up. Work up- wind of the spilled material.
- If pesticide spilled onto a person have the person remove contaminated clothing. Thoroughly wash the skin with soap and water and follow the first aid directions for skin exposure. If a person inhaled the pesticide take them to fresh air and follow the first aid directions for inhalation.

- As time permits, review the MSDS and pesticide label information (if label has not been damaged) or contingency plans before taking further action. Consider contacting the manufacturer or product supplier for advice.
- If the spill is inside, ventilate the area by opening door and windows and using the fans if necessary
- Keep bystanders and animals away from the spill. Do not let people walk or drive through the spilled material.
- Control the spill. Eliminate the source of the spill if possible and prevent the spill from continuing by setting the tipped container, sprayer or applicator upright.
- Contain the spill and prevent it fro spreading further. If the spill is near a sensitive area such as creek or pond, divert the spill away from this area away from the sensitive area.
- Surround the spilled pesticide with a barrier or dam so it cannot spread (on its own or as a result of the clean up procedure); use materials in the spill kit or material other absorbents such as soil, peat moss, saw durst, newspapers etc. Absorb or soak up as much liquid pesticide as possible, however don't use absorbent material if a dry pesticide formulation was spilled.
- Do not apply water to the spilled pesticide; water will spread the spill further. Certain pesticide spills can be cleaned up washing up the area with a mixture of household bleach, detergent and water. Use only a little water then cover the solution with absorbent material. Put the contaminated material in a labeled disposal container.
- Begin the cleaning up as soon as the spill is under control. Sweep up dry pesticides or use the absorbent material. Place the waste materials into an empty water proof container or strong garbage bag. Label the container with the name of the pesticide, the PCP Act number, and the approximate amount of pesticide that was spilled. If the spill occurs directly on the soil, dig up and remove the contaminated soil. Put the contaminated soil in a strong container, label it as above and dispose of it according to provincial regulations. Cover the area with at least 5 cm of lime then cover the lime with fresh top soil.
- Decontaminate all the equipment used in the clean up. Remove and wash the protective gear. Change clothing immediately. Launder clothing as soon as possible. Discard any badly contaminated clothing or equipment (i. e broom). Shower using lots of soap and water.
- Check your provincial regulations for spill reporting requirements and approved contaminated waste disposal procedures.
- Re- evaluate your pesticide handling procedures and your spill contingency plan.
- Re stock your spill kit.

13.4 RADIO ACTIVE SPILLS

In addition to radioactive clean up these spills may also require chemical neutralization or biological decontamination.

13.4.1 General Precautions

- Inform persons in the area that a spill has occurred. Keep them away from the contaminated area.
- Cover the spill with absorbent material to prevent spread of contaminated material
- Wear protective clothing and disposable gloves, clean the spill using absorbent paper. Place all items in a plastic bag for transfer to a labeled radioactive waste container.

13.4.2 Minor spills *(typically less than 100 exemption quantities of a nuclear substance)*

- Wearing protective clothing and disposable gloves, clean up the spill using absorbent paper and place it in a plastic bag for transfer to a labeled waste container.
- Avoid spreading contamination. Work from the outside of the spill towards the centre.
- Wipe test or survey for residual contamination as appropriate. Repeat decontamination if necessary, until contamination monitoring results meet the required standards..
- Check hands, clothing and shoes for decontamination.
- Report the spill and clean up to the person in charge and if necessary to the Radiation safety Officer.
- Record the spill details and contamination monitoring results. Adjust the inventory and waste records appropriately.

13.4.3 Major spills (Major spills involve more than 100 exemption quantities or contamination of personnel, or release of volatile material)

- Clear the area. Persons not involved in the spill should leave the immediate area. Limit the movement of all personnel who may be contaminated until they are monitored.
- If the spill occurs in laboratory, leave the fume hood running to minimize the release of volatile nuclear substances to adjacent rooms and hallways.
- Close off and secure the spill area to prevent entry. Post warning sign(s)
- Notify the Radiation Safety Officer or person in charge immediately on X3375
- The Radiation Safety Officer or person in charge will direct personnel to a decontamination and will decide about t decay or clean up operations and determine what, if any, measurements for radioactivity are necessary.
- In general, decontaminate the personnel by removing the contaminated clothing and flushing contaminated skin with luke warm water and mild soap.
- Follow procedures for minor spills (if appropriate)
- Record the names of all persons involved in the spill. Note the details of any personnel contamination.

- The radiation Safety Officer or person in charge will arrange for any special bioassay measurements.
- If required, submit a written report to the radiation safety officer or the person in charge.
- The radiation Safety Officer or person in charge must submit a report to RPB
- Major spill Procedures should be implemented whenever minor spill procedures would be inadequate. If an exposure may have occurred that is in excess of applicable dose limits, the RPB shall be contacted within 24 hours of the occurrence.

Appendix 1 – LABORATORY CHEMICAL SPILL RISK ASSESSMENT WORKSHEET * [1]		
CHEMICAL: Concentration: Container Type and Size:		Possible Quantity of Spill Scenarios -
ROOM INFORMATION		
Chemical Location(s) in room:	Ignition sources – yes no Floor Drains - yes no	No of Employees Working in Room:
Size of Room: Restricted Access: yes no	HVAC system air flow: positive negative Additional ventilation (fume hoods):	Other Chemicals in the Room:
CHEMICAL INFORMATION		
Vapour Pressure: Vapour Hazard Ratio:	Flash Point	LEL_____UEL
WHMI classifications: (specify)	PH:	Vapour Density
Reactivity: Incomparability with other substances:		
HAZARD IDENTIFICATION		
Inhalation ☐ yes ☐ no **Absorption** ☐ yes ☐ no **Ingestion** ☐ yes ☐ no **Injection** ☐ yes ☐ no		
TWAEV	LD50	LC50
Carcinogen ☐ yes ☐ no	Mutagens ☐ yes ☐ no	Teratogen ☐ yes ☐ no
SPILL CONTROL EQUIPMENT		
What type of spill equipment is available in what quantities?		
PERSONAL PROTECTIVE EQUIPMENT * *		

What type of personal protective equipment is available and is it adequate for what type of chemical spill?
SPILL RISK ASSESSMENT EVALUATION
After reviewing this assessment we can respond to a spill of this chemical? ☐ Yes ☐ no If yes, what is the approximate maximum size of a spill you could respond to given the spill control equipment, personal protective equipment and chemical you are dealing with? What other references have you used? MSDS Labels Other _____
ASSESSED BY: **DATE OF ASSESSMENT:**

[1] adapted from the Basic Spill Response Workbook Risk Assessment Worksheet – Echelon Response &Training Inc., Stoney Creek ON, 2005

* NOTE: You must be carefully trained in how to read an MSDS form "a spill response perspective" before completing this worksheet. You must also receive training in spill clean up procedures.

** NOTE: If you have respirators as part of your PPE, there must be a respirator training and maintenance program in your laboratory.

14 EMPLOYEES WORKING ALONE GUIDELINES

There are a variety of circumstances where employees will be working alone at International Livestock Research Institute. The institute must use the information in this chapter to help in setting up employees working alone guidelines.

14.1 ROLES AND RESPONSIBILITIES

14.1.1 Employer

- must develop in cooperation with the Standard Operating Procedures (SOPs) for working alone situations that are specific to their work area.

14.1.2 Employee

- must cooperate with employer in the implementation of Working Alone SOPs.

14.1.3 OHS Committee

The occupational safety and health (OHS) committees need to review the various situations where employees are required to work alone, and make recommendations concerning the most reliable and practicable means of providing the required assistance to those employees, who may be subject to a significant risk or hazard.

In this regard, items that should be reviewed by the OHS committee include:

- a review of the work procedures and processes carried out in a "working alone" situation;
- the adequacy of equipment and procedures used in the particular situation;
- the adequacy of emergency support systems and monitoring mechanisms;
- the adequacy of employee training and information respecting the use of survival equipment, protective equipment and clothing, and the use of communication or supervising systems

14.2 CODE OF PRACTICE FOR WORKERS WORKING ALONE

The Department of occupational health and safety (DOHSS) has developed Under "The occupational safety and health Act" and the key concepts relating to Workers Working Alone are:

- The necessity of assessing all working alone situations to determine the conditions or circumstances which may result in misfortune to the workers working alone and attempt to reduce the probability of such misfortune; and
- The provision of a means of securing assistance for workers working alone in the event of injury or other misfortune.

14.2.1 Securing Workers from Risks

When workers are involved in working alone situations, consideration should be given to the fact that, should some misfortune occur, the worker may not be able to secure assistance as readily as when working with a group of co-workers.

With the understanding that misfortunes to workers will never be totally eliminated while performing any given job junction, whether it is determined as working alone or not, both employers and workers have the responsibilities and duties to undertake that job function in the most knowledgeable and safest manner, thus minimizing the possibility of such misfortune.

14.2.2 Development of Plan

In consultation with the local OHS committees, the employer shall put into place a plan to address employee working alone situations.

14.2.3 Assessment

When assessing the conditions or circumstances under which the worker is required to work alone, particular job functions will have inherent hazards associated with them that may be deemed as high risk, low risk or combinations of both.

Some examples of work functions that present high risk hazards may include:

entering any confined space, working with radioactive materials , high temperature, toxic gases, liquids, or solids, cryogenic (low temperature) materials/processes, high pressure systems - high voltage electrical systems, moving equipment or machinery, handling or transferring flammable liquids.

Working in: extreme weather conditions, and using new procedures and unfamiliar equipment can increase the probability of accidents.

14.2.4 Control Measures and Documentation

Upon assessing the conditions or circumstances under which a worker is required to work alone, control methods shall be developed and documented to minimize the identified risks arising out of or in connection with that activity. A means of securing assistance for the worker working alone in the event of injury or other misfortune shall be included.

The following suggestions may be incorporated as part of the developed plan. Dependent on the situation to which they are to be applied, the examples could constitute control methods to minimize risks, means of securing emergency assistance or a combination of both.

- Second Person or "Buddy System"
- Personal Check by Another Person
- Periodic Telephone Contact
- Constant or Intermittent Mechanical or Electrical Surveillance
- Central Monitoring

The most important point to consider is the suitability of safety measures and systems to meet the worker's needs. For example, if an employee is deaf, visible alarms should be provided in the workplace.

14.2.5 Plan Criteria

Those persons directly involved in the consultation process for developing plans for workers working alone should ensure that as much information as possible is included to inform and instruct both the worker who is working alone and the supervisor as to the set procedures for that particular job function.

The minimum information to be included in the plan is:

- Each specific type of activity will no doubt have particular requirements and procedures in place for the function to be conducted in the safest possible manner. These requirements may be a result of company policy or pertinent regulations or standards.
- Working alone plans should be an extension of the safety and protective equipment necessary to perform that job function under any circumstance.
- Instances may occur where a particular employer will have more than one employee working alone. Frequent staff turnover may also be a factor in operations involving working alone situations. Uniform plans could therefore be developed by the same process as previously described to cover these persons, if all people directly involved in these working alone situations are in agreement. These types of "blanket plans" would be suitable only if the working alone situations involved similar conditions.
- Modifications would be necessary should a particular employee in a general plan have special needs.
- Plans should be reviewed and updated in the same manner as the original plan.

14.2.6 Plan Agreement & Implementation

After the plan is developed, the safety Representatives committee can recommend it be implemented by the Management.

The implementation of the plan must include an educational component to employers and employees affected by the plan. The developed plan shall provide instruction for supervisors and workers and designate their respective responsibilities.

The working alone plan must be in writing and shall be provided to all workers and supervisors directly involved in the working alone environment.

14.2.7 Tips for Working Alone

Appendix 1 lists a number of tips to take to reduce the risk for employees working alone. Some of these may already be part of your plan for your laboratory.

Appendix 1 - Tips for Working Alone

Working Alone "Working Alone" includes employees who work by themselves without close or direct contact with co-workers. For example the receptionist in a large office building may be considered a "lone" worker. Administrative Tips Every effort should be made to avoid having employees work alone in areas of recognized risk. Provide the employee with a means of emergency communication (e.g. A cellular phone). Check its proper operation at the beginning of the shift and at least once during the shift. Post emergency numbers. Periodically check the well-being of the employee. Arrange agreements with other company locations, adjacent merchants or security firm to monitor your employee. Provide a protective enclosure. Ensure that a qualified person will respond immediately to signs of distress. Post signs indicating employees are not working alone, e.g. real estate open house signs should list the names of two real estate agents. Prominently display signs indicating that the premises are monitored.		**Working Late** Let a security guard or friend know you are working late and when you expect to leave. Use established check-in procedures. "Use the buddy system". Arrange to work late the same night as a colleague or friend. While accompanied by a co-worker, check that all doors and windows are locked and make sure washrooms and storage rooms are empty. Before dark, move your car to a well-lit area, close to a building or a parking lot attendant. Call police or security officers if you suspect someone is lurking outside. If you enter a washroom and you suspect someone might be inside, DO NOT call out. Back out, go to safe area with a lockable door and call for help. Plan ahead which safe places you can retreat to and call for help. If you encounter someone unfamiliar, indicate that you are not alone. Say "my supervisor will be right here and will be able to help you." Ask your employer to consider providing safe transportation home after hours. Review the tips provided for public transit, parking lot safety and working alone, as appropriate.

15.0 CONTRACTOR SAFETY

Each worksite must have a policy and procedures in place related to the process of contracting work out to third parties for purposes of service contracts or construction contracts. ILRI worksite have:

1. Operations Manager
2. Engineering Manager
3. Contracts Officer
4. Director of Finance and Administration
5. Budget Manager

who develop and sign contracts for work to be performed by third parties at your worksite.

The Director of Finance and Administration at ILRI is responsible for contractors at ILRI workplaces.

15.1 BID DOCUMENTS & CONTRACT SAFETY MANUAL

There must be a process that assigns responsibility of contractor selection to designated positions or individuals.

- There must be an assessment or pre- qualification of the contractor and must be specific to the work performed.
- The bid documents should require information on the companies' health & safety program and past accident records.

- The company must provide proof of liability insurance and worker's compensation coverage before a contract can be awarded. (ideally, but not mandatory, the Worker's Compensation cost performance record of the company should be reviewed and be deemed to be acceptable before accepting the bid. This record must pertain to all parts of the company that will be performing work under the contract (mechanical, electrical, architectural, etc.) If the contractor has a poor worker's compensation record, it's best to ask the question why?

- The company must provide a copy of their current health & safety policy.

- Clearly specified in the contract are:

  - all hazardous materials or work performed that may be dangerous to ILRI employees must be performed off hours and where possible less hazardous materials or procedures be used

  - the requirement that the contractor and subcontractors adhere to the applicable provincial or federal safety regulations, whichever is stricter

  - contractors and service providers working in a ILRI workplace must have a valid RCMP security clearance, contractors and service providers without a valid security clearance must be escorted at all times by a ILRI representative

15.2 CONTRACTOR SAFETY MINIMUM COMPLIANCE REQUIREMENTS

The following checklist is the minimum standard for the orientation of contractors before beginning work in a ILRI Laboratory.

[ ] There is a designated site contact from the Laboratory ILRI while the contractor is on the site. The contact will monitor the activities of the contractor.

[ ] The contractor/ service provider acknowledges that all work is to be carried out in a safe and responsible manner and that all practices shall follow both federal and provincial regulations. The most stringent code shall prevail and be adhered to.

[ ] The contractor attends a pre-job meeting before work begins and is introduced to the onsite Contact for the Laboratory. This contact is the person the contractor reports any hazardous occurrences too.

[ ] The contractor will be given a walk through of the work areas they will be working in or near, explaining the location and use of emergency eye wash stations, emergency showers, drench hoses, emergency exits, emergency spill kits and their application, fire extinguisher locations, safety board and what to do should they hear the fire evacuation alarm. They must also be given a contact name and phone number in case of an emergency.

[ ] The contractor must be given a hazard awareness walk in their work location(s) identifying any hazards and precautions to be taken.

[ ] The contractor is given a thorough review of the security procedures used at the worksite.

[ ] The contractor reads the safe work procedures for contractors working in a ILRI laboratory and signs the document to indicate they have read and understood it.

[ ] The contractor must supply copies of records of their regular safety meetings, as well as copies of their regular Worker's Compensation Board contributions (as applicable, based on the length of the project)

[ ] The contractor must have on-site and provide to site authority manufacturers' MSDS sheets for all materials being used on this site, before they are brought onto the property.

[ ] Storage of any materials on-site must be authorized by the site contact.

[ ] If the contract and work involves subcontracting any part of the Scope of Work, a representative from the contractors firm must accompany any sub trades and be responsible for their actions at all times while onsite. They must also ensure that this compliance checklist is signed off by the subcontractor.

[ ] The contractor and subcontractors must comply with all Department of Occupational Health and Safety OHS legislation, including, but not limited to Personal Protective Equipment regulations.

[ ] Any use of open flames or other hot work like grinding or cutting can only be done with the approval of the site contact.

[ ] If fire occurs as a result of the work you are performing immediately activate the nearest fire alarm pull station. If the fire can be put out safely without endangering the safety of you or the safety of others, attempt to extinguish the fire. Report all fires. If you hear a fire bell immediately proceed to the nearest point of exit.

[ ] 48 hours advance notice required for taking fire alarm / sprinklers system off line.

[ ] ILRI strictly prohibits smoking onsite.

[ ] Eating and drinking is not permitted in laboratory area's.

[ ] The use of drugs or alcohol on ILRI facilities is strictly forbidden.

----------	----------	----------
ILRI supervisor	contractor	date

16. NEW EMPLOYEE ORIENTATION

16.1.1 Policy

All new employees, including temporary staff and students, must be given a safety orientation prior to beginning their duties. This orientation will include the whole facility as well as their specific work area.

16.2 ROLES AND RESPONSIBILITIES

16.2.1 Laboratory Supervisors

- it is the responsibility of supervisors to ensure that employees have receive their OHS training and are given hazard and emergency equipment awareness training in their work facility
- that the employee reads the pertinent sections of the ILRI Laboratory Safety Manual and views the Health and Safety Induction DVD.
- ensure that the training is documented and records are kept on file
- ensure a follow up review happens within two months of the new employee starting to ensure comprehension has been achieved
- ensure the new employee completes checklist 16.3
- ensure the employee receives their non OHS related orientation

16.2.2 New Employees

- must participate fully in the new employee training, and pass any required tests associated with the orientation

16.3 NEW EMPLOYEE OHS ORIENTATION COMPLIANCE CHECKLIST

The following checklist is the minimum standard for the OHS orientation of new employees.

I ---------- have completed and understood the following modules as required by the particular task(s) and areas I will be involved with.

[ ] I have read the ILRI health & safety Policy,

[ ] I have read the pertinent Sections in the ILRI Laboratory Safety Manual relating to the work I will be performing

[ ] I have been given a walk through of the work areas and have been shown the; location and use of emergency eye wash stations, emergency showers, emergency exits, emergency spill kits and their application, fire extinguisher locations, safety board and location of PPE required

[ ] I have been given a hazard awareness walk in my work location(s) identifying any hazards and precautions to be taken

[ ] I have been shown the location and how to access Material Safety Data Sheets

[ ] I have read the Job Hazard Analysis and Safe Work Practices related to the tasks I will be performing

[ ] I have been shown the location and how to access SOPs relating to the tasks that I will perform

[ ] I have completed On-Line WHMIS training program or equivalent

[ ] I have been given the names and phone numbers of all safety representatives and the LAC

[ ] I have given the name of the person they report any near misses or hazardous occurrences to (LAC) _____

[ ] I have been shown the place to meet outside in case of a fire emergency for attendance to be taken

[ ] I have completed the test to ensure competency on OHS issues has been achieved.

_____

Employee name **Date**

[ ] As a supervisor, I have confirmed the above tasks has been performed by the employee.

[ ] As a supervisor, part of my ongoing duties is to observe the worker for compliance to safe work practices.

_____

Supervisor Name **Date**

Appendix 1

Employer and Employee Duties & Employee Rights

1. As an employer, what are my duties?

Employers have a general obligation or duty to ensure that the health and safety of every person employed by the employer is protected while they are working. Also, employers have specific duties in regards to each work place they control and every work activity under their authority that occurs in a work place that is beyond the employer's control.

The employers need to ensure that the design, installation, operation, use or maintenance of the following meet the:

- buildings and structures (permanent or temporary), guards, guard rails, barricades and fences;
- protective devices, machinery, equipment, tools, vehicles, and mobile equipment;
- boilers, pressure vessels, escalators, elevators, electrical generation equipment, electrical distribution systems;
- heat generating equipment and heating, ventilating and air conditioning systems.

Employers have a further obligation to ensure that levels of:

- temperature, humidity, ventilation, lighting, sound and vibration meet with prescribed standards, and that employees are not exposed to levels exceeding prescribed exposure limits of hazardous substances including controlled products and any other chemical, biological or physical agents that may be harmful resulting from their storage, handling or use in the work place.

The employer must also ensure that all hazardous substances including controlled products are labeled appropriately. Material safety data sheets are to be made available to employees for the hazardous substances and/or controlled products to which the employee may be exposed. Employers are required to provide:

- safe entry to, exit from and occupancy of the work place;
- first-aid facilities and health services, sanitary and personal facilities, and safe drinking water;
- employees with the information, instruction, training and supervision necessary to ensure their health and safety at work;
- for the training of supervisors and managers in occupational health and safety and their responsibilities
- for the training of members of the policy and work place committees and health and safety representatives in occupational health and safety and their responsibilities
- a response to employees who have reported to the employer any thing or circumstance likely to be hazardous to the health and safety of employees or other persons granted access to the work place;
- written responses to recommendations made by policy and work place committees and health and safety representatives within 30 days after receiving them;

- the resources necessary for the operation of the policy and work place committees;
- to the policy and work place committees and health and safety representative a copy of any report relating to hazards in the work place;
- within 30 days, the information requested by a policy committee, a work place committee or a health and safety representative;
- every person granted access to the work place, with the prescribed safety materials, equipment, devices and clothing and ensure that every person is familiar with, and uses them.

Each employee, and each person granted access to the work place, be made aware of every known or foreseeable hazard in the area where the employee works or where the person is likely to be exposed.

- Posting the employer's general policy on the health and safety of employees, information on the work place health and safety committee and any other printed material as directed by a health and safety officer. Additionally where a safety representative or health and safety officer issues a direction, employers are required to post a notice of the direction, as may be specified by the safety representative or by a health and safety officer;
- investigating, recording and reporting all accidents, occupational diseases and other hazardous occurrences and keeping and maintaining accurate health and safety records;
- adopting and implementing prescribed safety codes, safety standards and standards relating to fire safety and emergency measures and taking the necessary steps to prevent and protect against violence in the work place;
- ensuring that the activities of every person granted access to the work place do not endanger the health and safety of employees;
  ensuring that the work place committee or health and safety representative conducts monthly inspections of all or part of the work place so that the entire work place is inspected at least once each year;
- complying with every oral or written direction given to the employer by a health and safety officer or safety representative;
- responding in writing, to a health and safety officer's direction or report when requested to do so by the health and safety officer.

2. What is the Internal Responsibility System?
Internal responsibility system is a phrase often used when referring to the work place and policy health and safety committees or health and safety representative. In reality it goes further, and is actually the collaborative approach taken by an employer and the employees to resolve health and safety concerns in the work place or when performing work activities.

A well functioning internal responsibility system is a valued asset for any organization or company. That is why

there is a requirement to establish, for all work places, a work place committee or health and safety representative to assist in protecting the health and safety of employees.

For large employers (more than 300 employees) there is an additional requirement to establish a policy health and safety committee to deal with global issues through a more strategic approach.

It is the responsibility of the employer to ensure the proper selection of policy and work place committee members and the selection of a health and safety representative, in accordance with requirements. Where such selections have not taken place, it is the employer's responsibility to perform those duties and functions that would otherwise be performed by the policy committee, the work place committee or the health and safety representative, as the case may be.

3. As a minimum, how must the employer support the internal responsibility system?
The employer must consult the policy committee on the development, implementation and monitoring of a program for the prevention of work place hazards. This program must also provide for the education of employees in health and safety matters.

Consultation must also occur between the employer and the policy committee in the development, implementation and monitoring of a program for the provision of personal protective equipment, clothing and devices.

The employer is to consult the policy committee to plan the implementation of changes in the work place that may have an affect on the health and safety of employees. Similar consultation is to take place at the policy committee level in the development of other health and safety policies and programs.

Where a policy committee is not required, the consultations identified above must take place at the work place or health and safety representative level.

Work place committees or health and safety representatives will be consulted in the development, implementation and monitoring of a program for the prevention of unique work place hazards that also provides for the education of employees in health and safety matters.

Work place committees or health and safety representatives will be consulted in the implementation of the work place changes planned at the policy committee level and the implementation and monitoring of any programs developed through consultation with the policy committee.

Employers are required to cooperate with policy committees, work place committees and health and safety representatives.

4. As an employee, what are my duties?
In order for the internal responsibility system to function properly, it requires the involvement and participation of the employees in the work place.

That is why the local and international standards places several obligations on employees, all of which have the goal of preventing occupational related injuries and diseases.

Employees have a responsibility to take all reasonable and necessary precautions to ensure their health and safety and that of anyone else who may be affected by their work or activities.
Specifically, employees are required to:

- use all safety materials, equipment, devices and clothing that are provided by the employer and are intended to protect the employees;
- follow procedures that relate to the health and safety of employees;
- follow all instructions provided by the employer concerning the health and safety of employees;
- cooperate with any person carrying out a duty or function required by the Code;
- cooperate with policy and work place committees and health and safety representatives;
- report to the employer any thing or circumstance that is likely to be hazardous to the employees or any other person in the work place;
- report to the employer, all work related accidents, occupational diseases or other hazardous occurrences that have caused injury to the employee or any other person;
- report to the employer, any situation the employee believes to be a contravention of the Code, Part II by the employer, another employee or any other person;
- comply with every oral direction or written direction given by a health and safety officer or an appeals officer;
- respond in writing to a health and safety officer's direction or report when requested to do so by the health and safety officer.

Nobody knows a work place better than the people who work in it. Most Labour legislations gives the work place parties a strong role in the identification and resolution of health and safety concerns.

The provisions of Local labour Regulations are designed to strengthen employers' and employees' self-reliance to effectively deal with occupational health and safety issues and, in so doing, make work places safer.

5. What are the employees' rights under the International Labour Organization guidelines adopted by most countries as part of their labour legislations?
The ILO guidelines provides the employees with three rights:

The Right to Know
The Right to Participate
The Right to Refuse Dangerous Work

The Right to Know
Through the provisions of Internationally acceptable guidelines, employees have the right to be informed of known or foreseeable hazards in the work place and to be provided with the information, instruction, training and supervision necessary to protect their health and safety.

This right to know is strengthened by ensuring that the methods of communication are appropriate for all employees, including employees with special needs.

Through their health and safety committees or representatives, employees are given the right to have access to government or employer reports relating to the health and safety of employees, but do not have access to medical records of any person except with that person's consent.

The Right to Participate

As health and safety representatives or committee members, employees have the right and the responsibility to participate in identifying and correcting job-related health and safety concerns.

Employers who employ 300 or more employees are required to establish a policy health and safety committee. The purpose of the policy committee is to handle issues that are organization-wide in nature. Because these types of issues go beyond a single work place, there is a need for a more strategic or global approach for their resolution.

The Right to Refuse Dangerous Work

An employee, at work, has the right to refuse dangerous work if he or she has reasonable cause to believe that:

- a condition exists at work that presents a danger to himself or herself;
- the use or operation of a machine or thing presents a danger to the employee or a co- worker; and
- the performance of an activity constitutes a danger to the employee or to another employee.

In order for an employee to be protected when exercising the right to refuse, the employee must follow the proper procedure.

17. EMERGENCY RESPONSE PLAN (ERP)

ILRI is committed to: protecting the health and safety of employees, persons granted access, the public and the environment, and will seek to mitigate threats by developing Emergency Response Plans (ERP).

17.1 STANDARDS, LEGISLATION AND GUIDES

Reference must be made to the ILO and WHO guidelines.
All local country legislation must also be adhered to when developing the ERP

You should be aware that at ILRI, the following sections are also involved in emergency preparedness. They are:

- EOHS office - This office is primarily concerned with ERPs relating to the delivery of ILRI programs.
- Security - This office safeguards employees and assets and assuring the continued delivery of services.

17.1.1 Definition of an emergency situation

A situation that could have adverse effects on the health and safety of employees and persons granted access to the facilities. An emergency may be the result of process upsets, uncontrolled reactions, fires, explosions, threats, releases of dangerous substances (including third party); natural disasters such as tornadoes, hurricanes, earthquakes, floods etc.

17.1.2 Purpose and Scope

To confirm the ILRI commitment to operating its business at the highest achievable standard to protect the health and safety of employees, persons granted access, the public and the environment.

The objective of this policy is to ensure each ILRI facility is equipped with an ERP which includes procedures to mitigate the effects of a natural or man-made emergency to ILRI employees, information and assets.

17.1.3 Application

This policy applies to all ILRI facilities where more than 50 employees are working at a facility at any time, an ERP must be set up and contain an emergency evacuation plan.

In a facility with less than 50 employees not requiring an ERP, one person plus an assistant must be designated to be responsible for emergency matters at the facility. They will be known as the " Emergency Response Officer" and the "Deputy Emergency Response Officer." Their emergency plan must contain procedures for the safe evacuation of employees and visitors in the event of an emergency.

Facilities managing an above ground or underground storage tanks must have an ERP and develop procedures to mitigate the release of hazardous substances into the environment.

17.1.4 Requirements

All ILRI facilities with more than 50 employees are required to: a) identify the hazards and associated risks that are within or related to their area of accountability and develop an ERP; and b) conduct training and exercises in relation to the ERP developed.

An ERP shall provide for the safety and welfare of employees, persons granted access, the public and the

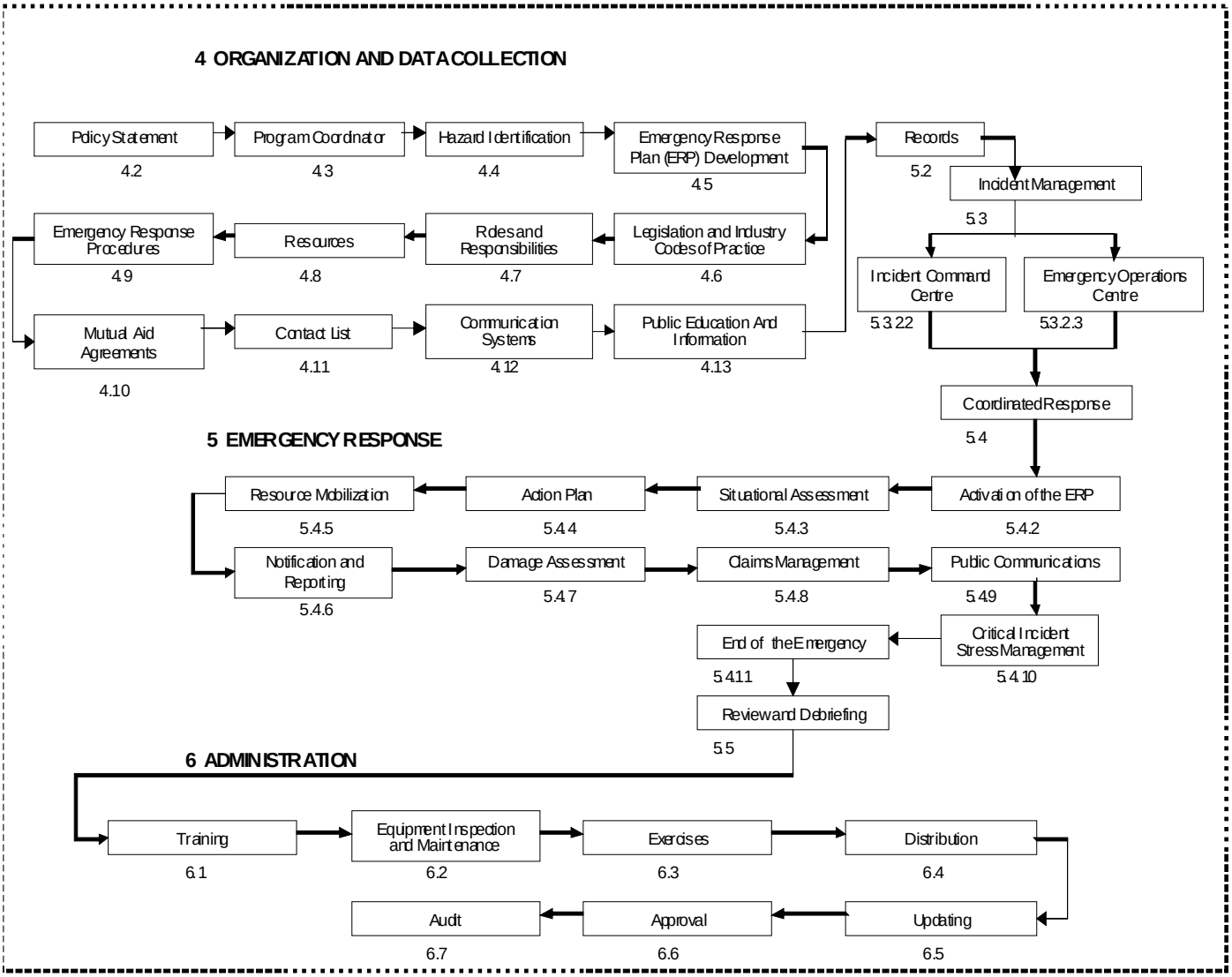
environment for emergency occurrences.

Inform employees and persons granted access of every known or foreseeable safety and health hazard in the areas where they work. The local Environment Occupational Safety and Health Committee or representative must be consulted in the development and review of emergency procedures and must be notified of all emergency situations.

1.7.1.5 Overall Responsibility

At ILRI the Director General has overall responsibility for the ERP. The DG must ensure the ERP is developed and maintained in order that immediate and proper action can be taken to mitigate emergency occurrence.

17.2 EMERGENCY PREPAREDNESS PROGRAM FLOW CHART



17.3 ADDITIONAL COMPLIANCE REQUIREMENTS TO MITIGATE FIRE EMERGENCIES

The threat of a fire hazard will be identified In the Hazard Identification & Evaluation stage of the plan.

17.3.1 Fire Evacuation drills

- The EOHS office must coordinate at least 2 fire drills every year.
- in multi-occupancy buildings where the ILRI is not the main tenant, the most senior official should make every reasonable effort to coordinate a yearly evacuation drill with the other occupants of the building

17.3.2 Fire Reporting

An ILRI facility which has a fire must report the fire to the EOHS office in writing of the details of the fire. within 24 hrs. of the fire occurring.

18. ERGONOMICS

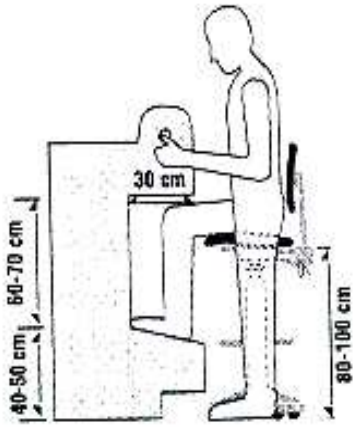
Ergonomics (from the Greek words *"ergon"* meaning work and *"nomos"* meaning knowledge) is the principle of making the workplace and job tasks fit the people. Poor ergonomics has been linked to fatigue, repetitive motion injuries, monotonous work, stress, back, shoulders, arm, hand and eye strains. Managers and supervisors who establish the work environment must have a basic understanding of ergonomics.

Repetitive strain injuries are becoming increasingly significant in our laboratories. Task analysis of common lab operations (e.g., working at a biological safety cabinet, pipetting, microscope usage, and data entry at computer workstations) should be performed to evaluate problems related to poor work design.

Ergonomics must be considered when purchasing equipment and when designing office and laboratory workstations.

18.1 KEY ELEMENTS OF GOOD ERGONOMIC DESIGNS

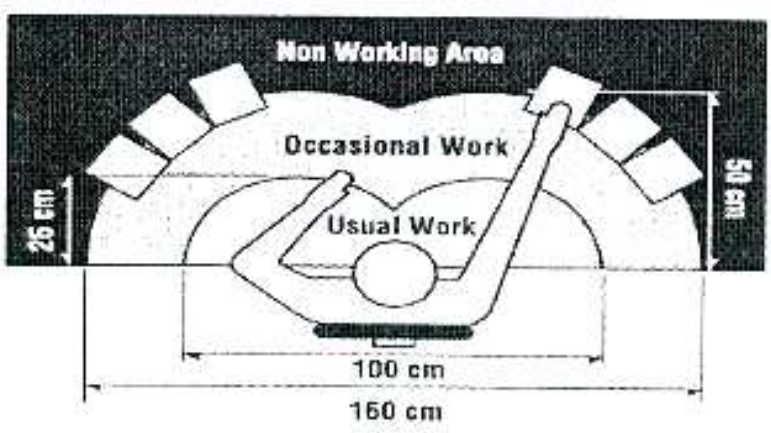
- shared equipment should be readily adaptable to different operators and to different tasks
- plan ergonomically when setting up workstations
- the height of work surfaces and lab benches should allow for elbows to bend at right angles with arms parallel to the floor; there should be sufficient leg clearance underneath (this is an inherent design flaw in older biological safety cabinets and fume hoods)



- chair and lab stool design should be adjustable (seat height, angle, and backrest); chairs should have a stable base (five legs) swivel, arms of chair shall be adjustable in height and width.
- foot rests may need to be provided to ensure legs are supported
- lab work areas should be designed to avoid excessive bending, reaching, stretching, twisting motions or awkward postures (see Appendix 2,3,4,5 – Body Postures)
- the most favorable working height for bench work while standing is 50-100mm below elbow level. (see Appendix 6 - Body Postures & Working Heights)
- task lighting should be used to provide for sufficient illumination and eliminate shadows (see Section 18.6 Lighting)
- sedentary and repetitive jobs should allow for activities that enable changes in posture and motions; tasks should be varied to avoid monotony and boredom; repetitive physical work could be rotated between employees
- adequate air quality, temperature, humidity and supply should be distributed to all work areas

- proper lifting techniques should be taught to and practiced by employees (see Appendix 7 Guidelines for Lifting Boxes)

- place frequently used items within easy reach; store infrequently used items farther away; avoid over-reaching and twisting



- if the task requires prolonged standing, ensure adequate supportive footwear, provide anti-fatigue mats, rest one foot and vary postures,

18.2 VIDEO DISPLAY TERMINALSWORKSTATION ERGONOMICS

Increasingly more and more time is spent working on computers. It is important that your computer workstation be designed to fit your ergonomic needs. Please refer to Appendix 8 for more details.

- properly adjust keyboard height and work surfaces (elbows should be at right angles, wrist rests should be used to support the heel of hand or wrist) (see Appendix 8 - VDT Workstation Ergonomics)

- evaluate new ergonomically designed mouse, keyboards, chairs etc. to see if they really fit your needs.

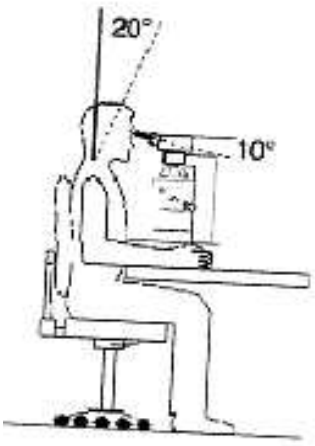
- place the mouse pad at the same level and as close to the side of the keyboard as possible.

- take frequent short breaks, vary tasks if possible, perform stretching exercises to help reduce the chance of an injury occurring.

18.3 ERGONOMIC CONSIDERATIONS WHEN USING A MICROSCOPE

Microscope usage can lead to visual fatigue, musculoskeletal strain and stress. Ways to reduce awkward postures and eye fatigue include:

- adjust the microscope workstation (e.g. use adjustable eyepieces, tube length and angle, chair, work surface height) to support a good work posture (i.e. neutral spine) including back and foot support



- avoid leaning forward when looking into the microscope; set the eyes at the eyepieces while sitting
- straight in the chair with a slight inclination of the head
- avoid elevating arms and hands without support; use forearm rests so that fingers are positioned at microscope dials to reach dial
- avoid long uninterrupted periods of microscope work; pace the workload to include breaks and stretches, rotate microscope work with non-microscope activities
- work with elbows close to sides, wrists in a neutral position as per Appendix 5
- where possible, replace microscopes with visual projection systems

18.4 ERGONOMIC CONSIDERATIONS WHEN PIPETTING

A number of cases of repetitive strain injuries (e.g. carpal tunnel syndrome) have been linked to pipetting activities. Pipetting also involves a considerable amount of static work for the muscles of the whole arm and shoulder resulting in shoulder or other musculoskeletal ailments. The following practices are intended to reduce wrist, hand, shoulder and neck stress and other repetitive motion injuries:

- position pipette tip and discard containers to avoid rotating the wrist when picking up or ejecting tips
- avoid rotating the arms inward when pipetting
- avoid bending the wrist and elbow up and down when picking up or ejecting tips
- position containers to avoid reaching across the work area
- do not keep the head and neck bent forward beyond the neutral position (more than 300)
- vary work tasks to reduce repetitive thumb or finger depression on pipettors

- perform your work at appropriate heights as per Appendix 6
- alter continuous repetitive pipetting by performing other tasks, or take frequent small rest breaks every 20 minutes
- be sure to work with wrists in neutral positions, see Appendix 5
- adjust height and position of sample holders, solution container, waste receptacle to prevent twisting and bending of wrist, neck and rolled shoulders.
- reduce shoulder strain; avoid working with winged elbows/arms, see Appendix 4
- use short pipettes, shorter waste receptacles for used tips to reduce reaching
- use electronic pipettes for highly repetitive pipetting tasks to reduce/eliminate contact pressure on thumb especially in situations of large work loads
- ensure proper lower back and thigh support, by using adjustable stools or chairs with built-in foot and arm rest
- avoid standing for long periods; if standing is unavoidable, use anti-fatigue mats and supportive footwear
- avoid elevating arms and elbows above shoulder for lengthy periods to prevent static work of arm and shoulder strain
- task sharing is another way to reduce the impact of risk factor associated with pipetting
- use trigger mechanisms and multi channel/electronic pipettes

18.5 REQUEST FOR WORKSITE ERGONOMIC EVALUATION

The ILRI EOHS office can provide worksite ergonomic evaluations for the laboratories and office workstations. Contact them for more information on this subject.

18.6 LIGHTING

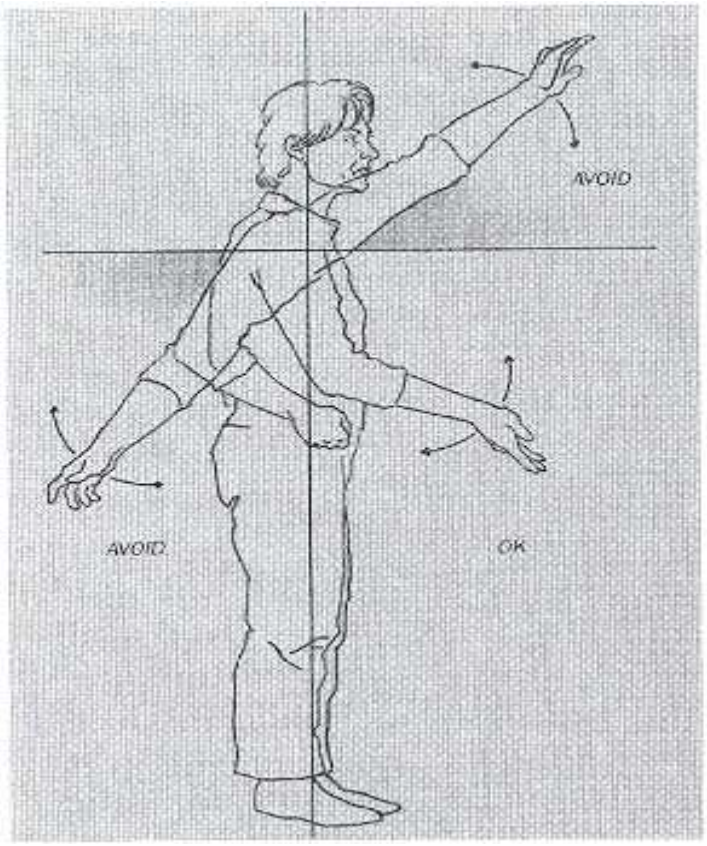
Lighting should be evenly distributed throughout the workplace and should not create a glare or shadows. The use of parabolic louvers/diffusers in an office situation has proven to be beneficial in reducing glare. See Appendix1 below for recommended light levels as per Canadian standards.

Appendix 1 - Minimum recommended levels of illumination for laboratory situations

Area/Operations	Foot-candles	(lux)
Reading instruments, gauges, etc. where errors could be the cause of a hazardous situation	75	750
Working with hazardous substances of severe or moderate hazard	75	750
General laboratory work of low hazard: Medium or fine work Rough work Emergency shower locations Emergency lighting	 50 30 5 1	 500 300 50 10

Appendix 2 - Body postures

SHOULDER/ ARM POSTURES

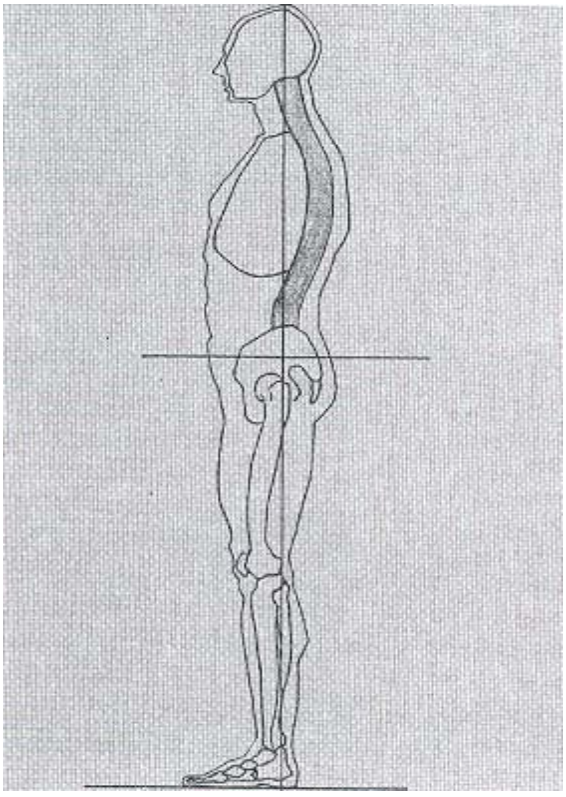


Avoid tasks that **harbitually** require:

- working/ reaching above shoulder height
- reaching behind midline of the body

Appendix 3 - Body postures

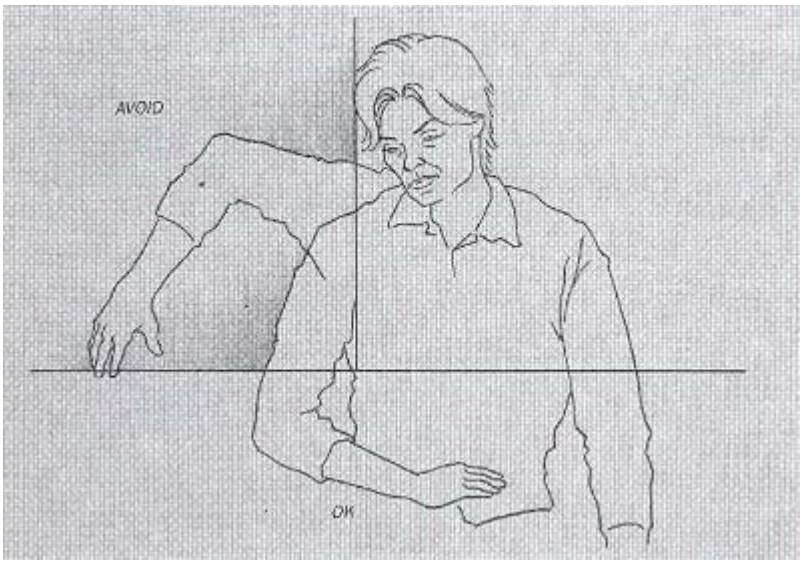
NEUTRAL BODY POSTURES



Any **neutral** body **posture** you assume means you work with **maximum efficiency** using the **least amount** of **energy.**

Appendix 4 – Body Postures

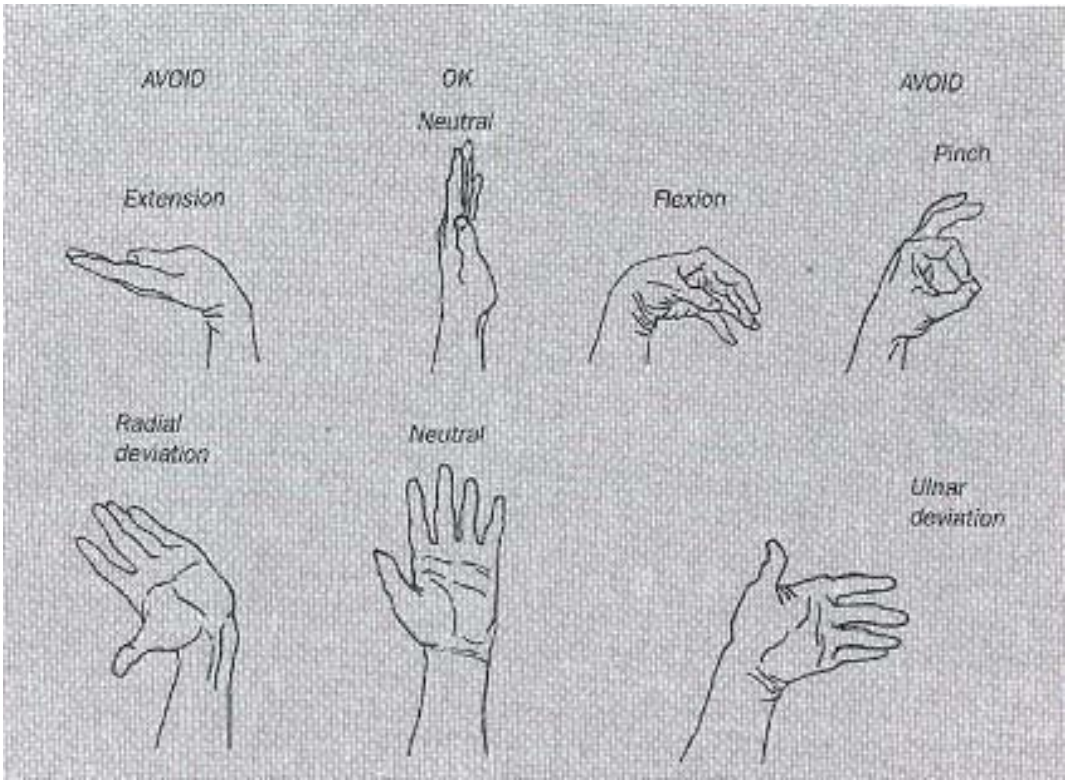
ELBOW POSTURES



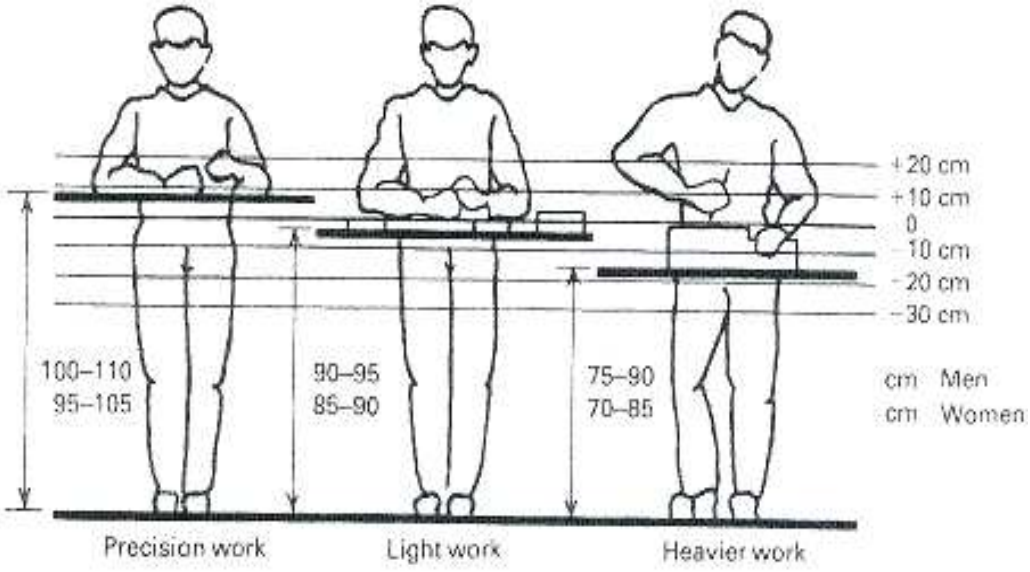
Avoid inward/outward rotation position above waist level. **OK** at waist level or below.

Appendix 5 - Body Postures

WRIST POSTURES



Appendix 6 - Body Postures & Working Heights

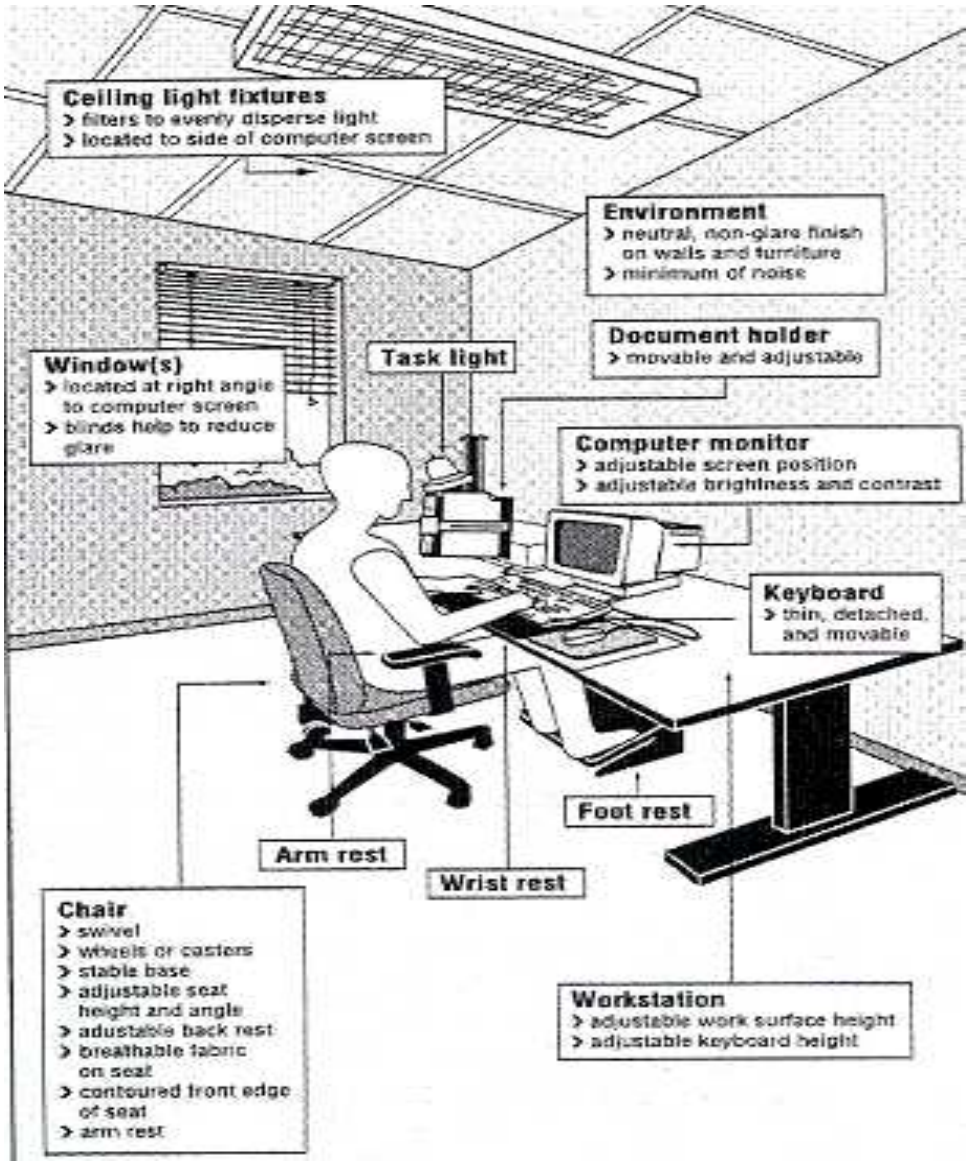


Appendix 7- Safe Lifting of Boxes


Store boxes at waist height
DO NOT BEND over and try to lift box all at once
To Lift from the ground
1 Raise box upright
2 Put one knee against box
3 Pull box up the leg
4 Rest box on edge of knee of the other leg
5 Carry the load with your back in upright position
6 Stand upright

Appendix 8

The VDT Workstation



19. PERSONAL PROTECTIVE EQUIPMENT

The selection of appropriate personal protective equipment (PPE) is of the utmost importance. One glove type or one respirator cannot possibly be expected to satisfy all needs encountered in your laboratory. Understanding of the PPE and its protection is essential in providing adequate safety to specific hazards in your laboratory. Poorly chosen PPE may also contribute to hazards by impairing performance e.g. stiff, and bulky gloves reduce dexterity and ability to control items held in the hand. PPE can also provide a false sense of security, particularly if it is not properly maintained.

If ILRI EOHS develop directives on subjects related to this chapter, the Laboratories will use them to be compliment to what is in the chapter.

If new tasks are developed at the laboratory, a job hazard analysis shall be completed to help identify PPE needs. A review of the Material Safety Data Sheet for the material you are using will also help identify PPE requirements.

19.1 ROLES AND RESPONSIBILITIES

19.1.1 Employees:

- must wear the required and appropriate personal protective equipment
- must follow prescribed safety procedures related to the use of PPE
- must participate in any training or fit testing relating to the use of PPE

19.1.2 OHS committees and representatives:

- must review the personal protection programs & related training programs developed by the employer

19.1.3 Employer:

- responsible for the prevention of hazardous work place conditions that would require the use of PPE. If the nature of the work requires the use of PPE then the employer is responsible for developing programs relating to the availability and safe use of PPE
- will perform a hazard assessment to determine the need for specific PPE programs in the workplace.
- responsible for implementing and monitoring the PPE safety programs
- responsible for ensuring that employees are given training and made aware of the prescribed safety procedures relating to the use of PPE.
- auditing compliance to the PPE programs on a yearly basis
- ensuring that the PPE programs comply with the standards identified in this chapter

19.1.4 ILRI Laboratory Coordinator

- provides advice on the implementation of this policy and procedure.

- develops programs, makes recommendations, monitors and evaluates work places for compliance to this chapter

19.2 LABORATORY CLOTHING

There is a wide variety of designs and materials available for lab coats, gowns, coveralls, aprons, shoes, boots, etc. Choices will depend on the nature of the work and degree of hazard. For example, knee-length, closed lab coats are suitable for working in general lab areas while surgical gowns with back closures and knitted cuffs offer superior protection for working with highly infectious agents in containment labs.
Coveralls and waterproof rubber suits are worn when working with large animals allowing for disinfection when exiting from animal cubicles. Plastic or rubber aprons are worn for activities that may result in splashes of infectious agents or chemicals.

- laboratory clothing is not permitted outside of laboratory areas
- protective laboratory clothing must be provided for all visitors entering the laboratory areas
- contaminated clothing must be decontaminated before laundering; this can be accomplished by autoclaving (lab coats, gowns, coveralls) or disinfection (rubber suits); home laundering of contaminated clothing must not be done
- clothing requirements for staff entering containment facilities with animal pathogens must followed.

19.3 GLOVES

19.3.1 Gloves for Working with Biological Hazards

For working with biological hazards, glove choices include latex or vinyl. Generally, intact latex and intact vinyl provide equivalent barrier protection. Although these gloves are required to pass a performance leak test (water tightness test), both glove types have been found to contain pinholes. Latex gloves with tight wrists usually offer better protection than loose-fitting vinyl gloves that are not tight fitting over the cuffs of lab coats.

The use of latex gloves has been recognized as a cause of irritant and delayed allergic reactions (e.g., hives, a runny nose, conjunctivitis, life-threatening anaphylactic reaction). These reactions are thought to be due to naturally occurring latex proteins (commonly adsorbed on the glove powder). Alternatives to latex gloves include the use of hypo-allergenic non powdered gloves and latex-free gloves and liners.

- users must inspect gloves for cracks, tears and holes before wearing
- when donning gloves, ensure that the gloves fit so that no skin will be exposed
- gloves should be changed when visibly contaminated and as soon as possible after handling infectious agents; proper glove removal technique involves removing each glove without touching the outer contaminated surface
- hands should be washed after removing gloves (they can contain pinholes and therefore allow the passage of infectious agents directly onto the skin)
- The reusing gloves is generally not recommended

- latex and vinyl gloves do not provide protection from sharps and needles; a metal mesh glove(very fine mesh gloves allowing good dexterity is now available) can be worn underneath the latex or vinyl glove to provide protection

- for bioassay work involving animals, double gloving, with a very fine mesh glove worn underneath the latex/non latex glove may be used

19.3.2 Gloves for Working with Chemical Hazards

For working with chemical hazards, choose gloves which provide adequate resistance to permeation. See Appendix 1 for Chemical Resistance of Common Glove Materials. The following are examples of breakthrough times (hours) for various gloves' types.

- Nitrile - hydrochloric acid (>4); sulphuric acid (>1); xylene (>4); formaldehyde (>4); phenol (>8)

- Neoprene - hydrochloric acid (>4); sulphuric acid (>1); xylene (>4); phenol (>2)

- Butyl Rubber - hydrochloric acid (>8); phenol (>8)

- Natural Rubber - hydrochloric acid (>2); sulphuric acid (>1); xylene (>4); phenol <1)

- PVC - hydrochloric acid (>2); sulphuric acid (<1); xylene (>4); phenol (<1)

Note: breakthrough times will vary between manufacturers, glove thickness, manufacturing process, etc.

19.3.3 Gloves for Protection Against Cold, Heat, Puncture & Tear Resistance

Gloves are also used for protection from cold, heat, sharp edges and abrasions. Glove materials are rated for their abrasion, cut, heat, puncture and tear resistance.

- Nitrile - excellent abrasion, excellent flexibility, cut and puncture resistance;

- Neoprene - excellent resistance but moderate flexibility

- Butyl Rubber - moderate resistance to cuts and punctures; excellent heat resistance

- Natural Rubber - poor heat resistance, excellent resistance to cuts and punctures;

- PVC - moderate cut and puncture resistance

- Others - Kevlar offer excellent heat resistance; metal mesh gloves offer protection from sharp tools and knives; lead-lined gloves protect from radiation hazards; leather provides protection against sparks and rough abrasives

19.4 EYE AND FACE PROTECTION

Eye and face protection guard against splashing chemicals or pathogenic suspensions, flying particles, harmful light or other rays, and other harmful substances.

- safety glasses with side shields provide general eye protection; safety goggles offer superior eye protection from splashes
- face shields offer protection from splashes and flying particles; ideally, protective goggles should be worn underneath face shields
- protection selected must comply with acceptable international/local guidelines.

19.4.1 Wearing of Contact Lenses

The wearing of contact lenses in the laboratory has been studied recently by various organizations. The wearing of contact lenses does not provide protection against chemical hazards.

- **Chemical** - The wearing of contact lenses does not provide protection against chemical hazards. The wearing of contact lenses in the laboratory where chemicals are used is acceptable as long as approved protective eyewear is worn where a chemical eye hazard has been identified . An evaluation of the task shall be done to evaluate what type of changes to the process or protective eyewear is required to protect the employee.
- **Biological** - The wearing of contact lenses does not provide protection against biological or particulate hazards.
- inserting or removing contact lenses are not permitted in any laboratory; the wearing of contact lenses is permitted only when other forms of corrective eyewear are not suitable.
- In locations where the preceding statement does not apply, the wearing of contact lenses is acceptable, If there is a biological or particulate eye hazard in the laboratory, controls (protective eyewear, engineering controls) shall be implemented to eliminate any hazards to the eye.

19.5 FOOTWEAR

A job hazard analysis can be completed to help determine what type of footwear is needed for your laboratory and facility.

- Internationally acceptable/local guidelines must be followed when selecting protective footwear
- "suitable footwear with closed toes and heels must be worn in all laboratory areas."
- "open toed shoes and high heeled shoes are not allowed" for laboratories.
- the wearing of open toed and open heeled shoes are forbidden unless a job hazard analysis or other risk analysis method demonstrates that no hazard to the feet exists in the workplace; high heel shoes are forbidden for laboratory work

19.6 RESPIRATORY PROTECTION

Respiratory hazards include particulates (dusts, fumes, mists, radio nucleotides, and infectious agents), chemical vapors and gases, and oxygen deficient atmospheres (<19.5%).

Air purifying respirators provide protection from particulates and low concentrations of some hazardous vapors and gases. Appropriate cartridges must be attached to the respirator when in use (e.g., HEPA cartridges for infectious aerosols, Organic Vapor/Acid Gas cartridges for chemicals, or a combination HEPA/Organic/Acid Gas cartridge for all three hazards).

Air supplying respirators (self contained breathing apparatus [SCBA]; airline systems; protective ventilated suits) are required for oxygen-deficient atmospheres, or when toxic gases or vapors with poor odour warnings are present in dangerous concentrations (e.g., entry into manure pits, bio waste tanks).

- simple disposable paper masks do not provide adequate respiratory protection
- air purifying respirators with HEPA filter cartridges are suitable for protection from infectious aerosols (e.g., cleaning of a biological spill, working with infected livestock); powered air purifying respirators (PAPRs) provide a cooler, less exhausting environment and may be more suitable for strenuous work or for those who are required to wear a respirator for a long period of time
- chemical cartridges must be appropriate for the specific class of hazardous substances such as acid vapors, ammonia and amines, organic vapors, pesticides, etc.
- cartridges must be attached to the air purifying respirator during use
- cartridges can be combined on the respirator as required (e.g., HEPA with organic vapors)
- full-face respirators provide protection to the face and eyes and are preferable to half-face respirators which fit only over the nose and mouth
- respirators, cartridges, tanks, etc. must be maintained in accordance with manufacturers' recommendations.

19.6.1 Components of a Respiratory Protection Program

A job hazard analysis or similar risk assessment tool shall be used determine if there is a need for a respiratory program to be developed.

If a need for a respirator program exists then a respiratory protection program must comply with internationally acceptable/local requirement, be administered by a designated individual and contain the following elements:

- roles & responsibilities
- hazard assessment
- selection of the appropriate respirator
- respirator fit testing
- training
- use of respirators
- cleaning, inspection, maintenance, and storage of respirators
- health surveillance for respirator users

- program evaluation
- record keeping

19.7 HEARING PROTECTION

Each document outlines steps to take to undertake a hazard evaluation and hearing protection program. The basic steps are:

- **Hazard Evaluation** - the measurement of sound levels will determine if future controls are needed. Ideally equipment purchased must meet minimum noise standards to reduce the chance of sound levels being exceeded in the workplace. Noise Evaluations can be performed by the EOHS office.

- **Control of Hazard** - Reducing the sound levels at the source by engineering controls such as; replacing the equipment or using a baffles

- **Hearing Conservation** - If the types of controls mentioned above cannot be done then a hearing conservation program is put into place. This would involve the fit testing , wearing, maintenance of hearing protection and audiogram testing for the employee.

- **Warning Signs** - Areas where sound levels are above the 87dBA must post signage identifying the area as a hazardous area for noise.

Chemical Resistance of Common Glove Materials
(E: Excellent, G: Good, F: Fair, P: Poor)

Chemical	Natural Rubber	Neoprene	Nitrile	Vinyl
Acetaldehyde	G	G	E	G
Acetic Acid	E	E	E	E
Acetone	G	G	G	F
Acrylonitrile	P	G	-	F
Ammonium Hydroxide	G	E	E	E
Aniline	F	G	E	G
Benzaldehyde	F	F	E	G
Benzene[3]	P	F	G	F
Benzyl Chloride[3]	F	P	G	P
Bromine	G	G	-	G
Butane	P	E	-	P
Butylaldehyde	P	G	-	G
Calcium Hypochlorite	P	G	G	G
Carbon Disulfide	P	P	G	F
Carbon Tetrachloride[3]	P	F	G	F
Chlorine	G	G	-	G
Cloroacetone	F	E	-	P
Chloroform[3]	P	F	G	P
Chromic Acid	P	F	F	E
Cyclohexane	F	E	-	P
Dibenzyl Ether	F	G	-	P
Dibutyl Phthalate	F	G	-	P
Diethanolamine	F	E	-	E
Diethyl Ether	F	G	E	P
Ethyl Acetate	F	G	G	F
Ethylene Dichloride[3]	P	F	G	P
Ethylene Glycol	G	G	E	E
Ethylene Trichloride[3]	P	P	-	P
Fluorine	G	G	-	G
Formaldehyde	G	E	E	E
Formic Acid	G	E	E	E
Glycerol	G	G	E	E
Hexane	P	E	-	P

Table 6.2 (Continued)
Chemical Resistance of Common Glove Materials
(E: Excellent, G: Good, F: Fair, P: Poor)

Chemical	Natural Rubber	Neoprene	Nitrile	Vinyl
Hydrobromic Acid	G	E	-	E
Hydrochloric Acid	G	G	G	E
Hydrofluoric Acid	G	G	G	E
Hydrogen Peroxide	G	G	G	E
Iodine	G	G	-	P
Methyl Cellosolve	F	E	-	P
Methyl Chloride[3]	P	E	-	P
Methyl Ethyl Detone	F	G	G	P
Methylamine	G	G	E	E
Methylene Chloride[3]	F	F	G	F
Monoethanolamine	F	E	-	E
Morpholine	F	E	-	E
Naphthalene[3]	G	G	E	G
Nitric Acid	P	P	P	G
Perchloric Acid	F	G	F	E
Phenol	G	E	-	E
Phosphoric Acid	G	E	-	E
Potassium Hydroxide	G	G	G	E
Propylene Dichloride[3]	P	F	-	P
Sodium Hypochlorite	G	P	F	G
Sulfuric Acid	G	G	F	G
Toluene[3]	P	F	G	F
Trichloroethylene[3]	P	F	G	F
Tricresyl Phosphate	P	F	-	F
Triethanolamine	F	E	E	E
Trinitrotoluene	P	E	-	P

[3] Aromatic and halogenated hydrocarbons will attack all types of natural and synthetic glove materials

Reproduced from: Chemical Safety in the Laboratory. 1994. s.k. Hall (ed.). CRC Press, Florida.

20. CONFINED SPACES

20.1 DEFINITION

Confined space – means an enclosed or partially enclosed space that:

- is not designated or intended for human occupancy except for the purpose of performing work;
- has restricted means of access and egress; and
- may become hazardous to an employee entering it due to its design, construction, location or atmosphere,
- the materials or substances in it, or
- any other conditions relating to it.

Some examples of confined spaces are: manholes, sewers, boilers, tunnels, pipelines, wells, fuel tanks, ballast tanks, storage tanks, tank cars and tank trucks, vats process vessels, septic tanks, sewage lift stations, silos, boots in grain elevators, trenches, and ventilation and exhaust ducts. Although some of these are easily recognized as confined spaces, others may not be.

20.2 ROLES AND RESPONSIBILITIES

20.2.1 Duties of the Employee

- must participate in confined space training.
- must follow all confined space procedures outlined by the employer

20.2.2 Duties of the OHS Committee or Representative

- the procedures will be established in consultation with the OHS committee or representative
- at least one member of the OHS committee shall be trained in confined spaces.

20.2.3 Duties of the Employer

- before permitting any person to enter a confined space, to inspect, clean or carry out a maintenance work, an employer shall provide every employee who is likely to enter a confined space with instruction and training in entry and emergency procedures and the use of protective equipment.
- perform a hazard assessment as per 20.31

20.3 CLASS & HAZARDS OF CONFINED SPACE

"class of confined spaces" means a group of at least two confined spaces that are likely, by reason of their similarity, to present the same hazards to persons entering, exiting or occupying them.

Use the following criteria to identify a class of confined spaces:

- the confined spaces may be of similar size and shape;
- they may contain equipment and machinery that has the same or similar purpose and use;
- they may present similar hazards, such as:

    - restricted entry and exit;
    - probable exposure to the same or similar hazardous substances, such as : asphyxiates (these smoother people), explosive gases, biological hazards (these are harmful to human cells) ;
    - exposure to an oxygen-deficient atmosphere;
    - exposure to hazardous substances near or surrounding the confined space;
    - possible leaks from pipes, or water entering;
    - danger of drowning or being covered in flowing material;

the entry and/or emergency procedures can apply to every confined space in a class.

20.3.1 Hazard Assessment

Where a confined space or class of confined spaces has not been assessed, the employer shall appoint a qualified person to:

- Carry out an assessment of the physical and chemical hazard that the person who is entering the space may be exposed to;
- Specify the tests to determine if the person will be exposed to any danger;
- Submit a signed report of the findings to the employer.

The employer shall make a copy of the report for the safety and health committee or the safety and health representative.
The employer shall review the report at least every three years.

20.3.2 specific Hazards associated with Confined Spaces

Accident investigation reports show that accidents are caused when people are not well trained or informed about the hazards of entering confined spaces. Accident statistics suggest that about 50 percent of deaths in confined spaces have resulted from oxygen deficiency and that no testing was done in those cases.

In addition, more than half of those who die in confined spaces do so while trying to rescue their fellow workers.

There are four main dangers in confined spaces:

- Oxygen deficiency and oxygen enrichment;
- Fire and/or explosion;
- Toxicity;
- Drowning in liquids and/or entrapment in free flowing solids.

20.3.3 Ventilation Equipment

When ventilation is used in a confined space the employer shall not grant access to any person unless the ventilation equipment is:

- equipped with an alarm
- monitored by an employee

20.4 OXYGEN DEFICIENCY AND ENRICHMENT

Many deaths in confined spaces are caused by lack of oxygen. The only way to be sure there is enough oxygen is to carefully test with an oxygen monitor **before you go in and, if the hazard assessment states that it is necessary, while you are working in the space.**

There are two main causes of oxygen deficiency:

- oxygen is displaced by gases such as nitrogen, an inert gas introduced to displace flammable gases when purging vessels in preparation of hot work;
- explosions or fires (oxygen levels may stay dangerously low long after the fire is out because the oxygen is replaced by the products of combustion);
- chemical reactions such as rusting of metal;
- people working in the space and using up oxygen as they breath.

What are the effects of reduced oxygen levels?

Normal air has approximately 21 percent oxygen by volume at normal atmospheric pressure.

- At 16 per cent oxygen your judgment and breathing are impaired and you are quickly exhausted.
- At 12 percent you become unconscious and will die unless removed to fresh air.
- At 6 percent you have difficulty breathing and will die in seconds.

WARNING!
Be sure the confined space gas been tested fully before you enter. Continue to test, if necessary, while you are working there. If the required air quality cannot be maintained, wear the prescribed breathing apparatus.

20.4.1 Oxygen Enrichment

What happens when the level of oxygen is high?

An oxygen-enriched atmosphere contains more than 23 percent oxygen by volume. This will cause flammable materials, such as clothing and hair, to burn violently when ignited. **Never** use pure oxygen to ventilate a confined space, since an oxygen-enriched atmosphere is a fire and explosion hazard.

20.5 FIRES AND EXPLOSIONS

Combustible gases have an explosive range with **a lower explosive limit (LEL)** and an **upper explosive limit (UEL).** When the fuel and air mixture is below the LEL, or above the UEL, ignition will not take place. A gas is combustible only between its LEL and UEL. For example, Methane is combustible only when mixed with air in a concentration between 5 percent and 15 percent.

Other combustible gases have different characteristics. Some have a wider range between their upper and lower explosive limit, making them even more dangerous.

Fires and explosions are serious dangers in confined spaces. Chemicals, poor ventilation, static electricity, or machinery may contribute to explosions or fires.

20.5.1 Hot Work

"Hot work" means any work where flame is used or a source of ignition may be produced.

Unless a qualified person has determined that the work can be performed safely, hot work shall not be performed where there are concentrations of explosive or flammable hazardous substances that do not meet the prescribed standards.

If hot work is to be performed where concentrations of explosive or flammable hazardous substances exist, a qualified person shall:

- patrol the area surrounding the confined space;
- maintain afire protection watch;
- provide fire extinguishers.

Where airborne hazards are produced by the hot work, no person shall enter or occupy the confined space unless equipped with a prescribed respiratory protection device.

20.5.2 Toxicity

Toxic (poisonous) gases present two kinds of risk in a confined space:

- chemical asphyxiation (smothering)
- irritation to respiratory system, the skin and eyes.

Some toxic gases that are especially dangerous in confined spaces:

Hydrogen Sulphide (H_2S), a by-product of sewage treatment, petroleum, and other industrial processes, may be encountered in mines, gas wells, sewers, and similar installations. Since hydrogen sulphide is heavier than air, it collects in low places. In low concentrations, H_2S smells like rotten eggs. However, this gas quickly deadens the sense of smell, leading to a false sense of security. **Always remember, high concentrations of H_2S are fatal.**

Methane (CH4) is highly explosive. It can leak from a gas line and is a by-product of sewage. It is also found in coal mines. Since methane displaces oxygen, it can smother workers.

Sulphur dioxide(SO_2) is colorless but has a strong smell. It is poisonous in small amounts.

Carbon monoxide (CO) is a colorless, odourless, tasteless and deadly gas. It is a product of incomplete combustion, and a common source is internal combustion engines. Overexposure may cause ringing in the ears, nausea, headache and sleepiness. Carbon monoxide may be fatal in very low concentrations.

REMEMBER! Engine exhaust gases contain carbon monoxide, carbon dioxide, and other harmful gases. Keep them away from openings of confined spaces where people are working.

TEST CAREFULLY FOR TOXIC GASES BEFORE ENTERING A CONFINED SPACE

WARNING! One of the biggest mistakes you can make is to ignore or not believe your test equipment. If a gas detector alarm sounds, **get out** even if you don't notice anything wrong.

Test equipment is designed to detect hazardous conditions long before you can. It can save tour life!

Do not enter a confined space if your employer has not had a qualified person establish entry procedures for the confined space or class of confined spaces and if you have not been trained in these procedures and in the use of any testing or safety equipment to be used in the confined space.

20.5.3 Drowning in Liquids of Entrapment in Free-flowing Solids

Some examples are: water in a tank; in a silo; earth falling into a trench or excavation.

20.6 CONFINED SPACE ENTRY

When a person is about to enter a confined space, the employer shall appoint a qualified person to verify: by tests, that compliance can be achieved for the period that the person will be in the confined space; that all free flowing solids and liquids have been removed.

A Good Rule to Follow:

If you can't test,
If you cant ventilate,
If you don't have breathing apparatus,
If you don't have an entry procedure…
then don't enter!

The qualified person shall submit a signed report notifying the employer of the results of the verification, including the test methods, test results, and the equipment used.

The employer shall make a copy of the report available to the safety and health committee or safety and health representative.

20.7 EMERGENCY PROCEDURES & EQUIPMENT

When conditions in a confined space cannot be complied with, the employer shall:

- consult with the safety and health committee or representative to establish emergency procedures;
- provide protective equipment;
- ensure that a qualified person trained in the entry and emergency procedures is in attendance outside the confined space;
- provide the qualified person with a suitable alarm for summoning assistance;
- ensure that two or more persons are in the immediate vicinity of the confined space to assist in the event of the emergency;
- ensure that the person in the confined space is wearing an appropriate safety harness that is attached to a secure anchor outside the confined space and attached to a mechanical lifting device; and
- keep records.

If you notice changes in you feel, get out of the confined space! A few seconds can be the difference between life and death. Workers die in the short time it takes to pick up a tool from the bottom of a tank. Wear the prescribed respirator and personal protective equipment only if you have been trained in their use and if the employer has taken all the necessary safety measures.

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20 - CONFINED SPACES

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GLOSSARY

ABSOLUTE PRESSURE:

The total pressure within a vessel, pipe, etc., not offset by external atmospheric pressure.

ABSORPTION:

To take in and make a part of an existing whole. The penetration of a solid substance by a liquid as by capillary, osmotic, solvent or chemical action.

ACCIDENT:

An undesired event that results in harm to people, damage to property or loss to process.

ACID:

Any chemical which undergoes dissociation in water with the formation of hydrogen ions. Acids have a sour taste and may cause severe burns. They turn litmus paper red and have ph values of 0 to 6. Acids will neutralize bases or alkaline media. Acids will react with a base to form a salt.

ACTION LEVEL:

Exposure level at which regulations to protect employees takes effect. Exposure at or above the action level is termed occupational exposure. Exposure below this level can also be harmful.

ACUTE EFFECT:

Adverse effect on a human or animal body, that takes place soon after exposure.

ADSORB:

Collect gas or liquid molecules on the surface of another material.

AEROSOL:

Fine aerial suspension of liquid (mist, fog) or solid (dust, fume, smoke) particles small enough to be stable.

ALKALI:

Any chemical substance which forms soluble soaps with fatty acids. Alkalis are also referred to as bases. May cause severe burns to the skin. Alkalis turn litmus paper blue and have pH values from 8 to 14.

ALLERGIC REACTION:

Abnormal physiological response to a chemical stimuli by a sensitive person.

AMBIENT:

Usual or surrounding conditions.

ANHYDROUS:

No water. Substance in which no water molecules are present as hydrate or as water crystallization.

AQUEOUS:

Water-based solution or suspension. Frequently, a gaseous compound dissolved in water.

ASPHYXIA:

Lack of oxygen and interference with the oxygenation of the blood. Can lead to unconsciousness.

ASPHYXIANT:

A vapour or gas which causes unconsciousness or death by suffocation. Most simple asphyxiants are harmful to the body only when they become so concentrated that they reduce oxygen in air (normally 21%) to dangerous levels (16% or lower). Asphyxiation is a potential hazard of working in confined spaces. Some examples of asphyxiants are Carbon Dioxide, Carbon Monoxide, Argon, etc. They function as asphyxiants by reducing the blood's ability to carry oxygen.

ATMOSPHERE (atm.):

Pressure measurement. One atmosphere (atm) = 14.7 lbs/sq in.

AUTOIGNITION TEMPERATURE:

Minimum temperature at which a substance will self ignite without a source of ignition such as flame or spark.

BASE:

Substances that (usually) liberate OH anions when dissolved in water. Bases react with acids to form salts and water. Bases have a pH greater than 7, turn litmus paper blue, and may be corrosive to human tissue. A strong base is called alkaline or caustic.

BENIGN:

Not recurrent or not tending to progress. Not cancerous.

BIOLOGICAL EXPOSURE INDEXES (BEI):

Numerical values based on procedures to determine the amount of a material absorbed into the human body by measuring it or its metabolic products in tissue, fluid or exhaled air.

BIOLOGICAL MONITORING:

Periodic examination of body substances, such as blood or urine, to determine the extent of hazardous material absorption as opposed to mere exposure.

BOILING POINT (BP):

Temperature at which a liquid changes to a vapour state at a given pressure. Flammable materials with low boiling points generally present special fire hazards.

BRITISH THERMAL UNIT (BTU):

Quantity of heat required to raise the temperature of 1 pound of water 1 degree F at

39.2F, its temperature of maximum density.

BUFFER:

Substance that reduces the change in hydrogen ion concentration (pH) that otherwise would be produced by adding acids or bases to a solution.

CARBON DIOXIDE:

(CO2) heavy, colourless gas produced by combustion and decomposition of organic substances and as by-product of chemical processes. Will not burn, relatively non-toxic, and unreactive. Can cause oxygen deficient environments in large concentrations. Is useful as fire-extinguishing agent to block oxygen and smother fire.

CARBON MONOXIDE:

(CO) colourless, odourless, flammable, and very toxic gas produced by the incomplete combustion of carbon compounds and as a by-product of many chemical processes. A chemical asphyxiant, it reduces the blood's ability to carry oxygen.

CARCINOGEN:

Substance or agent capable of causing or producing cancer in mammals.

(CAS) CHEMICAL ABSTRACTS SERVICE NUMBER:

An assigned number used to identify a chemical. CAS stands for Chemical Abstracts Service, an organization that indexes information published in Chemical Abstracts by the American Chemical Society and that provides index guides by which information about particular substances may be located in the abstracts. Sequentially assigned CAS numbers identify specific chemicals, except when followed by an asterisk(*) which signifies a compound (often naturally occurring) of variable composition. the numbers have no chemical significance. The CAS number is a concise, unique means of material identification.

CATALYST:

Substance that modifies a chemical reaction (makes it faster or slower) without being consumed.

CAUSTIC:

See Alkali

CEILING:

See Exposure Limit

CEPA 1999:

Canadian Environmental Protection Act 1999. Canada's most significant environmental legislation encompassing pollution prevention and the protection of the environment and human health.

CHELATING AGENT:

Chemical compound capable of forming multiple chemical bonds to a metal ion. Used to treat metal poisoning.

CHEMICAL:

Any element, chemical compound, or mixture of elements and/or compounds.

CHEMICAL FAMILY:
Group of single elements or compounds with a common general name.

CHEMICAL FORMULA:
Gives the number and kinds of atoms that comprise a molecule of a material.

CHEMICAL NAME:
Scientific designation of name that clearly identifies chemical for hazard evaluation purposes.

CHEMICAL REACTIVITY:
Ability of a material to chemically change. Undesirable and dangerous effects such as heat, explosions, or the production of noxious substances can result.

CHRONIC EFFECT:
Adverse effect on a human or animal body with symptoms that develop slowly over a long period of time or that recur frequently.

CHRONIC EXPOSURE:
Long-term contact with a substance.

COMBUSTIBLE:
See Flammable

COMMON NAME:
Designation for material other than chemical name, such as code, trade, brand, or generic name.

CONCENTRATION:
Relative amount of a substance when combined or mixed with other substances.

CONFINED SPACE:
An enclosed or partially enclosed space that is not designed or intended for human occupancy (except for the purpose of performing work), has restricted means of access and egress and may become hazardous to an employee entering due to it's design, construction, location, atmosphere, the materials/substances in it or other conditions.

CORROSIVE:
Liquid or solid that causes visible destruction or irreversible alterations in tissue at site of contact, or, in the case of leakage from its packaging, liquid that has severe corrosion rate on steel.

CRITICAL PRESSURE/TEMPERATURE:
Temperature above which a gas cannot be liquefied by pressure. The critical pressure is that pressure required to liquefy a gas at its critical temperature.

CUTANEOUS:
Pertaining to the skin.

DANGEROUSLY REACTIVE MATERIAL:

Material that can react by itself or with water/air producing hazardous condition.

DIKE:

A barrier constructed to control or confine hazardous substances and prevent them from entering sewers, ditches, streams, or other flowing waters.

DISTRIBUTOR:

A business, other than a chemical manufacturer or importer, which supplies hazardous chemicals to other distributors or to employers.

ENDOTHERMIC:

A chemical reaction that absorbs heat.

EMPLOYEE:

Under the Canada Labour Code (CLC), Part II, the term means a person employed by the employer. It is important to note that under this legislation "employee" could include, and apply to, more persons in an employment relationship with a department or agency than those that are traditionally considered to be employees of the Public Service.

EMPLOYER:

Under the Canada Labour Code (CLC), Part II, this term means a person who employs one or more employees and includes an employers' organization and any person who acts on behalf of an employer. In the Public Service context the term includes an agency acting on behalf of the Treasury Board, a department or any person who acts in a supervisory or managerial capacity on behalf of a department

ERGONOMICS:

Study of human characteristics for the appropriate design of living and work environments.

EVAPORATION RATE:

Rate at which a particular material will vaporize when compared to the rate of vaporization of a known material. Evaporation rate can be useful in evaluating the health and fire hazards of a material.

EXPLOSIVE:

Material that produces a sudden, almost instantaneous release of pressure, gas, and heat when subjected to abrupt shock, pressure, or high temperature.

EXPOSURE OR EXPOSED:

State of being open and vulnerable to a hazardous chemical by inhalation, ingestion, skin contact, absorption, or any other course; includes potential (accidental or possible) exposure.

EXPOSURE LIMIT (EL):

The concentration a chemical in the workplace to which most people can be exposed without experiencing harmful effects. The American equivalent is THRESHOLD LIMIT VALUE (TLV). ELs or TLVs are expressed in 3 ways:

C: Ceiling limit, concentration that should not be exceeded at any time.

STEL: Short term exposure limit, average concentration to which workers may be exposed during intervals of up to 15-minutes without experiencing irritation or irreversible effects.

TWA: Time-weighted average, concentration for a normal 8-hour work day or 40-hour work week to which workers may be exposed without harmful effects.

FOOTWEAR:

Footwear suitable for the laboratory must meet the following criteria:
a) to be secure on the foot
b) provide solid, stable footing
c) should have non slip soles
d) provide coverage of the foot as protection against chemical and biological spills and dropped objects

In certain cases, the hazards present in the work area may require that CSA approved safety footwear be worn. Sandals, open-toed shoes and high heels are inappropriate footwear for laboratory areas. In addition, footwear in Level 3 laboratories should require minimum or no handling to put on and take off, be liquid resistant (not necessarily liquid proof) and wipeable (i.e. not open mesh or gauze).

FLAMMABLE:

The ability to ignite and burn readily. Under the Canadian Controlled Products Regulations (part of WHMIS) and the U.S. HAZCOM Standard, there are specific technical criteria for identifying flammable materials. There are closely related criteria for the classification of certain flammable materials under the Canadian Transportation of Dangerous Goods regulations and the US Department of Transportation regulations. In Canada, local, provincial and national fire codes also classify and regulate the use of flammable materials in the workplace.

FLAMMABLE GAS:

A flammable gas is a gas which can ignite readily and burn rapidly or explosively. Under the Canadian Controlled Products Regulations , part of the national Workplace Hazardous Materials Information System (WHMIS), and under the US Hazard Communication Standard, there are certain technical criteria for the identification of materials as flammable gases for the purposes of each regulation.

FLAMMABLE LIQUID:

A flammable liquid gives off a vapour which can be readily ignited at normal working temperatures. Under the Canadian Controlled Products Regulations (part of WHMIS), a flammable liquid is a liquid with a flash point (using a closed cup test) below 37.8 degrees C (100 degrees F). The US Hazard Communication Standard uses a similar, but not identical, definition.

FLAMMABLE SOLID:

A flammable solid is a material which can ignite readily and burn vigorously and persistently. There are certain technical criteria in the Canadian Controlled Products Regulations (part of WHMIS) and in the US OHSA Hazard Communication Standard for the identification of flammable solids for the purposes of each regulation. These criteria are based on ease of ignition and rate of burning. Flammable solids may be hazardous

because heat from friction (for example, surfaces rubbing together) or heat from processing may cause a fire. Flammable solids in the form of a dust or powder may be particularly hazardous because they may explode if ignited.

FLASH BACK:

Occurs when a trail of flammable material is ignited by a distant spark or ignition source. The flame then travels along the trail of the material back to its source.

FLASH POINT:

Temperature at which a liquid will give off enough flammable vapour to ignite. Lower flash points indicate greater risk of fire.

GROUNDING:

Safety practice to conduct electrical charge to ground, preventing igniting sparks of a material.

HAZARDOUS DECOMPOSITION:

Breaking down or separation of a substance into its constituent parts, elements, or into simpler compounds accompanied by the release of heat, gas, or hazardous materials.

HAZARDOUS MATERIAL:

Any substance or mixture of substances having properties capable of producing adverse effects on the health or safety of a human being.

HAZARDOUS OCCURRENCE:

An unexpected or unplanned event where personal injury or property damage has or could have occurred. This includes the definitions of accident, incident, near miss, occupational illness or injury and environmental spills/releases.

HAZARDOUS OCCURRENCE INVESTIGATION:

The determination of the facts of a hazardous occurrence by inquiry, observation, and examination, an analysis of these facts to establish the causes of the hazardous occurrence and the measures that must be adopted to prevent its recurrence.

HVAC:

Acronym for Heating, Ventilation and Air Conditioning System.

HYGROSCOPIC:

Readily adsorbing available moisture in any form.

IGNITION TEMPERATURE:

Lowest temperature at which a combustible material will catch fire in air and will continue to burn independently of the initial source of heat.

IMPERVIOUS:

Material that does not allow another substance to pass through or penetrate it.

INCIDENT / NEAR MISS:

An unexpected event that did not cause injury or damage, but had the potential to. It is a "significant near miss" when the loss potential is sufficient enough to trigger use of the Hazardous Occurrence Reporting Form & Procedures.

INCOMPATIBLE:

Materials which could cause dangerous reactions from direct contact with one another.

INERT INGREDIENTS:

Anything other than the active ingredient in a product; not having active properties.

INGESTION:

Taking in of a substance through the mouth.

INHALATION:

Breathing in of a substance in the form of a gas, vapour, fume, mist, or dust.

INORGANIC MATERIALS:

Compounds derived from sources other than vegetable or animal; generally do not contain carbon atoms.

INSOLUBLE:

Incapable of being dissolved in a liquid.

IRRITANT:

Substance which, by contact in sufficient concentration for a sufficient period of time, will cause an inflammatory response or reaction of the eye, skin, or respiratory system.

LABEL:

Any written, printed, or graphic sign or symbol displayed on or affixed to containers of hazardous chemicals. Labels may be from the suppliers or made in the workplace. Requirements of WHMIS specify what information must be on a product label. Typically labels must include the material, appropriate hazard warnings, and name and address of the chemical manufacturer, importer, or other responsible party and recommended PPE.

LC50:

Lethal concentration 50, median lethal concentration. The concentration of a substance that when administered by inhalation is expected to cause the death of 50% of a defined animal population; usually a single exposure in a specific time period. LC50 is expressed as parts of material per million parts of air, by volume (ppm) for gases and vapours, as micrograms of material per litre of air (ug/L), or milligrams of material per cubic meter of air (mg/m3) for dusts and mists, as well as for gases and vapours.

LD50:

Lethal dose 50. The single dose of a substance that, when administered by a particular route of entry, is expected to cause the death of 50% of an animal population from exposure. LD50 is usually expressed as milligrams or grams of material per kilogram of animal weight (mg/kg or g/kg).

MELTING POINT:

Temperature at which a solid substance changes to a liquid state. For mixtures, a melting range may be given.

MUTAGEN:

Substance or agent capable of altering the genetic material in a living cell.

NEAR MISS:

See Incident

NEUTRALIZE:

To render chemically harmless; to return the pH to the neutral level of 7.

ODOUR:

Description of the smell of the substance.

ODOUR THRESHOLD:

Lowest concentration of a substance's vapour in air that can be smelled.

OPEN TRANSFER:

Any transfer that, at any time, involves contact of a moving fluid with the atmosphere, air, or oxygen. Open transfer of flammable liquids is dangerous due to the release of flammable vapours into the work area. Since there is a risk of fire or explosion if an ignition source is present, do these transfers only in a hood.

OXIDATION:

Reaction in which a substance combines with oxygen provided by an oxidizer or oxidizing agent. An oxidation reaction is always accompanied by an offsetting reduction reaction in which oxygen is removed from a compound or atoms, molecules, or ions gain electrons.

OXIDIZER:

Substance that yields oxygen readily to stimulate the combustion of organic matter.

OXIDIZING AGENT:

Chemical or substance that brings about an oxidation reaction.

PARTICULATE:

Small, separate pieces of an airborne material. Generally, anything that is not a fibre and has an aspect ratio of 3 to 1.

PARTS PER MILLION (PPM):

Unit for measuring concentration of a gas or vapour in air. Parts of the gas or vapour in a million parts of air. Also used to indicate the concentration of a particular substance in a liquid or solid.

PERCENT VOLATILE:

Percent volatile by volume is the percentage of a liquid or solid (by volume) that will evaporate at an ambient temperature or other specified temperature. The percent volatile can vary from 0%, meaning none of the material will evaporate, to 100% volatile, meaning all of the material will evaporate if given enough time. Butane and gasoline are two examples of solvents that are 100% volatile; their individual evaporation rates vary, but in time, each will evaporate completely.

PERSONAL PROTECTIVE EQUIPMENT (PPE):

Devices or clothing worn to help isolate a worker from direct exposure to hazardous

materials. Examples include gloves and respirators. Recommended PPE is often indicated on the MSDS.

pH:

Scale of 0 to 14 representing acidity or alkalinity of aqueous solution. Pure water has pH of 7. Substance in aqueous solution will ionize to various extent giving different concentrations of H+ and OH- ions.

PHYSICAL HAZARD:

Means a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water reactive.

PHYSICAL STATE:

A description of the condition of a material (solid, liquid, or gas) at room temperature.

POISON:

Any substance that is injurious to health and may lead to death when relatively small amounts are taken either internally or externally. Under the Canadian Controlled Products Regulations, a poisonous and Infectious Material is any material which meets the criteria for a "Material Causing Immediate and Serious Toxic Effects", a "Material Causing Other Toxic Effects", or a "Bio-hazardous Infectious Material".

PRODUCT IDENTIFICATION NUMBER:

Four-digit number, prefaced by UN or NA, used in Canada under the Transportation of Dangerous Goods Regulations for use by emergency personnel to identify a material in the event of an accident.

QUALIFIED PERSON:

A person deemed capable of performing a specified duty or task safely and properly because of acquired knowledge, training and experience.

REACTION:

Chemical transformation or change; interaction of two or more substances to form new substance.

REACTIVE MATERIAL:

Chemical substance or mixture that will vigorously polymerize, decompose, condense, or become self-reactive due to shock, pressure, or temperature. Includes explosive materials, organic peroxides, pressure-generating materials, and water-reactive materials.

REACTIVITY:

Tendency of a substance to undergo chemical reaction with the release of energy.

RECOMMENDED EXPOSURE LIMIT:

The highest allowable airborne concentration that is not expected to injure a worker. Expressed as a ceiling limit or as a time weighted average, usually for 10-hour work shift.

REDUCING AGENT:

Substance that combines with oxygen or loses electrons to the reaction during a reduction reaction.

RESPIRATOR/ RESPIRATORY PROTECTION:

Devices that will protect the wearer's respiratory system from overexposure by inhalation to airborne contaminants. Respiratory protection is used when a worker must work in an area where he/she might be exposed to concentration in excess of the allowable exposure limit. Examples include AIR-LINE RESPIRATORS which actively deliver air from a compressed breathable source, CHEMICAL CARTRIDGE RESPIRATORS which use various chemical substances to purify inhaled air of specific contaminants, and Self Contained Breathing Apparatus (SCBA)

RESPONSIBLE PARTY:

Someone who can provide additional information on the hazardous chemical and appropriate emergency procedures, if necessary.

ROUTES OF ENTRY:

Means by which material may gain access to the body (inhalation, ingestion, skin contact).

SENSITIZATION:

The development, over time, of an allergic reaction to a substance. The allergic reaction becomes more severe with each subsequent exposure.

SOLVENT:

Substance, usually liquid, in which other substances are dissolved. Water is the most common solvent.

SPECIFIC GRAVITY:

Ratio of the density of a material to the density of water.

STABILITY:

Ability of a material to remain unchanged. A material is stable if it remains in the same form under expected and reasonable conditions of storage or use.

TERATOGEN:

A substance which can cause birth defects.

TOXICITY:

Sum of adverse effects resulting from exposure to a material, generally by the mouth, skin, or respiratory tract. Adverse effects resulting from repeated doses of or exposures to a material over a relatively prolonged period of time indicate chronic toxicity, while acute toxicity refers to adverse effects resulting from a single dose of or exposure to a substance.

TOXIC SUBSTANCE:

Toxic means able to cause harmful health effects. As defined by CEPA 1999, a substance is toxic if it is entering or may enter the environment in a quantity or concentration or under conditions that 1) have or may have an immediate or long-term harmful effect on the environment or its biological diversity; 2) constitute or may

constitute a danger to the environment on which life depends; or 3) constitute or may constitute a danger in Canada to human life or health." (Section 64). If a substance is found to be toxic, it is recommended for inclusion on the List of Toxic Substances (CEPA 1999, Schedule 1).

TRADE NAME:

Trademark name or commercial trade name for a material given by the manufacturer.

UPPER EXPLOSIVE (FLAMMABLE) LIMIT (UEL):

Highest concentration (highest percentage of the substance in air) that will produce a flash of fire when an ignition source (heat, electric arc, or flame) is present.

UNSTABLE:

Tending toward decomposition or other unwanted chemical change during normal handling or storage.

VAPOUR:

Gaseous state of a material suspended in air that would be a liquid or solid under ordinary conditions.

VAPOUR DENSITY:

Weight of vapor or gas compared to an equal volume of air; expression of the density of the vapor or gas.

VAPOUR PRESSURE:

Pressure exerted by a saturated vapor above its liquid in a closed container. It is a measure of the tendency of a material to form a vapor. The higher the vapor pressure, the higher the vapor concentration.

VENTILATION:

Refers to the movement of air, typically the circulation of fresh air to replace contaminated air.

VISCOSITY:

Tendency of a fluid to resist internal flow without regard to its density.

VOLATILITY:

Measure of how quickly a substance forms a vapor at ordinary temperatures.

WATER REACTIVE:

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

WORK AREA:

A room or defined space in a workplace where hazardous chemicals are produce or used, and where employees are present.

WORKPLACE:

Any place or establishment containing one or more work areas where an employee is engaged in work for their employer. The workplace follows' the employee wherever he or she may be while engaged in work for the employer.

WORKPLACE HAZARDOUS MATERIALS IDENTIFICATION SYSTEM (WHMIS):

A Canadian system developed to protect workers by providing information about hazardous materials in the workplace. It addresses controlled products, labeling, information disclosure and worker education. WHMIS is implemented by a series of federal, provincial and territorial acts and regulations.