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Handbook of Occupational Hazards and Controls for Laboratory Workers

Government of Alberta

Credits

This document has been developed by the Government of Alberta and derived as a profession-specific summary of information contained in the five volumes of Best Practices in Occupational Health and Safety in the Health Care Industry. Full text of these documents can be found at http://www.employment.alberta.ca/SFW/6311.html

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Introduction

As part of the Alberta Healthcare Initiative, a series of Best Practice documents were produced by Alberta Employment and Immigration – Workplace Health and Safety to better acquaint healthcare workers with workplace hazards and appropriate control measures. Five documents have been produced; each developed with the input of a multidisciplinary stakeholder group. The documents are available on the Alberta Employment and Immigration website http://www.employment.alberta.ca/SFW/6311.html as follows:

Overview of Best Practices in Occupational Health and Safety in the Healthcare Industry Vol. 1
http://www.employment.alberta.ca/documents/WHS/WHS-PUB_bp009.pdf

Best Practices for the Assessments and Control of Biological Hazards Vol. 2
http://www.employment.alberta.ca/documents/WHS/WHS-PUB_bp010.pdf

Best Practices for the Assessments and Control of Chemical Hazards, Vol. 3
http://www.employment.alberta.ca/documents/WHS/WHS-PUB_bp011.pdf

Best Practices for the Assessments and Control of Physical Hazards, Vol. 4

Best Practices for the Assessments and Control of Psychological Hazards, Vol. 5

In an effort to focus the hazard assessment and control information for specific healthcare professions, a series of short summaries of relevant information have been produced using excerpts from the five best practice documents. Readers are directed to the original documents for more details and more comprehensive information. *Please note that hyperlinks are provided to reference documents for the convenience of the reader. These links are functional at the time of first availability of this document but, due to the changing nature of web information, may not be functional at a later date. The Government of Alberta does not assume responsibility for updating hyperlinks.*

This document focuses on hazards and controls in laboratories and is applicable for both diagnostic and many research laboratories.

Hazard Assessment Process

Laboratory workers may be exposed to a variety of workplace hazards in the course of performing their functions. The type and degree of exposure is dependent upon the type of laboratory and its location. A key component of a health and safety program is to identify and assess hazards and determine appropriate controls. A systematic approach to hazard assessment includes the following steps:

1. List all work-related tasks and activities.
2. Identify potential biological, chemical, physical and psychological hazards associated with each task.
3. Assess the risk of the hazard by considering the severity of consequences of exposure, the probability that the exposure will occur and the frequency the task is done.
4. Identify the controls that will eliminate or reduce the risk. The hierarchy of controls should be followed. This means that engineering controls are the most effective, followed by administrative controls (such as training and rules), followed by personal protective equipment (PPE).
5. Implement the controls for each hazard.
6. Communicate the hazard assessments and required controls to all workers who perform the tasks.
7. Evaluate the controls periodically to ensure they are effective.

Potential Hazards and Recommended Controls

The following charts summarize potential hazards for laboratory workers and recommended controls to reduce the risk of exposure to the hazards.

Biological Hazards and Controls

In this section the most commonly encountered biological hazards and methods to control them in laboratories are presented. Employers should carefully evaluate the potential for exposure to biohazardous materials in all tasks and ensure that they have an effective hazard control plan in place. This information will be useful for inclusion into hazard assessments. Please note, this is not designed to be an exhaustive treatment of the subject, but is rather an overview summarizing the most frequently encountered biological hazards in diagnostic laboratories.

Note:
The following chart provides basic information about control strategies for commonly occurring biological hazards. Administrative controls include Routine Practices that are to be used as a minimum and Additional Precautions as warranted based on the risk assessment. Worker education and good communication processes are also critical administrative controls. Any PPE selected must be based upon the risk assessment of the task and the environment in which it is used. All legislation related to the selection and use of controls must be followed.

Potential Biological Hazards	Summary of Major Control Strategies		
	Engineering	Administrative	PPE
Exposure to bloodborne pathogens through needle stick, glass slides, tubes, pipettes or other sharps injuries	Engineered needle stick prevention devices. Elimination of use of any unnecessary sharps. Avoid using glass products whenever possible. Availability of sharps containers for disposal. Vaccines.	Compliance with all infection prevention and control practices. Immunization program. Worker education.	Gloves, protective clothing, eye and face protection.
Exposure to bloodborne pathogens through contaminated items and surfaces, exposure to mucous membranes	Vaccines.	Compliance with all infection prevention and control practices. Immunization program. Worker education.	Gloves, protective clothing, eye and face protection.
Exposure to airborne biological agents through contact with secretions from infectious patients	Early detection of infection status. Isolation.	Compliance with all infection prevention and control practices. Immunization program. Worker	PPE based on the risk assessment may include gloves, respiratory

(coughing, sneezing, etc.) or air contaminated with infectious biological agents		education.	protection, eye and face protection and other protective clothing.
Exposure to droplets containing infectious biological agents through contact with patient secretions or contaminated environmental surfaces or equipment	Use of biosafety cabinets for handling patient samples. Early detection of infection status.	Good housekeeping practices. Compliance with all infection prevention and control practices. Spill response procedures. Worker education.	PPE based on the risk assessment may include gloves, respiratory protection, eye and face protection and other protective clothing.
Exposure to biological hazards through specimen accessioning and laboratory testing procedures that generate aerosols	Automated systems where possible. Aerosol reduction equipment, including use of centrifuge carriers with lids. Use of biosafety cabinets. Vaccines.	Training in and enforcement of safe work practices. Designation of clean/contaminated areas or equipment. Immunization program.	PPE based on the risk assessment may include protective clothing, gloves, respiratory protection, eye and face protection.
Exposure to concentrated doses of biological agents	Use of biosafety cabinets. Appropriate containment level facilities. Aerosol reduction equipment. Vaccines.	Aerosol reduction procedures. Training in and enforcement of safe work practices. Immunization program. Worker education.	PPE based on the risk assessment may include protective clothing, gloves, respiratory protection, eye and face protection.
Exposure to pathogens present in tissues	Appropriate containment level facilities. Local exhaust ventilation for grossing. Appropriate autopsy room ventilation.	Training in and enforcement of safe work practices.	PPE based on the risk assessment may include protective clothing, gloves, respiratory protection, eye and face protection.
Exposure to environmental biological contaminants from ventilation systems, water or food	Maintenance of ventilation systems. Early spill clean-up. Preventive maintenance of ventilation systems and water supply systems with regular testing to ensure proper functioning. Early detection and remediation of mould.	Infection prevention and control practices related to building maintenance and food preparation. Protocols for construction and renovation projects that reduce contamination. Worker education.	Use of proper PPE when cleaning contaminated environmental surfaces, including gloves, respiratory protection, and eye protection.

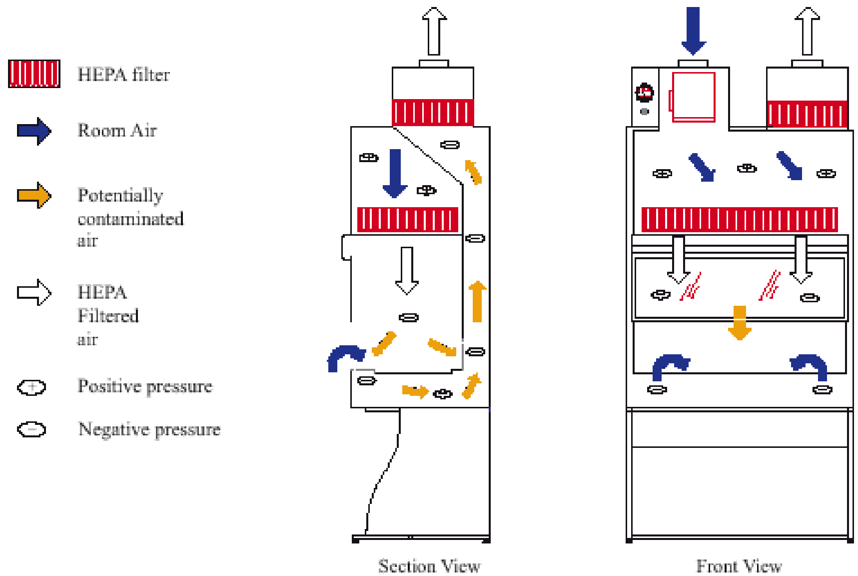
Notes about controls for biological hazards

Engineering Controls

In the hierarchy of controls, the highest level of control is directed at the source. Typically, for patient related infectious disease, this means isolation of the patient and precautions related to handling blood and body fluids of the patient, as well as biological waste handling procedures. From an occupational health perspective, the highest level of control may be immunization of workers who may come in direct contact with infected patients. Good engineering controls such as vaccines, proper ventilation, needleless systems, safety engineered sharps, biological safety cabinets, and effective biological waste containment also contribute to minimizing the transmission of infectious agents. Engineering controls, once designed and implemented, are not under the control of the worker, but are directed at the source of the hazard.

Biological Safety cabinets are specialized local exhaust ventilation devices often used in laboratories. Class II cabinets are the most common type used in biomedical laboratories as they provide both health care worker (HCW) and sample protection from contamination. Several types of Class II cabinets are available. These types vary as to percentage of air recirculated to the cabinet, as well as the type of exhaust (hard-ducted to the exterior or exhausted into the laboratory air). The following diagram[1] depicts how the ventilation works in a BSC Class II cabinet (Type B2):

[1] Taken for Health Canada's *Laboratory Biosafety Guidelines 3rd Edition*, 2004. Used through courtesy of the Public Health Agency of Canada.



Proper use of BSCs is essential for the devices to function as they are designed.

Safe needle devices have built-in engineering features that assist in preventing injuries during and after use of the device. Examples of safe needle devices that have built-in engineering features include:

- Needleless connectors for IV delivery systems
- Protected needle IV connectors
- Needles that retract into a syringe or vacuum tube holder
- Hinged or sliding shields attached to syringes
- Self-blunting phlebotomy and winged steel needles
- Blunt tip suture needles
- Retractable finger/heel-stick lancets

While some engineered safe needle devices have been available for some time, new engineered safe needle devices continue to be introduced for the healthcare industry. Sharps disposal containers assist in protecting HCWs from injuries when handling and transporting waste sharps. The CSA standard *Z316.6-07 Evaluation of Single-use and Reusable Medical Sharps Containers for Biohazardous and Cytotoxic Waste* should be consulted when selecting sharps containers.

Administrative Controls

The next level of controls includes administrative controls. Because it is not always possible to eliminate or control the hazard at the source, administrative controls are frequently used for biological hazards in healthcare. Administrative controls focus on ensuring that the appropriate prevention steps are taken, that all proper work procedures are documented, that laboratory staff are trained to use the proper procedures, and that their use is enforced.

Administrative controls include policies and procedures that establish expectations of performance, codes of practice, staff placement, required orientation and training, work schedules, and occupational health programs in which baseline immune status is recorded and immunizations are provided. Procedural controls may include procedures that relate to detection and follow-up of infectious diseases, baseline health assessments and periodic screening of workers, hazard identification and control processes, and outbreak management procedures. All work procedures should include the consideration and control of the risk of exposure to workers.

Administrative controls related to the prevention of exposure to biological hazards include the development of infection prevention and control guidelines, including equipment decontamination and safe work procedures for building maintenance and protocols for construction and renovation projects.

Surfaces must be decontaminated after any spill of potentially infectious materials and at the end of the working day. Specific written protocols must be developed and followed for each decontamination process. Laboratory staff must be trained in all decontamination procedures specific to their activities and should know the factors influencing the effectiveness of the treatment procedure.

Personal Protective Equipment (PPE)

Personal protective equipment such as gloves, respiratory protection and eye protection should be used based on the risk assessment. PPE is often used in conjunction with other controls (engineering and administrative) to provide additional protection to workers. The primary types of PPE are designed to protect the worker from infectious disease by breaking the chain of infection at the “portal of entry or exit” of the microorganisms. This means that all PPE is designed to reduce exposure via specific routes of transmission.

Gloves, gowns and other protective clothing reduce exposure through the dermal (skin) contact route and help contain the microorganisms to the work environment. Eye and face protection reduce exposure through mucous membrane contact. Masks worn by patients reduce exposure through droplet containment at the source, and respirators worn by HCWs reduce exposure to the respiratory system.

The choice of gloves must often balance the needs for protection and dexterity. While thicker gloves (or double gloves) may appear to provide greater protection, it may make tasks more difficult and increase the exposure risk. In Recommendations for Canadian Health Care and Public Service Settings[2], it is noted that the *"Selection of the best glove for a given task should be based on a risk analysis of the type of setting, type of procedure, likelihood of exposure to blood or fluid capable of transmitting bloodborne pathogens, length of use, amount of stress on the glove, presence of latex allergy, fit, comfort, cost, length of cuffs, thickness, flexibility, and elasticity."*

[2] *Recommendations for Canadian Health Care and Public Service Settings*; found at http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/97vol23/23s3/index.html (See Supplement)

Chemical Hazards and Controls

This section will provide a brief overview of selected chemicals used in healthcare workplaces. **Note that this list is not extensive or all-inclusive.** While some of these chemicals are relatively common, several are used in very specialized areas or processes. In the control column, E, A and P are used to designate Engineering, Administrative and PPE controls. These controls are briefly summarized and the reader should link to the references provided for additional information. The proper choice of control measures must be based on a risk assessment for the specific tasks being performed. Safe work practices are administrative controls necessary for working with all harmful substances and educating workers in the practices is vital. Safe work procedures should be designed to:

- Limit the worker's exposure time
- Reduce contact with the substance through any route of exposure to the worker
- Ensure safe disposal of substances and disposable equipment that comes into contact with harmful substances
- Ensure safe handling and decontamination of reusable equipment
- Require the use of all designated controls.

Worker education is critical for safely handling harmful substances.

General Resources – Chemical Hazards
For more information about specific chemical hazards, consult the following resources:
NIOSH Pocket Guide to Chemical Hazards (http://www.cdc.gov/niosh/npg/).
CCOHS Cheminfo (http://ccinfoweb.ccohs.ca/).
Alberta Workplace Health and Safety Bulletins (http://employment.alberta.ca/SFW/136.html).

Chemical (category or group)	Common Uses and Examples	Exposure and Health Effects Information	Controls	For more information:
These are examples of chemicals, uses, health effects and controls. For each chemical used in the workplace, specific information MUST be consulted to determine controls based on what the product is used for, how it is used and the environment it is used in. This may be found on MSDSs, information provided by the manufacturer or supplier, or other sources. Individual reactions to chemicals must also be considered in determining appropriate controls.				
Alcohol hand sanitizers	Hand hygiene when water is not available and hands are not visibly soiled	May cause skin dryness. Product is flammable.	**A**- Appropriate storage of product (away from ignition sources and incompatible products). Provision of hand cream to soothe hand dryness.	http://www.ottawa.ca/residents/health/emergencies/pandemic/hand/faq_gel_en.html http://employment.alberta.ca/documents/WHS/WHS-PUB_fex002.pdf http://www.municipalaffairs.alberta.ca/documents/ss/STANDATA/fire/fcb/97fcb026.pdf
Detergents	Cleaning a variety of surfaces	Possible eye, skin, and respiratory irritants. Some products may cause allergic dermatitis or contain sensitizers such as nickel or limonene. May react with other products to create hazardous products.	**E**- Substitution with less harmful product. Properly designed and maintained ventilation systems. Automatic diluting machines. **A**- Practice to purchase products in ready to use concentrations to minimize handling. Safe work procedures. WHMIS program and maintenance of MSDSs. Worker education. Accommodation for sensitized workers or those with health issues, **P**- Gloves and eye protection.	http://www.hercenter.org/hazmat/cleaningchems.cfm http://www.museo.unimo.it/ov/fdrEdete.htm
Low Level Disinfectants	Chlorine compounds, alcohols, quaternary ammonium salts, iodophors, phenolic	Most are eye, skin, and respiratory irritants, particularly when concentrated. Some products may produce sensitization. Toxic effects depending on	**E**- Substitution with less harmful product. Properly designed and maintained ventilation systems. Automatic diluting machines. Closed systems. **A**- Practice to purchase products in ready to use concentrations to minimize handling. Safe work procedures.	http://ehs.virginia.edu/biosafety/bio.disinfection.html http://www.cdc.gov/niosh/topics/chemical.html http://cms.h2e-

	compounds, hydrogen peroxide used widely for disinfection; usually prepared and used in low concentrations.	nature of chemical. May react with other products to create hazardous products.	WHMIS program and maintenance of MSDSs. Worker education. Accommodation for sensitized workers or those with health issues. **P**- Gloves and eye protection.	online.org/ee/hazmat/hazmatconcern/steril/ http://www.mtpinnacle.com/pdfs/disinfectant-selection-guidelines.pdf
Formaldehyde	May be used to disinfect biological safety cabinets. Used in some cases for tissue preservation.	Eye and respiratory irritant and possible sensitizer. Toxic effects. Classified as a suspected human carcinogen. Ceiling Limit OEL exists. May react with other products to create hazardous products.	**E**– Substitution with less harmful product. Local exhaust ventilation. Enclosed processes. **A**- Practice to purchase products in ready to use concentrations to minimize handling. Safe work procedures including spill and disposal procedures. Routine exposure monitoring. WHMIS program and maintenance of MSDSs. Worker education. Accommodation for sensitized workers or those with health issues, **P**- Gloves, eye protection, face shield, chemical-resistant protective clothing. Respirators for use in the event of spills. Respirators if engineering controls are insufficient.	http://www.osha.gov/SLTC/formaldehyde/index.html http://www.ccohs.ca/oshanswers/chemicals/chem_profiles/formaldehyde/health_for.html?print http://www.ccohs.ca/oshanswers/chemicals/chem_profiles/formaldehyde/personal_for.html http://www.sustainablehospitals.org/cgi-bin/DB_Index.cgi.
Glutaraldehyde	High level disinfection.. May also be used in tissue processing	Contact allergen, may cause occupational asthma and respiratory and skin sensitization. Ceiling Limit OEL exists. Strong skin and respiratory irritant. May react with other products to create hazardous products.	**E**- Substitution with less harmful product. Properly designed and maintained ventilation systems. Local exhaust ventilation. Enclosed processes. **A**- Practice to purchase products in ready to use concentrations to minimize handling. Safe work procedures including spill procedures. WHMIS program and maintenance of MSDSs. Worker education. Routine exposure monitoring. Accommodation for sensitized workers or those with health issues, **P**- Gloves, eye protection, face protection, and chemical-resistant	http://www.osha.gov/Publications/3258-08N-2006-English.html http://www.osha.gov/SLTC/etools/hospital/hazards/glutaraldehyde/glut.html http://www.cdc.gov/niosh/docs/2001-115/ http://www.sustainablehospitals.org/cgi-bin/DB_Index.cgi.

			protective clothing. Respirators for use in the event of spills. Respirators if engineering controls are insufficient.	
Hydrogen Peroxide	Sterilization of some surfaces	Skin, eye and respiratory irritant. Oxidizer. May react with other products to create hazardous products. Fire hazard.	**E**- Substitution with less harmful product. Properly designed and maintained ventilation systems. May require local exhaust ventilation. Enclosed processes. **A**- Practice to purchase products in ready to use concentrations to minimize handling. Safe work procedures. WHMIS program and maintenance of MSDSs. Worker education. Accommodation for workers who are sensitized or may have health issues. **P**- Gloves, eye protection and chemical-resistant protective clothing. Respiratory protection based on risk assessment.	http://www.cdc.gov/niosh/npg/npgd0335.html
Ortho-phthalaldehyde (OPA)	High level disinfection. Replaces glutaraldehyde containing disinfectants.	Eye and respiratory irritant and skin sensitizer. May cause skin discoloration. May react with other products to create hazardous products.	**E**- Properly designed and maintained ventilation systems. May require local exhaust ventilation. Enclosed processes. **A**- Practice to purchase products in ready to use concentrations to minimize handling. Safe work procedures including disposal and spill procedures, and keeping soaking containers closed at all times. WHMIS program and maintenance of MSDSs. Worker education. Control access to work area. Exposure monitoring. Accommodation for sensitized workers or those with health issues, **P**- Gloves, eye protection, face shield and chemical-resistant protective clothing.	http://www.mtpinnacle.com/pdfs/Cydex.pdf http://www.aspjj.com/us/supports/material-safety-data-sheets http://www.sustainablehospitals.org/cgi-bin/DB_Index.cgi
Acids/bases	Reagents in a variety of diagnostic procedures	Exposure may occur from skin contact, mucous membrane contact or inhalation.	**E**- Elimination where possible. Substitution with less harmful products. Properly designed and maintained ventilation systems. Local exhaust	http://www.ee.byu.edu/cleanroom/acid_safety.phtml http://www.lbl.gov/ehs/chsp/html/aci

		Corrosive causing destruction of tissue on exposure. May be a skin, mucous membrane, eye and respiratory system irritant. Effects may be delayed. Many are oxidizers and may not be stored with flammable products.	ventilation may be required including fume hoods. Enclosed and automated processes. **A**- Purchase products in small quantities with the highest dilution that is appropriate for the task. Safe work procedures including using proper handling techniques, using mechanical transfer devices, and spill procedures. Appropriate storage of products to decrease exposure. Maintain inventory of products and remove unused products. WHMIS program and maintenance of MSDSs. Worker education. **P**- Tight-fitting eye protection (indirect vented goggles), face shields, chemical resistant aprons, closed-toed shoes and appropriate gloves selected based on the nature of acid/base. Respiratory protection based on hazard assessment.	ds_bases.shtml
Alcohols	Disinfection for some surfaces and as a reagent in some procedures	Skin, eye and respiratory irritant. Flammable. Central nervous system depressant.	**E**- Substitution with less harmful products. Maintain adequate general ventilation. Enclosed and automated processes. Grounded and bonded transfer equipment. **A**- Purchase of products in small quantities with the highest dilution that is appropriate for the task. Safe work procedures including spill procedures. Appropriate storage of products to decrease exposure and reactions. Maximum storage volumes allowed based on flammability and container material. Maintenance of an inventory of products and removal of unused products. WHMIS program and maintenance of MSDSs. Worker education. **P**- Gloves and eye protection depending	http://www.ee.byu.edu/cleanroom/solvent_safety.phtml http://www.cdc.gov/NIOSH/NPG/npgd0359.html http://employment.alberta.ca/documents/WHS/WHS-PUB_fex002.pdf

			upon the products used, concentration and tasks. Respiratory protection based on hazard assessment	
Organic solvents	Reagents in a variety of diagnostic procedures; also used extensively in maintenance areas; examples include toluene, alcohols, acetone, xylene, etc.	May cause a variety of effects including skin, eye and respiratory effects, neurological effects (central nervous system depressant) and acute and chronic organ damage. May be absorbed through skin. Fire hazard related to use and storage.	**E**- Elimination of solvent use. Substitution of solvent with less harmful products. Properly designed and maintained ventilation systems. Local exhaust ventilation may be required including fume hoods. Enclosed and automated processes. Ground and bond transfer equipment. **A**- Purchase of products with the highest dilution that is appropriate for the task. Safe work procedures including spill, proper handling and disposal procedures. Appropriate storage of products to decrease exposure and minimize fire and reaction hazards. Maximum storage volumes allowed based on flammability and container material. Maintenance of an inventory of products and removal unused products. Routine exposure monitoring. WHMIS program and maintenance of MSDSs. Worker education. **P**- Gloves, eye protection and chemical-resistant protective clothing. Respiratory protection based on hazard assessment. Proper footwear (non-porous with closed heel and toe).	http://www.ccohs.ca/oshanswers/chemicals/flammable/flam.html http://www.ccohs.ca/oshanswers/prevention/flammable_general.html http://www.ee.byu.edu/cleanroom/solvent_safety.phtml http://employment.alberta.ca/documents/WHS/WHS-PUB_ch013.pdf http://employment.alberta.ca/documents/WHS/WHS-PUB_fex002.pdf http://www.sustainablehospitals.org/cgi-bin/DB_Index.cgi
Toxic chemicals, including research laboratory chemicals	Wide variety of chemicals used in laboratories for testing and research – may include stains, fixatives, and other reagents. Geno-reactive/geno-	Depending upon the toxicology of specific chemical, exposure can be through any route of entry and affect most human organs. Other effects may include reproductive effects, carcinogenicity, mutagenicity,	**E**- Elimination where possible. Substitution with less harmful products. Local exhaust ventilation may be required including fume hoods. Enclosed and automated processes. **A**- Safe work procedures and provide worker education. Safe work procedures and education are critical for safe handling with hazardous materials. Exposure monitoring where applicable.	http://www.uos.harvard.edu/ehs/ih/lp_chemical_safety_chp.shtml http://ehs.ucsb.edu/units/labsfty/labrsc/chemistry/lschemosha.htm http://www.ehrs.upenn.edu/programs/labsafety/labsafety_manual.html http://www.ehs.cornell.edu/lrs/manu

	toxic and mutagenic chemicals (e.g. ethidium bromide, osmium tetroxide) are used in some specialized laboratories.	teratogenicity etc.	WHMIS program and maintenance of MSDSs. Accommodation for workers with special needs (pregnant workers, persons with sensitivities). **P**- PPE as required based on hazard assessment. Refer to individual MSDSs.	al/index.cfm http://www.cdc.gov/niosh/database.html http://hazard.com/ http://siri.org/msds/
Other chemical waste	Waste chemicals can be generated in any area where chemicals are used, including used protective clothing.	Exposure routes of entry and health effects are dependent upon the nature of waste chemicals. Mixed wastes may pose multiple hazards.	**E**- Designated waste storage and collection areas. Adequate ventilation. Use of bonding, grounding and explosion control. **A**- Appropriate storage of products to decrease exposure and minimize fire hazards and chemical reactions. Policies and procedures for safe chemical disposal. Education of workers in the nature of the hazard. **P**- As required based on specific hazard assessment.	http://employment.alberta.ca/documents/WHS/WHS-PUB_fex002.pdf
Compressed gases	Commonly used with some laboratory equipment, including tissue culture incubators, etc. Liquid nitrogen is used for tissue preservation	Asphyxiation, anaesthetic effects. Toxicity is dependant on chemical products. Other hazards include explosions, fire hazards, flying projectiles, and release of gas. Cryogenic gases may also cause skin damage through freezing.	**E**- Substitution with less harmful product. Adequate ventilation. Proper storage of cylinders. **A**- Appropriate store of products to decrease exposure and minimize fire and explosion hazards. Safe work procedures including transportation. WHMIS program and maintenance of MSDSs. Worker education. Good housekeeping. **P**- PPE based on hazard assessment.	http://www.ccohs.ca/oshanswers/chemicals/compressed/compress.html http://www.ccohs.ca/oshanswers/prevention/comp_gas.html http://www.chem.ubc.ca/safety/safety_manual/hazard_chem_gases.shtml
Mercury	Metallic mercury may be found in thermometers and pressure gauges	Exposure is through inhalation of vapours, ingestion and skin absorption. Skin sensitizer. Corrosive as liquid. Target effects to the nervous system,	**E**- Elimination of mercury containing equipment. Substitution with less harmful product. Enclosed mercury sources. Properly designed and maintained ventilation systems. Local exhaust ventilation may be required. **A**- Safe work procedures including spill	http://employment.alberta.ca/documents/WHS/WHS-PUB_ch003.pdf http://www.cdc.gov/niosh/npg/npgd0383.html http://www.mtpinnacle.com/pdfs/ME

		kidneys, cardiovascular and eyes.	procedures. Education of workers in the nature of the hazard. Purchasing controls to restrict mercury containing materials from entering facility. Monitoring of the work environment following a spill. Good hygiene practices. Appropriate storage of products to decrease exposure. **P**- Protective clothing, gloves, eye and face protection, and respiratory protection based on hazard assessment.	RCURY-USE-%20HOSPITALS-AND-CLINICS.pdf

In this section the most commonly encountered chemical hazards in laboratories and methods to control are presented. Employers should carefully evaluate the potential for exposure to chemical hazards in all laboratory tasks and ensure that they have an effective hazard control plan in place. This information will be useful for inclusion into hazard assessments. Please note, this is not designed to be an exhaustive treatment of the subject, but is rather an overview summarizing the chemical hazards most frequently encountered in diagnostic laboratories.

Note:
The following charts taken from Volume 3 – Best Practices for the Assessment and Control of Chemical Hazards in Healthcare provide basic information about control strategies for commonly occurring chemical hazards related to laboratory tasks. The selection of controls must be based on a risk assessment of the tasks and environment. Worker education and good communication processes are critical administrative controls. All legislation related to the assessment of hazards, selection and use of controls must be followed.

Potential Chemical Hazards	Summary of Major Control Strategies		
	Engineering	Administrative	PPE
Exposure to glutaraldehyde or other cold sterilants for disinfecting bench tops and biosafety cabinets.	Substitution with less harmful product. Maintain adequate general ventilation. Local exhaust ventilation.	Safe work procedures including spill procedures. Worker training.	Chemical-resistant gloves, eye protection, face protection, and chemical-resistant protective clothing. Respirators for use in the event of substantial spills. Respirators if engineering controls are insufficient.
Exposure to glutaraldehyde when used as a tissue fixative	Substitution with less harmful product. Maintain adequate general ventilation. Local exhaust ventilation. Enclose processes.	Safe work procedures including spill procedures. Worker training.	Chemical-resistant gloves, eye protection, face protection, and chemical-resistant protective clothing. Respirators for use in the event of substantial spills. Respirators if engineering controls are insufficient.
Exposure to formaldehyde when used as a tissue fixative in laboratories or in the morgue; Paraformaldehyde is commonly used in the decontamination of biological safety cabinets for certification	Substitution with less harmful product. Maintain adequate general ventilation. Local exhaust ventilation.	Safe work procedures including spill procedures. Worker exposure monitoring. Worker training.	Chemical-resistant gloves, eye protection, face protection, and chemical-resistant protective clothing. Respirators for use in the event of substantial spills. Respirators if engineering controls are insufficient.
Exposure to a wide variety of solvents as reagents in diagnostic procedures	Elimination of solvent use. Substitution of solvent with less harmful products. Maintain adequate general ventilation. Local exhaust ventilation may be required. Enclose and automate processes.	Purchase products with the highest dilution that is appropriate for the task. Safe work procedures including spill procedures. Store products appropriately to decrease exposure and minimize fire hazards. Maintain inventory of products and remove unused products.	Gloves, eye protection and protective clothing.
Exposure to acids, bases, and other	Elimination where possible.	Purchase products in small	- Eye protection

toxic chemicals used in diagnostic procedures	Substitution with less harmful products. Maintain adequate general ventilation. Local exhaust ventilation may be required including fume hoods. Enclose and automate processes.	quantities with the highest dilution that is appropriate for the task. Safe work procedures including spill procedures. Store products appropriately to decrease exposure. Maintain inventory of products and remove unused products.	(goggles), face shields, chemical resistant aprons, closed-toed shoes and appropriate gloves selected based on the nature of acid/base.
Exposure to mercury if there are broken thermometers or other mercury-containing equipment	Elimination of mercury containing equipment. Substitution with less harmful product. Enclose mercury sources. Maintain adequate general ventilation.	Safe work procedures including spill procedures. Educate workers in the nature of the hazard. Purchasing controls to restrict mercury containing materials from entering facility. Monitor work environment following a spill. Ensure good hygiene practices. Store products appropriately to decrease exposure.	Protective clothing, gloves, eye and eye protection, and respiratory protection.
Exposure to latex from contact with latex gloves	Substitution with less harmful product. Maintain adequate general ventilation.	Purchasing controls to limit latex containing materials from entering facility. Educate workers in the nature of the hazard, hand washing after glove removal, proper glove donning and removal. Periodic screening of workers.	
Exposure to a variety of disinfecting and cleaning agents in routine cleaning activities	Maintain adequate general ventilation. Automatic diluting machines.	Purchase in ready to use concentrations to minimize handling. Worker education. Safe work procedures. WHMIS program and maintenance of MSDSs.	Gloves and eye protection.
Exposure to scented products that may induce sensitization	Elimination of scented products. Substitution with less harmful products. Maintain adequate general ventilation.	Develop scent-free policies. Educate worker in the nature of the hazard. Post signage in work areas where affected workers work.	

Notes about controls for chemical hazards

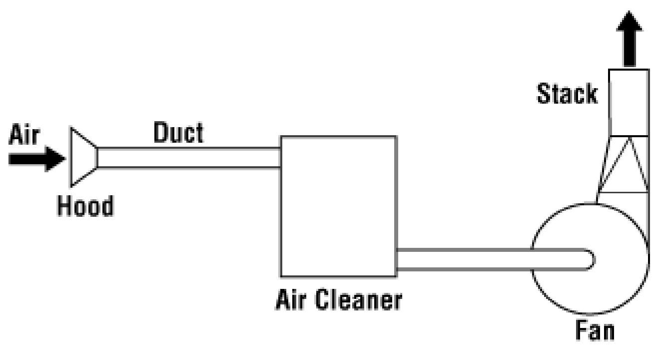
Engineering Controls

Many engineering controls are available for controlling the hazard at the source and along the path of transmission. For chemical hazards, common engineering controls include:

- Elimination
- Substitution
- Local exhaust ventilation
- General ventilation (only appropriate for non-toxic chemicals)
- Isolation/enclosed processes
- Proper chemical storage
- Facility design

Local Exhaust Ventilation

The most common engineering control used in healthcare to minimize exposure to chemicals in the air is local exhaust ventilation (LEV). LEV captures contaminants at the point where they are released or generated and mechanically removes them before workers can inhale them. The following figure[3] outlines the major components of a basic local exhaust ventilation system.



[3] From CCOHS Publication *OSH Answers – Industrial Ventilation;* found at http://www.ccohs.ca/oshanswers/prevention/ventilation/. Used with permission.

Air containing contaminants is drawn through ductwork or tubing by means of a fan, removing it from the work environment and then expelling it to a safe location. Prior to being expelled, the air is sometimes decontaminated through filters.

Diagnostic laboratories use local exhaust ventilation extensively. Chemical fume hoods are used for preparing reagents and conducting some procedures where volatile or toxic substances are handled. Biological safety cabinets are used when adding reagents to diagnostic samples. Ventilated capture systems are used when working with solvents and fixatives in histology. Safe use of chemical fume hoods requires that air flow is not obstructed, the sash height is appropriate for the procedure and required face velocity, work is carried out at least 6 inches from the front of the hood and that the hood is well maintained and face velocity monitored.

All local exhaust systems must be inspected and maintained according to the manufacturer's instructions to ensure that they are functioning properly. Routine checks of the face velocity should be performed regularly on all fume hoods. Biological safety cabinets must also be checked regularly to ensure that they are functioning properly and certified annually by qualified persons. Chemicals should not be used in biological safety cabinets except in very minute quantities unless the cabinet vents 100% of the air outside the building via a duct.

Vacuums are forms of local exhaust ventilation that are used to capture particles in bags or central systems. Standard vacuums and central vacuum systems are sometimes used for cleaning up spilled or accumulated particulate material. High Efficiency Particulate Air (HEPA) filters are used with other equipment such as activated charcoal filters to filter the air to remove contaminants. It is important to handle HEPA vacuums with care to avoid chemical exposure when removing or replacing filters or bags and attaching nozzles.

Isolation/Enclosed Processes

Isolating the source or location of the hazard helps to reduce exposure. When isolation is physical (separate rooms, closed doors, isolated locations, etc.), the isolated area must be maintained at a negative air pressure relative to the surrounding areas. This will allow air to flow into the isolated area, keeping the contaminant within the space. (Positive pressure would force the air out of the room and into the surrounding area.)

Chemical Storage

An often-neglected engineering control is the proper storage of chemicals. Chemicals must be stored properly to reduce risks of fire and explosion, chemical reactions, and worker exposure. Chemical storage must consider local fire regulations that specify the types and quantities of specific chemicals that may be stored. Organizations should reduce the risks related to chemical storage by ensuring that only quantities of chemicals and sizes of containers that are necessary for the tasks are purchased and stored. The temptation to save money by purchasing large quantities should be discouraged, as these quantities have more stringent storage requirements and are often more difficult (and expensive) to dispose of than to purchase.

Some major reasons why chemicals are stored improperly include:

- An initial decision (when the area is designed) to purchase small quantities of chemicals that is later reversed for economic reasons, leading to the purchase of larger quantities that exceed the storage capabilities of the area
- Lack of space to accommodate storage facilities
- "Shared" storage facilities, with no one designated as responsible for ensuring proper storage
- Confusion as to how to store chemicals that have more than one hazard
- Lack of training/knowledge of chemical composition and reactivities
- Bad habits related to convenience
- Lack of a well thought out chemical storage plan

Administrative Controls

Administrative controls used for reducing exposure to chemical hazards include:

- Having an effective WHMIS Program
- Monitoring the environment for chemical hazards
- Work scheduling
- Purchasing practices
- Health surveillance and medical monitoring; follow-up procedures for exposed workers
- Safe work procedures including spill response, chemical waste handling and disposal
- Training

Personal Protective Equipment (PPE)

Gloves

The personal protective equipment most commonly used in laboratories to protect against chemical exposures includes gloves, gowns, eye protection and (in some case) respirators. PPE should be chosen based on a careful consideration of tasks and the nature of the drugs or chemicals used.

When choosing gloves, the following must be considered:

- The nature and concentration of the chemicals
- The amount of time the gloves will be exposed to the chemical
- Dexterity required to perform the task
- Extent of protection needed (to wrist or higher)
- Decontamination and disposal requirements

Rules for glove use for chemicals[4,5]

- Wear the appropriate gloves for the task when needed; for reusable gloves, follow the manufacturer's guidelines for care, decontamination and maintenance. Choose gloves resistant to holes and tears.
- Ensure gloves fit properly and are of the appropriate thickness to offer protection; ensure adequate supplies of gloves in appropriate sizes.
- Avoid using latex gloves (due to latex allergies).
- Do not use worn or defective gloves.
- Wash hands once gloves have been removed.
- Disposable gloves must be discarded once removed. Do not save for future use.
- Dispose of used gloves into the proper container. Have separate disposal locations for gloves contaminated with chemicals which pose a toxic hazard if mixed.
- Non-disposable/reusable gloves must be washed and dried, as needed, and then inspected for tears and holes prior to reuse.
- Remove gloves before touching personal items, such as phones, computers, pens and one's skin.
- Do not wear gloves into and out of areas. If gloves are needed to transport anything, wear one glove to handle the transported item. The free hand is then used to touch door knobs, elevator buttons, etc.
- Do not eat, drink, or smoke while wearing gloves. Gloves must be removed and hands washed before eating, drinking, or smoking.
- If for any reason a glove fails, and chemicals come into contact with skin, remove the gloves, wash hands thoroughly and obtain first aid or seek medical attention as appropriate.

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[4] OSH Answers- Chemical Protective Clothing – Gloves; http://www.ccohs.ca/oshanswers/prevention/ppe/gloves.html

[5] Glove Use in Laboratories; University of Florida Chemical Hygiene Plan; http://www.ehs.ufl.edu/Lab/CHP/gloves.htm

Eye and face protection

For most laboratory staff who use chemicals, goggles or face shields are necessary. In most cases, goggles are considered re-usable. All reusable PPE must be properly decontaminated and maintained. Selection of protective eyewear should take into account:

- Level of protection required
- Comfort of the wearer
- Secure fit that does not interfere with vision or movement
- Ease of cleaning and disinfection
- Durability
- Compatibility with prescription glasses and other PPE that must be worn at the same time (e.g. respirators)

Goggles come as vented (direct or indirect) or non-vented. If there is a chance that a splash of chemical can occur, direct vented goggles must not be used. If there is a risk of exposure to chemical vapours, non-vented goggles are required. In certain situations, anti-fog lenses or tinted lenses may be required. As with all PPE, sufficient quantities and sizes of protective eyewear must be available to workers who will use them.

Face protection is required if there is the potential for exposure to mucous membranes. Face shields are secondary protective equipment designed to protect the entire face from chemical hazards. In most situations, face shields are used in conjunction with goggles as face shields alone may not provide adequate eye protection.

Respirators

According to the Alberta Occupational Health and Safety Code 2009[6], there is a duty to provide and use respiratory protective equipment (RPE) when a hazard assessment indicates that a worker may be exposed to airborne contaminants Employers are required to use engineering and administrative controls before using RPE (respecting the hierarchy of controls). Respirators may be required to protect laboratory workers from exposure to certain biological agents or chemicals by inhalation. If a hazard assessment identifies the need for RPE, the specific legislated requirements are outlined in the *OHS Code, Part 18.*

[6] Alberta OHS Code 2009, Part 18 – Personal Protective Equipment

Protective Clothing

Chemical protective clothing is available as gowns, aprons, uniforms, foot covers and full body suits. The choice of protective clothing relies on an accurate hazard assessment. As with gloves, there is a wide range of available products to choose from. The selection of chemical protective clothing is based on:

- The nature of the chemicals or drugs being used and the suitability of the protective clothing material
- The parts of body that may be exposed to the chemicals
- Whether protective clothing is worn over street clothes or in place of street clothes
- The comfort and flexibility of the clothing so that it does not interfere with the performance of the tasks or create other hazards
- Sizes available
- Whether the clothing is disposal or re-usable
- Cleaning, decontamination and disposal procedures

Should protective clothing become contaminated with a drug or chemical or damaged, the clothing must be removed and handled according to organizational procedures (disposal or proper decontamination). Workers must not wear clothing that is contaminated with chemicals home, as this may pose a danger to themselves and others.

The following checklist may be useful to verify controls for chemical safety in laboratories.

General Chemical Safety

- ☐ Chemicals properly labelled?
- ☐ Chemicals properly stored?
- ☐ MSDSs readily accessible?
- ☐ Staff aware of location of MSDSs?
- ☐ MSDSs current?
- ☐ Chemical response procedures available?
- ☐ Staff trained on chemical response for chemical in their areas?
- ☐ Flammable liquids stored in approved containers and cabinets?
- ☐ Flammable liquids stored in approved quantities?
- ☐ Chemical storage shelves are appropriate?
- ☐ WHMIS policy in place?
- ☐ Chemical inventories available for all areas?
- ☐ Chemical inventories current?
- ☐ Workplace labels available where required?

- ☐ Purchasing procedures require hazard assessment for new chemicals?
- ☐ Workers have received initial WHMIS orientation?
- ☐ Workers receive periodic WHMIS updates?
- ☐ Contractors required to identify chemicals in use on site?
- ☐ Hazard assessments include identification of chemical hazards?
- ☐ Controls identified and chosen according to hierarchy of controls?
- ☐ Ventilation systems maintained?
- ☐ Local exhaust ventilation systems verified at least annually?
- ☐ Eye protection required where chemicals are used?
- ☐ Protective clothing required where deemed necessary?
- ☐ Is there a respiratory Code of Practice?
- ☐ Adequate numbers, types, sizes of PPE available?
- ☐ Respirator fit-testing in place?
- ☐ Safe work procedures documented, followed, and enforced?
- ☐ Decontamination of surfaces and equipment done as required?
- ☐ Appropriate eyewash facilities available?
- ☐ Appropriate shower facilities available?
- ☐ Are spill kits available and adequate?
- ☐ Routine maintenance and checks done on emergency eyewash and shower equipment?
- ☐ Proper number and types of fire extinguishers available?

Laboratories

- ☐ Chemicals stored properly?
- ☐ Chemical spill kits available?
- ☐ Chemical spill kits checked regularly?
- ☐ Periodic worker exposure monitoring done as required for toxic substances?
- ☐ Fume hoods maintained and certified properly?
- ☐ Fume hoods free of chemicals and other items?
- ☐ Fume hoods ducted to outside?
- ☐ Are emergency eyewashes/showers available and tested regularly?
- ☐ Workers wear proper PPE?

- ☐ Workers wear closed shoes?
- ☐ Compressed gas cylinders properly handled, used, stored and transported?
- ☐ Trash cans fire-rated?

Physical Hazards and Controls

There are a variety of potential physical hazards in medical laboratories. Ergonomic hazards may be associated with workstation design as well as specific laboratory procedures that utilize repetitive motion or sustained awkward positions. Microwave, non-ionizing and ionizing radiation may be physical hazards in some laboratories. Mechanical hazards or electrical hazards associated with laboratory equipment may be present. Cuts are common laboratory injuries, often sustained when coming into contact with broken glassware or sharp tools or equipment. Exposure to extremes of temperature may also produce injury – working for extended periods in cold rooms, working with cryogenic materials, using hot plates, coming into contact with hot surfaces or materials or steam from autoclaves may all pose risks to laboratory workers. Slips, trips and falls may also occur in laboratories, especially those with slippery floor surfaces.

In this section the most commonly encountered physical hazards in laboratories and methods to control them are presented. Employers should carefully evaluate the potential for exposure to hazards in all laboratory tasks and ensure that they have an effective hazard control plan in place. This information will be useful for inclusion into hazard assessments. Please note, this is not designed to be an exhaustive treatment of the subject, but is rather an overview summarizing the most frequently encountered physical hazards in laboratory settings.

Note:
The following chart provides basic information about control strategies for commonly occurring physical hazards in laboratories. The selection of controls must be based on a risk assessment of the tasks and environment. Worker education and good communication processes are critical administrative controls. All legislation related to the assessment of hazards, selection and use of controls must be followed.

Potential Physical Hazards	Summary of Major Control Strategies		
	Engineering	Administrative	PPE
Ergonomic hazards associated with computer use or workstation design	Ergonomically designed workstations, chairs and equipment. Incorporate adjustable workstation to accommodate shared use by employees of various sizes.	Adjustment of workstation and chair to fit user. Worker education regarding ergonomic hazards and control strategies. Self assessment tools to assist workers in identifying and controlling risk factors. Safe work procedures. Early reporting of signs and symptoms of ergonomic concerns. Stretches and micro-breaks. Purchasing standards for ergonomically designed computer workstations, chairs and equipment. Ergonomic assessments. Maintenance of workstations, chairs and equipment.	
Ergonomic hazards associated laboratory activities (pipetting, microscopy, microtome or cryostat, glove boxes, etc.) and autopsy including awkward and sustained postures, high forces, repetition, and compression forces	Provide ergonomically designed equipment including pipettes, microscopes, microscope tables, chairs, footrests or foot rails, etc. Consider the use of automatic foot operated cryostat when frequent cryo sectioning is performed. Ensure work surfaces are designed with a smooth, rounded edge to minimize compression forces. Provide anti-fatigue matting for standing work areas. Consider a sit-stand seat.	Develop safe work procedures for key lab activities. Worker education and awareness sessions. Arrange samples and instruments in easy reach. Each worker should use adjustable features to optimize their working posture. Early reporting of signs and symptoms of ergonomic concerns. Stretches and micro-breaks. Job rotation and job expansion. Purchasing standards for ergonomically designed instruments, equipment, chairs and work surfaces. Maintenance program for instruments, equipment, etc.	
Exposure to UV-C used in germicidal lamps found in microbiology laboratories and some biological safety cabinets	Eliminate all non-essential use of UV lamps. Interlock systems on biological safety cabinets.	Worker education. Safe work procedures (including designated times to turn on the UV lamps, etc.). Proper signage and warning	Goggles with appropriate optical density to block UV rays when lamps are on.

		when UV lamps are turned on.	
Exposure to ionizing radiation through the use of radio-isotopes for various assays/procedures	Substitute process with an alternative that does not use radioisotopes (ELIZA, fluorescence, etc.). Use of short-lived isotopes. Use of fume hood. Shielding appropriate to nature of isotope.	Radiation safety program. Worker education. Radiation safety program. Designated Radiation Safety Officer (RSO). Safe work procedures including minimizing time of exposure, proper labeling, etc. Exposure monitoring. Medical monitoring with some isotopes (Iodine). Proper waste disposal.	Gowns, gloves, eye protection.
Exposure to microwave radiation through the use of microwave ovens to heat agar or other reagents	Ensure proper maintenance of equipment (including periodic verification of any leaks). Interlock systems to ensure microwaves not generated when oven doors are open.	Worker education. Safe work procedures that incorporate ensuring the worker uses distance as a control measure	.
Falling hazards associated with slips, trips and falls	Install slip resistant flooring. Design stairwells according to accepted safety standards. Ensure adequate lighting.	Perform regular maintenance on flooring, stairwells, hallways, handrails, etc. Inspect ladders prior to use. Worker education. Implement a spill cleanup program that includes prompt spill cleanup, use of warning signs, etc. Maintain good housekeeping practices and minimize clutter and tripping hazards.	Appropriate footwear with gripping soles and good support.
Cuts from broken glassware, including capillary tubes and specimen vials	Substitute with other materials (plastics). Change procedure to reduce use of capillary tubes. Proper type of glass for use in autoclaves. Use of centrifuge carriers with caps.	Worker education. Safe work procedures including removal of broken items from equipment (autoclaves, centrifuges, etc.), safe disposal of sharps, etc.	Eye protection, protective clothing, and gloves as per hazard assessment.
Cuts from sharp instruments including scalpels, scissors and medical instruments	Avoid use of sharps when not required. Replace sharps with Safety Engineered Medical Devices. Proper storage of sharps.	Worker education. Safe work procedures.	Eye protection, protective clothing, and gloves as per hazard assessment.
Injuries from centrifuge malfunction	Safety features of equipment including interlock system to prevent opening lid before rotor	Worker education. Safe work procedures in keeping with manufacturer's instructions.	Usually gloves. As required based on hazard assessment.

	has stopped, safety switches, and imbalance sensors. Containment of centrifuge.	Equipment maintenance. Proper tube selection and balancing of the centrifuge. Rotor logbook maintenance for high speed rotors.	
Exposure to cold temperatures when working in walk-in refrigerators or freezers	Door release on the inside of walk-in refrigerators and freezers. Use of refrigerators and freezers that avoid walk-in. Temperature monitoring equipment and with warning alarms. Equipment maintenance.	Worker education. Safe work practices including efficient planning of work to avoid prolonged exposure to cold conditions.	Insulated gloves, protective clothing and footwear as required for task and according to hazard assessment.
Exposure to cryogenic agents when freezing/thawing tissues or cells	Use correct vials that have not expired. Proper equipment selection and maintenance. Proper storage of cryogenic containers that includes exhaust ventilation.	Worker education. Safe work procedures (including slowly introducing probes into cryogenic liquid, use in well ventilated area, positioning vials so that the vials are shielded when rapidly thawing.) Spill response and emergency exposure procedures.	Goggles, insulated gloves, protective clothing, protective footwear, face shield depending upon hazard assessment.
Burns related to contact with hot surfaces (ovens, heating plates, burners, etc.) or products	Warning alarms on equipment. Interlock systems to prevent opening equipment which is hot. Isolation/shielding of hot apparatus. Programmable automatic shut-offs on equipment.	Worker education. Safe work procedures including proper use and maintenance of all apparatus.	Heat-resistant gloves, eye protection, protective clothing and footwear as required based on hazard assessment.
Burns related to contact with steam from autoclaves	Equipment maintenance, local exhaust (canopy) ventilation over autoclave door. Interlock system preventing opening of autoclave until specific temperature is reached. Proper autoclave carriers. Alarm systems on autoclaves.	Worker education. Safe work procedures, including proper loading and unloading of autoclave, loosening of caps before autoclaving, allowing sufficient standing time before removing items.	Heat-resistant gloves, rubber apron, and rubber sleeve protectors.
Fire, projectiles, or physical injury if compressed gas cylinders used for a variety of procedures and maintenance activities are damaged, dropped or mishandled	Install protective valve caps when cylinder is not in use if the cylinder is equipped with a means of attaching caps. Secure and restrain cylinders.	Safe work procedures that includes use, care, maintenance, storage and transport. Worker training.	PPE based on hazard assessment and type of compressed gas. Protective footwear for impact hazard when

			handling large cylinders.
Electrical hazards arising from use of electrical cords and appliances	Ground fault circuit interrupters when used close to water sources.	Safe work procedures that include use of electrical cords, power bars and appliances that includes facility approval requirements. Worker training.	
Mechanical hazards from machinery during autopsy	Safeguarding of machinery.	Control of hazardous energy (lockout) program. Inspections and preventative machine maintenance. Safe work procedures. Only authorized workers operate specific machinery. Worker training. Signs informing of guards.	PPE based on hazard assessment and machinery hazards. No loose clothing, gloves, or jewelry or other items that could entangle workers in machinery.

Notes about controls for physical hazards

Engineering Controls

Ergonomic hazards

Engineering controls are recognized as the most effective category of hazard controls. Examples of general engineering controls that apply to biomechanical hazards include:

- Change the process through automation to eliminate the hazard.
- Use handling equipment (e.g. lifts, hoists, etc.) to reduce manual handling.
- Modify the design of workstations, hand tools, equipment, etc. to reduce the hazard.
- Provide ergonomically designed equipment and furniture – The goal is to purchase and provide equipment and furniture that will support ergonomically correct work postures and behaviours.
- Design workstation layout and arrange equipment to minimize biomechanical risk factors. For example, frequently accessed equipment and materials should be located in easy reach (and located to minimize awkward postures).

Radiation

Engineering controls are designed to reduce the radiation hazard at the source.

1. Elimination and substitution

For ionizing radiation, elimination is sometimes an option when considering radioimmunoassays in laboratories, which are increasingly replaced by enzyme immunoassays or fluorescent marker procedures. In some cases, short-lived isotopes can be substituted for isotopes with a longer half-life.

2. Shielding

Shielding is a critical engineering control for controlling exposure to external ionizing radiation hazards. It relies on providing a specific barrier material that absorbs, stops or attenuates the radiation. The type of shielding material required is determined by the type of radiation. Alpha particles can be stopped by paper or clothing; beta particles can be stopped with Plexiglas, while gamma and X-rays require denser materials (concrete, lead) to provide adequate shielding. Shielding may be permanently installed in a location, or may be erected temporarily for more infrequent use of radiation. The use of shielding requires a careful consideration of the type of radiation, the required thickness of the shielding material, the location of the workers, and the potential for leakage or scatter. Shielding calculations should only be performed by individuals with current knowledge of structural shielding design and the acceptable methods of performing these calculations.

3. Design considerations

For both ionizing and non-ionizing radiation, design considerations are important as engineering controls to prevent exposures. For ionizing radiation, permanent shielding should be provided in areas where there is frequent need for shielding. Mazes and other traffic area designs are used to reduce exposure by providing barriers and reducing traffic. The placement of equipment can greatly reduce awkward movement for workers.

4. Interlock systems

Interlock systems are mechanical systems that prevent the operation of the equipment or some facet of the equipment until an action or other system is engaged or completed. Interlock systems are used extensively in radiation equipment to ensure that the equipment cannot be accidentally activated. Examples of interlock systems include the system that prevents the operation of a biological safety cabinet light when the UV lamp is turned on, the turning off of microwave generation in a microwave oven when the door is opened, and a key control to activate the master switch on a laser.

5. Equipment selection and maintenance

The choice and the maintenance of equipment are critical engineering controls. Equipment design that includes advanced safety features (such as audible/visible signals when the equipment is operating, interlock or key/lock systems, permanent shielding, etc.) should be considered whenever possible. Equipment calibration and maintenance will ensure the equipment performs optimally and reduces the potential for accidental worker exposure.

Trips, Slips and falls

In order to prevent slips, trips and falls in laboratories, organizations should implement a multifaceted prevention program. A key prevention strategy is the installation of proper flooring, maintenance practices and appropriate cleaning and care. The immediate clean up of liquid and contamination on walking surfaces is essential in controlling the hazard as well as the use of signs to identify potentially slippery walking surfaces.

- Put a spill plan in place for areas that are prone to moisture and spills. Use absorbent mats at entrances. Ensure appropriate spill cleanup equipment is available at key locations where sudden spills of food, beverages or bodily fluids are likely to occur.
- Ensure stairways in new facilities are designed safely (see National Building Code and local jurisdictional building codes).
- Utilize non-slippery surfaces on the whole steps or at least on the leading edges.
- Provide adequate lighting in stairways (at least 50 lux).
- Use angular lighting and colour contrast to improve depth perception.
- Provide adequate storage space to minimize the storage of equipment in hallways.
- Keep hallways clear of obstructions.
- Use cord covers over electrical cords, as necessary.
- Provide well designed stools that have slip resistant surfaces and a stable, strong base.

Cuts

The most effective controls to reduce cuts are engineering controls. Common engineering controls include substitution of medical sharps with safety engineered medical devices (SEMDs)

- Substitution of a sharp instrument with a less sharp alternative (e.g. engineered sharps injury prevention devices)
- Isolation of the process
- Machine guarding to prevent direct contact with moving parts
- Area design to reduce likelihood of exposure (including having sufficient room to work safely, designated locations for storage of knives and other sharp instruments, etc.)

- Safety utility knives
- Safety cutters as bag and box openers
- Interlock systems that do not permit the operation of equipment unless the guards are engaged
- Equipment selection and maintenance.

Temperature Extremes

Engineering controls for heat and cold include reducing the level of work required in hot or cold environments, changing location of the work, using insulating materials and shields as appropriate. For those working in walk-in refrigerators or freezers, the rooms must have a release handle on the inside.

For those working with cryogenic materials, substitution with a less hazardous freezing agent is the engineering control of choice if possible. Other engineering controls include local exhaust ventilation where cryogens are stored and used (the type depending upon the hazard assessment), effective general ventilation to dilute any vapours, design of storage area to ensure proper segregation of chemicals, use of proper and well-maintained storage vessels, restricted access to storage areas, proper calibration and maintenance of equipment, pressure release valves, and alarm systems.

Engineering controls to prevent burns are aimed at reducing contact with hot surfaces or steam. These include effective workplace design (that limits traffic in hot areas, reduces proximity to hot surfaces, provides sufficient space to work and move around hot equipment, etc.), shielding, process changes, local exhaust ventilation for the removal of steam, interlock systems that prevent opening autoclaves or sterilizers until a cooler temperature is reached, mechanical devices (tongs, etc.) for manipulating hot items, temperature and pressure relief valves, and reducing hot water temperatures.

Pressure

Compressed gas cylinders are designed to safely hold their contents during regular use and the demands expected to be placed on them. Regulators, fittings and delivery systems must likewise meet manufacturers' requirements.

Protective valve caps are an engineering control to protect the valve head from damage when the cylinder is not in use. If the cylinder has a valve cap, the cap should always be placed on cylinders when the cylinder is not expected to be used for a period of time, such as for a work shift. All cylinders must be restrained from tipping by means of racks, chains, strap or other suitable means. Metal racks and chains are preferable to fabric straps, which may burn and tear during a fire.

Electrical Hazards

All electrical rooms and vaults must be guarded from unauthorized access. Warning signs must be placed on doors warning employees of the electrical dangers as well as indicating that only authorized workers are permitted in these rooms. Electrical services need to be guarded by means of locked enclosures and/or elevating them away from where workers can reach them.

Insulation protects workers from contact with electricity. All equipment, wiring and cords must be maintained and used in a manner that keeps electrical insulation intact.

Electric appliances and equipment are protected from overloading by means of electric overloading devices such as fuses or circuit breakers. Although these devices will stop the flow of current when too much current flows through them, they are intended to protect equipment but not workers. All overloading devices must be of sufficient ratings. Replacing fuses or circuit breakers with overloading devices that trip at a higher current than specified is a dangerous practice as is replacing overloading devices with a conductor. Ground fault circuit interrupters (GFCIs) are safety devices that will interrupt the flow of current by monitoring the flow of current to and from the device. GFCIs are important engineering controls that should be used in wet environments and to power tools and equipment outdoors.

Another important engineering control is grounding. Grounding of electrical equipment refers to creating an electrical path to earth (ground). Grounding provides some protection to equipment operators if there is a fault in the equipment or insulation that energizes the equipment housing; electricity would flow to ground rather than through the worker. Grounding for equipment that is plugged into electrical receptacles can be identified by the third prong on the electrical plug. Similarly electrical cords commonly have a third prong on the plug end. The third prong that facilitates grounding must not be removed or defeated. The housings of all equipment should be suitably grounded. Some electrical cords for tools or other equipment do not have a third grounding prong.

This equipment is double insulated, meaning that it has been designed with additional insulating considerations to prevent the housing of the device from becoming energized. Such a device will be labelled with the term “double insulated” or with a symbol comprised of a square box within another square box.

Centrifuge Hazards

Engineering controls include interlock systems that do not allow the centrifuge lid to be opened until the rotor has stopped, centrifuge design features such as latched lids, inner safety lids, viewing windows, safety shut-off switches, and imbalance sensors.

Mechanical Hazards

Safeguards prevent workers from contacting dangerous machine motions by means of a physical guard, distance, or other mechanism that stops the machine from operating when the worker attempts to access dangerous machine areas.

Guards, which are physical barriers that cover dangerous machine areas, are usually the preferred method of safeguarding. Guards must be durable enough to withstand conditions that are placed on them and must not be easily removed by operators. Generally, tools must be used to remove guards unless the machine is protected by other means.

Safeguarding devices are other means of engineering controls. Safeguarding devices stop a machine from operating if an operator attempts to access dangerous machine parts. Safeguarding devices can be of various types including laser or light curtains that sense a person's body or hands, or interlocks that automatically deactivate a machine when a guard is removed.

The choice of guards, safeguarding devices or other methods of control is largely dependent on the nature and function of the equipment. New equipment that is brought into laboratories is usually equipped with adequate safeguards, as its design and manufacture must meet requirements of safety standards. However, older equipment may be in use in facilities that does not incorporate sufficient safeguards and this machinery may require additional safeguarding upgrades.

Fire Hazards

Engineering controls include a variety of fire prevention and fire suppression strategies. Fire detection and control equipment includes smoke or heat alarms, automated sprinkler systems, workplace design to ensure safe and effective egress, fire doors, emergency lighting, appropriate chemical storage, use of fire retardant materials, construction in compliance with the Alberta Fire Code and the Alberta Building Code.

Administrative Controls

Ergonomic hazards

Controls that focus on how work is performed and organized are administrative controls. Administrative controls include policies, procedures, work practices, rules, training and work scheduling, including:

- Establish ergonomic purchasing standards for tools, equipment and office furniture.
- Conduct user trials to test new equipment and tools with input from workers.
- Maintain equipment, workstations and tools to optimize their operation.

- Develop work practices to reduce biomechanical hazards.
- Provide training programs to educate workers regarding biomechanical risk factors, signs and symptoms and safe work practices (including proper lifting methods).
- Provide self assessment tools to identify and control biomechanical hazards.
- Perform ergonomic assessments to identify hazards and implement controls.
- Implement job rotation designed to move workers between jobs that utilize different muscle groups.
- Use job expansion to integrate a variety of tasks that utilize different muscle groups and address repetition and mental demands.
- Optimize work shift scheduling to minimize extended work hours and overtime.
- Design break schedules to reduce biomechanical hazards.
- Use micro-breaks to give the body a chance to change posture and recover.
- Encourage monitoring and early reporting of the signs and symptoms of MSIs.

Radiation

Administrative controls include policies and procedures and on-going assessment of possible exposures to radiation. The policies and procedures are designed to ensure that workers are informed about the hazards of radiation and are trained in the safe work procedures necessary to prevent exposure.

1. Inspection and Registration of Radiation Equipment

In Alberta certain medical radiation emitting equipment requires registration with the College of Physicians and Surgeons of Alberta prior to clinical operation.

2. Radiation Safety Program

A key administrative control is the development and implementation of a comprehensive radiation safety program, with a designated radiation safety officer. The purpose of the program is to ensure compliance to all radiation protection legislation, provide oversight to those using radiation, provide training and exposure monitoring, and ensure that equipment is properly registered and maintained. More details about roles and responsibilities in a radiation safety program can be found in Health Canada Safety Code 35: Safety Procedures for the Installation, Use and Control of X-ray Equipment in Large Medical Radiological Facilities[7]. When nuclear materials are being used the requirements for the radiation safety program are set by the Canadian Nuclear Safety Commission

[7] Accessible at http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/safety-code_35-securite/section-a1-eng.php

(CNSC). A laser safety program is required for facilities with class 3B and 4 lasers and an individual with specific training must designated as the laser safety officer.

3. Time

As one of the three key principles of radiation control, limiting the time workers may be exposed to radiation is an administrative control. The scheduling of workers to reduce individual exposure and reduce the number of workers required in an exposure area limits exposure time. Scheduling is an important administrative control for UV exposure as well as exposure to ionizing radiation.

4. Training

Worker education is a critical administrative responsibility. In order to install, maintain, repair or operate radiation equipment a worker must be adequately qualified, suitably trained and sufficiently experienced to perform the work safely. In some cases (such as in laboratories and nuclear medicine departments which must obtain CNSC licenses for using radioactive material), specific certification is required. Workers must be trained on the nature of the hazards they may be exposed to and the control measures that must be utilized to reduce exposure. Engineering, administrative and personal protective equipment controls should be covered in training. In addition, emergency response procedures, hazard reporting, and proper waste disposal must be addressed. There should be a mechanism to assess worker competency following training to ensure the effectiveness of the training.

5. Safe work procedures

Safe work procedures for working with radiation are established as part of a radiation safety program. The procedures are developed to protect both patients and workers. For workers, the procedures involve the use of all levels of control with an emphasis on the strategies to increase distance between the worker and the source, decrease time spent where exposure could occur and provide appropriate shielding or barriers to block exposure. The design of safe work procedures also incorporates information found in equipment instruction manuals.

6. Exposure monitoring

Where there is the potential for employee exposure to ionizing radiation, exposure monitoring must be part of the radiation safety program. The Alberta Radiation Protection Regulation requires exposure monitoring for workers who are working with ionizing radiation.

Long term effects from exposure to ionizing radiation are cumulative and may appear many years later. Health Canada’s National Dose Registry will provide a worker's own dose history upon request. Also, employers and prospective employers can obtain a worker's dose history upon written consent of the individual. This information is available at http://www.hc-sc.gc.ca/ewh-semt/occup-travail/radiation/regist/index-eng.php.

The most common approach to exposure monitoring for ionizing radiation is the use of radiation dosimeters, which measure the individual's exposure. Types of ionizing radiation dosimeters include thermoluminescent dosimeters (TLDs) and pocket or ring dosimeters. Ring dosimeters are TLDs that are designed to wear on a finger to measure exposure to the hands. In healthcare facilities TLDs provide a quarterly (every 3 months) accumulation of radiation exposure. Pocket dosimeters use quartz fibres and provide a direct read-out so that workers working in high radiation areas may check their exposure as they perform their tasks and take corrective action when necessary.

Dosimetry for various forms of non-ionizing radiation is available but more complex in terms of operation and interpretation and is not widely used for worker exposure monitoring in healthcare.

7. Disposal procedures

Waste disposal is a critical component of a radiation safety program, particularly with regard to radioactive material. A radiation safety officer should be consulted on the appropriate disposal procedures. In many cases, radioactive waste is segregated by type and stored until it decays (loses radioactivity) sufficiently for disposal.

Trips, Slips and falls

Administrative controls to prevent slips, trips and falls include:

- Selection of proper flooring
- Education of workers and enforcement of the use of proper footwear
- Timely clean-up of any spills
- Conduct frequent inspections of walking surfaces
- Eliminate the use of extension cords that may pose tripping hazards
- Keep aisles and hallways free of clutter
- Safe work procedures

Cuts

Administrative controls widely used to reduce the potential for cuts include

- Worker education
- Safe work procedures
- Keeping sharp edges away from the body
- Use of tools correctly

- Engaging all machine guards
- Choice of appropriate tool
- Restricted access to work areas
- Signs and warnings in hazardous areas, and
- Safe disposal of all sharps, including broken glass.

Temperature Extremes

Administrative controls for cold environments include allowing an adjustment period, work-rest schedules with rest periods in a warm area, scheduling of work for warmer periods of the day, reducing periods of physical inactivity, such as sitting for long periods of time and occupational health programs to identify medical conditions that may pre-dispose workers to exposure.
For working with cryogenic materials, administrative controls include worker education about the nature of the hazard and how to work safely with cryogenic agents, safe work practices (including insertion of materials so that boiling and splashing can be avoided, avoiding touching the skin with any part of the equipment, purchasing appropriate vials for freezing and thawing, etc.), and emergency response procedures for spills or exposures.

To prevent burns, administrative controls include worker education, established safe work practices, assessment of work area to identify potential sources of burns, and equipment maintenance programs.

Pressure

Compressed gas cylinders must be handled, maintained and stored carefully to prevent cylinders from falling or a gas release. Proper transportation of cylinders must also be considered whether it be by vehicle or within a work area by use of a hand cart or other means. A safe work procedure should be developed for the use, transport, storage and maintenance of compressed gas cylinders in the workplace. Some key compressed gas safe work practices are detailed below:

What are basic safe practices when working with compressed gases?[8]

- Read the MSDSs and labels for all of the materials you work with.
- Know all of the hazards (fire/explosion, health, chemical reactivity, corrosivity, pressure) of the materials you work with.
- Know which of the materials you work with are compressed gases and check the label, not the cylinder colour, to identify the gas.

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[8] CCOHS; *OSH Answers – How Do I Work Safely with Compressed Gasses?;July 8, 2008;* http://www.ccohs.ca/oshanswers/prevention/comp_gas.html

- Store compressed gas cylinders in cool, dry, well-ventilated areas, away from incompatible materials and ignition sources. Ensure that the storage temperature does not exceed 52°C (125°F).
- Store, handle and use compressed gas cylinders securely fastened in place in the upright position. Never roll, drag, or drop cylinders or permit them to strike each other.
- Move cylinders in handcarts or other devices designed for moving cylinders.
- Leave the cylinder valve protection cap in place until the cylinder is secured and ready for use.
- Discharge compressed gases safely using devices, such as pressure regulators, approved for the particular gas.
- Never force connections or use homemade adaptors.
- Ensure that equipment is compatible with cylinder pressure and contents.
- Carefully check all cylinder-to-equipment connections before use and periodically during use, to be sure they are tight, clean, in good condition and not leaking.
- Carefully open all valves, slowly, pointed away from you and others, using the proper tools.
- Close all valves when cylinders are not in use.
- Never tamper with safety devices in cylinders, valves or equipment.
- Do not allow flames to contact cylinders and do not strike an electric arc on cylinders.
- Always use cylinders in cool well-ventilated areas.
- Handle "empty" cylinders safely: leave a slight positive pressure in them, close cylinder valves, disassemble equipment properly, replace cylinder valve protection caps, mark cylinders "empty" and store them separately from full cylinders.
- Wear the proper personal protective equipment for each of the jobs you do.
- Know how to handle emergencies such as fires, leaks or personal injury.
- Follow the health and safety rules that apply to your job.

Electrical Hazards

Laboratories should develop a written electrical safety program that addresses all aspects of electricity use. CSA Z32 *Electrical Safety and Essential Electrical Systems in Health Care Facilities* outlines guidelines of an electrical safety program. Some elements of an electrical safety program include:

- Education of staff that operate equipment
- Inspection, testing and maintenance of electrical equipment
- Design and management of electrical installations

Extension cords are used in many applications and should only be used for temporarily supplying power. Extension cords are not to replace permanent wiring. Other considerations to follow when using extension cords include:

- Protect cords from damage; do not allow vehicle to drive over cords.
- Never keep an extension cord plugged in when it is not in use.
- Do not use a damaged extension cord.
- Extension cords and most appliances have polarized plugs (one blade wider than the other). These plugs are designed to prevent electric shock by properly aligning circuit conductors. Never file or cut the plug blades or grounding pin of an extension cord.
- Do not plug one extension cord into another. Use a single cord of sufficient length.

Hazard assessments should guide the development of work procedures to assess and control electrical hazards.

Centrifuge Hazards

Worker education is a key administrative control to prevent centrifuge accidents. Safe operating procedures include pre-centrifugation, during centrifugation and post-centrifugation procedures that are consistent with the manufacturer's instructions. Emergency procedures must address incidents where the centrifuge is unbalanced as well as tube breakage and possible contamination of the centrifuge or its parts. Equipment selection and maintenance is critical for ensuring the centrifuge is appropriate for the needs of the laboratory and continues to function without problems. Keeping a log book for rotor use is necessary to track rotor fatigue for ultracentrifuge rotors.

Mechanical Hazards

Written safe work procedures and policies for machinery should outline operator responsibilities, work practices, maintenance procedures, removal of guards and training requirements. For hazardous machinery, policies should also specify the requirements of workers' clothing to fit closely to the body and to prohibit jewellery and unrestrained long hair that can become entangled in machines, resulting in serious injury. Equipment must only be operated by trained and authorized users which management must enforce.

Machinery should be regularly inspected to identify potential conditions that could result in an equipment failure or conditions that could contribute to an injury. Where applicable, preventative maintenance must also be performed. Machinery controls must be clearly identified. Signs that indicate that the removal of guards can result in an injury and to alert workers of machinery that starts automatically should be placed on machinery.

Fire Hazards

Administrative controls are widely used to ensure the maintenance of fire equipment and effectiveness of the response plan. Major aspects of the fire prevention and response plan include:

- Employee training
- Safe work procedures that minimize the potential for fires, including surgical fires
- Building design considerations
- Proper storage and use of chemicals and other materials, including bonding and grounding where required based on quantity and class of liquids
- Ensure flammable chemicals are not used near an ignition source
- Development of evacuation plans/routes
- Designated roles and responsibilities in a fire response plan
- Routine inspection for potential fire hazards
- Availability and maintenance of fire response equipment, including the appropriate numbers and types of fire extinguishers
- Availability and maintenance of alarm systems
- Regular fire drills (including evaluation and identification of opportunities to improve)
- No smoking policy
- Use of approved equipment and appliances only
- Contractor orientation to include fire hazard information and fire response plan.

Personal Protective Equipment Controls

Radiation

Depending upon the nature of the radiation and the specific tasks the worker is performing, a range of PPE may be used as additional controls (to engineering and administrative controls) to reduce exposures. Examples include protective eyewear used when working with lasers, UV, infrared or ionizing radiation that is specifically made to reduce exposure to each type of radiation.

Protective clothing is also used when working with various forms of radiation. For ionizing radiation, protective clothing (commonly called lead aprons) includes shielding materials. All ionizing radiation protective clothing must be uniquely identified and inspected annually with an x-ray machine for any cracks or holes in the shielding material. These inspections results must be recorded and saved. Clothing also protects against exposure to UV rays. Gloves protect workers from contamination with radioactive material and must be worn when there is the potential for contamination.

Trips, Slips and falls

The use of appropriate footwear in the laboratory is essential to prevent trips, slips and falls. Workers should be required to wear flat shoes with non-slip soles. (To prevent chemical exposure in the event of a spill, footwear should cover the entire foot and be of non-porous material.)

Cuts

PPE is available to reduce cuts. In choosing PPE, the dexterity required to do the task must be considered. When there is the potential for body contact with blades or other equipment that may cause cuts, protective clothing should be worn. Eye protection is important if there is any possibility that fragments of glass or other sharps may enter the eyes, and footwear must protect the wearer from accidental exposure to sharps. Gloves are usually required as PPE to protect workers from cuts. In some cases, full arm coverage is recommended. The selection of gloves depends on the nature of task. Cut-resistant gloves are available that are made from a variety of materials including Kevlar, Dyneema, HexArmor, stainless steel and wire mesh.

Temperature Extremes

For cold environments, PPE includes layers of clothing, mittens rather than gloves if possible, head and face covers, insulated footwear. All PPE should be kept dry.

PPE to protect workers from cryogenic hazards include non-porous and non-woven protective clothing, full foot protection, insulated gloves, safety glasses or a face shield (based on nature of the task).

PPE is often used to prevent burns. Insulated gloves, protective clothing, foot protection, and eye/face protection should be chosen based on the hazard assessment. Pot holders and long oven mitts protect workers from burns or contact with hot surfaces.

Pressure

Personal protective equipment should be selected based on the hazards presented by the substance under pressure. Consult Material Safety Data Sheets for the specific products that are used. General PPE requirements for compressed gas cylinders may include gloves if hands may be exposed to substances that may cause freezing and protective footwear protects the feet from a large cylinder that is inadvertently dropped.

Electrical Hazards

PPE is selected on the risk level that is presented by the electrical equipment that is worked on, voltage and the potential for arcs. CSA Z462 provides detailed selection criteria for PPE including body, hand, head, face, eye, and hearing protection. PPE must be approved or certified by agencies as required by the OHS Code.

Eye protection should be worn by all workers who work on energized equipment to protect from burns and flying particles. Face shields must be worn, based on the risk level presented to workers to protect from burns and flying particles.

Centrifuge Hazards

PPE for centrifuge operators is based on the nature of the materials being centrifuged. Gloves are commonly used when handling specimens and rotors.

Mechanical Hazards

PPE must be selected based on an assessment of the hazards arising from the operation and function of each piece of machinery. Where hazardous mechanical motions are present, loose clothing must not be worn and some PPE such as gloves can create additional hazards if they were to become entangled in moving machinery.

Psychological Hazards and Controls

Each laboratory should systematically conduct hazard assessments for tasks performed by laboratory workers and identify if and where the potential exists for psychological hazards. In this section, examples are provided of psychological hazards that may be encountered in laboratories, and possible control measures will be suggested. Employers should carefully evaluate the potential for exposure to hazards in all areas and ensure that they have an effective hazard control plan in place. This information will be useful for inclusion into hazard assessments. Please note, this is not designed to be an exhaustive treatment of the subject, but is rather an overview summarizing the some of the reported psychological hazards in healthcare settings.

Note:
The following chart provides basic information about control strategies for commonly occurring psychological hazards. The selection of controls should be based on a risk assessment of the tasks and environment. Worker tolerance to stressors varies considerably. Most controls listed here relate to organizational controls, with some mention of personal controls that may be useful in controlling risk. Worker education and good communication processes are critical administrative controls. All legislation related to the assessment of hazards, selection and use of controls should be followed.

Potential Psychological Hazards or Effects of Workplace Stressors	**Summary of Major Control Strategies**		
	Engineering	Administrative	Personal
Abuse by clients or members of the public	Isolation areas for agitated clients. Furniture arrangement to prevent workers entrapment. Lockable washrooms for workers separate from client or visitors. Controlled access. Grating or bars on street level windows. Bright lighting in parking lots. Alarm systems and panic buttons. Video surveillance.	Management policies and procedures related to no tolerance of violence or abuse. Worker education in violence awareness, avoidance and de-escalation procedures. Well-trained security guards. Escort services to parking lots. Liaison and response protocols with local police. Policies related to control of keys. Working alone policies. Reporting procedures for incidents and near misses. Use of nametags.	Ability to request support. Use of counselling services.

Abuse by co-workers	Alarm systems and panic buttons. Video surveillance.	Management policies and procedures related to no tolerance of violence or abuse. Worker education in violence awareness, avoidance and de-escalation procedures. Well-trained security guards. Escort services to parking lots. Working alone policies. Reporting and investigation procedures for incidents and near misses.	Assertiveness training. Use of mediation and/or counselling services.
Hazards related to working alone • **Threat of violence** • **Medical emergencies when alone**	Communication devices. Restricted access. Workplace design considerations. Panic alarms. Bright lighting. Mirrors to facilitate seeing around corners or hallways. Surveillance cameras.	Scheduling to avoid having workers work alone. Worker training. Working alone policies. Adequate security. Escort services to parking lots.	
Stress related to critical incidents		Training to increase awareness of signs and symptoms of critical incident stress. Critical incident stress team to respond to incidents. Communication and call procedures to mobilize team. Defusings and debriefings.	Development of support systems to assist in dealing with stress. Use of counselling services.
"Technostress" related to the introduction of new technology	Design of instruments or equipment with user-friendly features.	Selection procedures to ensure user-friendly technology choices. Provision of sufficient training for workers. Worker participation in selection and implementation of new technology. Provision of problem solving resources and support workers. Back-up plans in the event of failures. Change management strategy for introduction of new technology. Realistic expectations regarding use of communication technology. Limit use of technological monitoring of worker productivity. Setting and communication of priorities.	Self-education concerning new technologies. Time management strategies. Open communication about stress related to change. Healthy lifestyles. Setting realistic goals. Limiting the need to multi-task. Technology "time outs". E - vacations.
Substance abuse as a response to excessive workplace stressors		Worker involvement in substance abuse policy and procedures development. Worker education about	Increase awareness of substance abuse signs and symptoms.

		substance abuse. Training workers and supervisors to recognize the signs of substance abuse. Procedures to limit individual access to narcotics. . Provision of counselling services and return to work plans.	Communication with counsellors. Report to family physician. Participate in treatment programs and return to work programs.
Depression, anxiety, sleep disorders, other mental illness as a response to excessive workplace stressors		Worker education about the signs and symptoms of depression, anxiety, sleep disorders, other mental illness. Elimination of workplace risk factors for depression, anxiety, sleep disorders, other mental illness. Provision of support services and programs. Benefit plans provision. Effective return to work programs.	Programs to maintain or build resilience or coping skills. Development of support system. Communication with family physician.
Hazards related to impacts of aging on workers		Management policies and procedures that ensure no age discrimination. Proactive policies to accommodate aging workers. Training opportunities for aging workers. Education for all workers on intergenerational communication. Aging workers as trainers/mentors. Flexible work arrangement. Job redesign to accommodate aging workers.	Healthy lifestyle. Use of client and material handling equipment. Adequate sleep. Awareness of potential side effects of medication.
Hazards related to shiftwork and hours of work	Work environment designed to improve alertness (and minimize drowsiness). Appropriate lighting levels. Lighting levels that are adjustable by workers. Appropriate thermal environment. Well lit, safe and secure working environment.	Management policies and procedures to address working hours and shift design. Worker involved in design of shift schedule. Limit hours of work and overtime. Shifts designed so workers get enough rest between shifts. Split shifts are avoided, if possible. Train workers and management in fatigue and shift work issues. Work shift schedules designed to minimize fatigue (e.g. maximum number of consecutive night shifts, forward rotation, etc.). Work designed so that critical tasks are not conducted at ends of shifts or "low points" in shift. Quality breaks are in	Appropriate sleep schedule and sleep environment. Strategies in place to promote sleep. Diet adjusted to accommodate shift schedule. Healthy lifestyle. Physical exercise. Safe plan for commute to work. Plan for family and friends. Use of stimulants and sedatives are minimized. Alertness strategies are

		place. Policies to encourage the reporting of concerns associated with fatigue. Thorough investigation of incidents and near misses with fatigue as a possible cause.	utilized (e.g. bright lighting levels, regular short breaks, communication with co-workers, etc.).
Stress related to work-life conflict		Management policies and procedures that support work-life balance (e.g. voluntary reduced hours, voluntary part-time work, phased in retirement, telecommuting, job sharing, paid and unpaid leaves, dependent care initiatives, etc.). Work designed to address workload and work demands issues. Reliance on paid and unpaid overtime is reduced. Supportive management culture. Work-life balance policies are communicated to workers. The use and impact of work-life balance policies is measured.	Time log used to track time. Work-life balance programs are utilized. Work activities are isolated from home time. Time is effectively managed. Days off are protected. Appropriate sleep habits. Social support system is in place.
Exposure to nuisance or irritating noise levels that may induce stress	Any engineering controls required to abate noise to allowable levels, if over PEL. Sound absorber panels. Personal communication devices rather than overhead pagers. Maintenance and repair of facility equipment, including the ventilation system. Lubrication of equipment with moving parts. Design considerations related to noise reduction in new/renovated facilities. Padded chart holders and pneumatic tube systems. Sound-masking technology.	Lower rings on telephones. Encourage use of soft-soled shoes. Worker education on noise levels created by various activities. Posted reminders to reduce noise. Purchasing decisions that take into account noise levels of equipment. Location of noisy equipment to more isolated areas. Work organization at nursing stations to reduce noise.	
Exposure to poor indoor air quality that may induce stress	Proper ventilation system design. Ventilation system maintenance activities. Isolation/segregation of work processes that may create	Contractor requirements to reduce air contamination. Selection of low-pollutant cleaning chemicals. Cleaning schedules. Infection prevention and controls standards. Rules regarding the	

	contaminants.	use of personal appliances that may impact HVAC operations. Procedures to report and investigate indoor air quality complaints. Worker involvement in indoor air quality investigation. Communication to enable frank and timely discussion of IAQ issues and what is being done to resolve them.	

Selected notes about controls for psychological hazards

Potential psychological hazards and controls vary greatly in jobs, locations and organizations and are only briefly discussed here. Personal factors impact how stressors are viewed and addressed. A comprehensive discussion of causes and impacts of psychological stressors on workers and on the organization can be found in Best Practices for the Assessments and Control of Psychological Hazards – Vol. 5.

Program elements for preventing or controlling abuse towards workers in the workplace

Because the scope of abuse of workers is broad, with a wide range of potential internal and external perpetrators and a myriad of individual considerations, prevention of abuse of workers is multi-faceted. This list of prevention procedures and control techniques is not all-inclusive, but rather a sample of the complexities that should be considered in a program for laboratories:

- ☐ Development, communication and enforcement of policies that indicate no tolerance for any form of violence, harassment, or abuse including bullying. Awareness sessions for all workers on abuse and violence in the workplace, reporting procedures and controls.
- ☐ Staff identification to reduce unauthorized access to areas – this includes a requirement of all workers to wear identification badges. It is suggested that information that is not necessary not be shown on the front to the badge to reduce risk to workers.
- ☐ Client guidelines and signage to emphasize that abuse will not be tolerated – this may include the preparation and dissemination of client information guidelines, in which client behaviour is discussed, the commitment to no tolerance for abuse against workers and the encouragement of mutual respect are covered.
- ☐ Working alone guidelines and communications protocols. Working alone guidelines are required by Alberta occupational health and safety legislation (OHS Code, Part 28), and must include a written hazard assessment as well as communication protocols for workers who must work alone.

- ☐ Alarm systems and emergency communication devices (panic buttons, etc.). Identification of workers or locations that should be provided with alarm systems and panic buttons should occur. Once any alarm systems are installed or provided, all workers should be trained on how to use them and how to respond to alarms.
- ☐ Identification and correction of high risk facility issues (e.g., isolated areas, parking lots, low lighting, no escape routes, etc.). There are many risk factors posed by the design of the facility. The laboratory should identify risk factors and work to reduce the risk in the areas. A checklist would be useful for departments to help identify facility issues contributing to worker risk.
- ☐ Training programs that include non-violent crisis intervention and assault management techniques.

Working alone

Working alone is addressed in the Alberta OHS Code 2009.

Controls required

- Employers must, for any worker working alone, provide an effective communication system consisting of
- radio communication,
- and land line or cellular telephone communication, or some other effective means of electronic communication that includes regular contact by the employer or designate at intervals appropriate to the nature of the hazard associated with the worker's work.

If effective electronic communication is not practicable at the work site, the employer must ensure that

- the employer or designate visits the worker, or
- the worker contacts the employer or designate at intervals appropriate to the nature of the hazard associated with the worker's work.

Alberta OHS Code 2009, Part 28

Work-Life balance

An employer should strive to develop policies and programs that support work-life balance. The following is a list of general work-life balance policies and programs to consider:

- Flexible time arrangements including alternative work schedules, compressed work week, voluntary reduced hours / part-time work and phased in retirement

- Flexible work locations through the use of technology such as telecommuting and satellite offices
- Flexible job design through job redesign, job sharing
- Wellness programs
- Flexible benefits including paid and unpaid leaves for maternity, parental care giving, educational and sabbatical leaves
- Employer sponsored childcare and eldercare practice and referral services

A work-life conflict issue recognized in healthcare is often brought on by workload and work demands. Some strategies to reduce the impact of increased workloads and work demands include the following:

- Identify methods to reduce worker workloads. According to research, special attention is required for managers and professionals.
- Track the costs associated with understaffing and overwork (paid and unpaid overtime, increased turnover, employee assistance program use, increased absenteeism).
- Strive to reduce the amount of time workers spend in job-related travel.
- Reduce reliance on paid and unpaid overtime.
- Consider a "time in lieu" system to compensate for overtime.
- Develop norms regarding the use of technology (e.g. cell phones, PDA, laptops, email) outside of work time.
- Allow workers to say "no" to overtime without repercussions.
- Provide a limited number of days of paid leave per year for caregiver responsibilities (childcare and eldercare) and personal problems.
- Measure the use of work-life practices (e.g. job sharing, compressed work week, etc.) and reward sections of the organization with high usage. Investigate sections where usage is low.
- Increase supportive management. Specifically, organizations should increase the extent to which managers are effective at planning the work to be done, make themselves available to answer worker questions, set clear expectations, listen to worker concerns and give recognition for a job well done.

Shiftwork

The following guidelines will assist in reducing the psychological impacts of shift work.

Good Practice Guideline for Shift Work Schedule Design[9]

- Plan a workload that is appropriate to the length and timing of the shift.
- Strive to schedule a variety of tasks to be completed during the shift to allow workers some choice about the order they need to be done in.
- Avoid scheduling demanding, dangerous, safety-critical or monotonous tasks during the night shift, particularly during the early morning hours when alertness is at its lowest.
- Engage workers in the design and planning of shift schedules.
- Avoid scheduling workers on permanent night shifts.
- When possible, offer workers a choice between permanent and rotating shifts.
- Use a forward-rotating schedule for rotating shifts, when possible.
- Avoid early morning shift starts before 7AM, if possible.
- Arrange shift start / end times to correspond to public transportation or consider providing transport for workers on particular shifts.
- Limit shifts to a maximum of 12 hours (including overtime) and consider the needs of vulnerable workers.
- Limit night shift to 8 hours for work that is demanding, dangerous, safety critical or monotonous.
- Avoid split shifts unless absolutely necessary.
- Encourage and promote the benefit of regular breaks away from the workstation.
- Where possible, allow workers some discretion over the timing of breaks but discourage workers from saving up break time for the end of the workday.
- In general, limit consecutive working days to a maximum of 5-7 days.
- For long work shifts (>8 hours), for night shifts and for shifts with early morning starts, consider limiting consecutive shifts to 2-3 days.
- Design shift schedules to ensure adequate rest time between successive shifts.
- When switching from day to night shifts (or vice versa), allow workers a minimum of 2 nights' full sleep.
- Build regular free weekends into the shift schedule.

[9] Adapted from Government of the U.K; Health and Safety Executive; Managing shift work HSG256; 2006; www.hse.gov.uk/pubns/priced/hsg256.pdf

For a more detailed discussion of controls to prevent or reduce psychological hazards, please consult Best Practices for the Assessments and Control of Psychological Hazards – Vol. 5.

APPENDIX 1 - OHS-related Competencies for Laboratory Technologists

Professional competencies for Laboratory Technologists are established by the Canadian Society for Medical Laboratory Science (CSMLS). Part 1 – Safe Work Practices – includes 14 specific competencies related to occupational health and safety. The complete list of competencies can be found at
http://www.csmls.org/images/csmls/Certification/Competency_Profiles/ctr001e_general_mlt_competency_profile_2005.pdf

Examples of OHS-related competencies include the following.

Canadian Society for Medical Laboratory Science – **General Medical laboratory Technologist** – Competencies Expected for Entry Level

Competency
Safe Work Practices 1.01 Applies the principles of standard precautions
1.02 Uses personal protective equipment, e.g., gloves, gowns, mask, face shields, aprons
1.03 Applies appropriate laboratory hygiene and infection control practices
1.04 Minimizes possible dangers from biological specimens, laboratory supplies, radioactive material, and equipment
1.05 Utilizes laboratory safety devices in a correct manner, e.g., biological safety cabinets, fume hoods, laminar flow cabinets, safety pipetting devices, safety containers and carriers, safety showers, eye washes
1.06 Labels, dates, handles, stores, and disposes of chemicals, dyes, reagents, and solutions according to WHMIS and existing legislation
1.07 Handles and disposes of "sharps" according to institutional policy
1.08 Stores, handles, transports and disposes of biological, toxic, and radioactive material according to existing legislation
1.09 Selects and utilizes the appropriate method for items to be disinfected/sterilized
1.10 Minimizes the potential hazards related to disinfection/ sterilization methods
1.11 Applies first-aid measures in response to incidents, e.g., chemical injury, traumatic injury, electrical shock, burns, radioisotope contamination
1.12 Applies spill containment and clean up procedures for infectious materials and dangerous chemicals according to institutional policy
1.13 Responds appropriately to fire emergencies

1.14 Reports incidents related to safety and personal injury (e.g., needle stick injuries), in a timely manner

Canadian Society for Medical Laboratory Science – **Medical Laboratory Assistant** – Competencies Expected for Entry Level

Competency
Safe Work Practices 2.01 Applies the principles of standard precautions
2.02 Uses personal protective equipment correctly, e.g. gloves, gowns, masks, face shields, aprons
2.03 Applies appropriate laboratory hygiene and infection control practices
2.04 Minimizes possible dangers from biological specimens, laboratory supplies, and equipment
2.05 Utilizes available laboratory safety devices in a correct manner, e.g. fume hoods, biosafety cabinets, safety pipetting devices
2.06 Applies WHMIS and existing legislation to the labeling, dating, handling, storing and disposal of chemicals, dyes, reagents and solutions
2.07 Handles and disposes of “sharps” according to safety guidelines
2.08 Selects and utilizes the appropriate method for items to be disinfected and/or sterilized
2.09 Responds to incidents such as chemical injury, traumatic injury, needle stick injury electrical shock, burns, patient collapse, e.g. first aid
2.10 Applies spill containment and clean up procedures for infectious materials and dangerous chemicals
2.11 Responds appropriately to all emergency codes
2.12 Reports incidents related to safety and personal injury (e.g. needle stick injury, chemical splash) in a timely manner
2.13 Applies occupational health and safety guidelines with respect to electrical, radiation, biological and fire hazards

APPENDIX 2 - Additional Resources

The following are useful references and links to relevant resource materials. For complete reference lists, please consult the Best Practice documents developed by Alberta Employment and Immigration available at http://www.employment.alberta.ca/SFW/6311.html

Alberta Government legislation related to chemicals in the workplace may be accessed through the Government website at http://employment.alberta.ca/SFW/307.html

Alberta Human Resources and Employment; Workplace Health and Safety; *Respiratory Protective Equipment: An Employer's Guide*; Bulletin PPE001 – Breathing Apparatus; April 2005. http://employment.alberta.ca/documents/WHS/WHS-PUB_ppe001.pdf

Alberta OHS Code 2009, Part 18 – Personal Protective Equipment

Alberta Workplace Health and Safety *Preventing Violence and Harassment at the Workplace*, Bulletin VAH001, 2006, retrieved from http://www.employment.alberta.ca/documents/WHS/WHS-PUB-VAH001.pdf

American Chemical Society – Chemical Storage Resources http://portal.acs.org/portal/acs/corg/content?_nfpb=true&_pageLabel=PP_ARTICLEMAIN&node_id=2231&content_id=WPCP_012310&use_sec=true&sec_url_var=region1&__uuid=dae6dbb6-9d03-4590-8995-5325374e8844

BC Centre for Disease Control – A Guide for the Selection and Use of Disinfectants http://www.mtpinnacle.com/pdfs/disinfectant-selection-guidelines.pdf

Berkeley Lab – Chemical Hygiene and Safety Plan – Control Procedures for Acids and Bases http://www.lbl.gov/ehs/chsp/html/acids_bases.shtml

Best Practices for Infection Prevention and Control Programs in Ontario In All Health Care Settings; Provincial Infectious Diseases Advisory Committee (PIDAC); Ministry of Health and Long-Term Care; September 2008. http://www.health.gov.on.ca/english/providers/program/infectious/diseases/ic_ipcp.html

Bilsker, D., Gilbert,M., Myette, T.L., and Stewart-Patterson, C. *Depression & Work Function: Bridging the gap between mental health care & the workplace;* Retrieved from www.comh.ca/publications/resources/dwf/Work_Depression.pdf

Brigham Young University – Acid Safety http://www.ee.byu.edu/cleanroom/acid_safety.phtml

Brigham Young University – Solvent Safety http://www.ee.byu.edu/cleanroom/solvent_safety.phtml

Canadian Centre for Occupational Health and Safety, *OHS Answers: Fatigue* July 2007; Retrieved from www.ccohs.ca/oshanswers/psychosocial/fatigue.html

Canadian Centre for Occupational Health and Safety, *OSH Answers: Substance Abuse in the Workplace*, Retrieved from www.ccohs.ca/oshanswers/psychosocial/substance.html

Canadian Centre for Occupational Health and Safety, *OSH Answers: How do I work safely with Flammable and Combustible Liquids?* http://www.ccohs.ca/oshanswers/prevention/flammable_general.html

Canadian Centre for Occupational Health and Safety, *OSH Answers: Flammable and Combustible Liquids Hazards -* http://www.ccohs.ca/oshanswers/chemicals/flammable/flam.html

Canadian Centre for Occupational Health and Safety, *OSH Answers: OHS Legislation in Canada; Basic Responsibilities:* http://www.ccohs.ca/oshanswers/legisl/responsi.html

Canadian Centre for Occupational Health and Safety, *OSH Answers: Due Diligence:* http://www.ccohs.ca/oshanswers/legisl/diligence.html

Canadian Centre for Occupational Health and Safety, *OSH Answers: OHS Legislation in Canada; Internal Responsibility System;* http://www.ccohs.ca/oshanswers/legisl/irs.html

Canadian Centre for Occupational Health and Safety, *OSH Answers*: Contact Lenses at Work http://www.ccohs.ca/oshanswers/prevention/contact_len.html

Canadian Centre for Occupational Health and Safety, *OSH Answers: Safety Glasses and Face Protectors;* http://www.ccohs.ca/oshanswers/prevention/ppe/glasses.html

Canadian Centre for Occupational Health and Safety, *OSH Answers: - Chemical Protective Clothing – Gloves;* http://www.ccohs.ca/oshanswers/prevention/ppe/gloves.html

Canadian Centre for Occupational Health and Safety, *OSH Answers: Industrial Ventilation;* CCOHS -, http://www.ccohs.ca/oshanswers/prevention/ventilation/

Canadian Centre for Occupational Health and Safety; *OSH* Answers – *How Do I Work Safely with Compressed Gasses?* Updated July 8, 2008; http://www.ccohs.ca/oshanswers/prevention/comp_gas.html

Canadian Centre for Occupational Health and Safety; *OSH Answers – Electrical Safety Basic Information;* updated June 1, 2000; http://www.ccohs.ca/oshanswers/safety_haz/electrical.html

Centers for Disease Control and Prevention, USA; *Guideline for infection control in health care personnel*; http://www.cdc.gov/ncidod/dhqp/gl_hcpersonnel.html

Gaines, B. R., *Adapting to a Highly Automated World*, , University of Calgary, retrieved from http://pages.cpsc.ucalgary.ca/~gaines/reports/MFIT/Trust/index.html

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Health Canada, *Best Advice on Stress Management in the Workplace*, Part 2, 2000 retrieved from www.mentalhealthpromotion.net/?i=promenpol.en.toolkit.162

Health Canada; *Prevention and Control of Occupational Infections in Healthcare, An Infection Control Guideline,* CCDR, 28SI, 2002; http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/02vol28/28s1/index.html

Laboratory Safety Supply – Chemical Compatibility Concerns in Storage http://www.labsafety.com/refinfo/ezfacts/ezf181.htm

NIOSH: Recommendations for Chemical Protective Clothing: A Companion to the NIOSH Pocket Guide to Chemical Hazards: Database; http://www.cdc.gov/niosh/ncpc/ncpc1.html

NIOSH; *Alert Preventing Needlestick Injuries in Healthcare Settings*; 2000-108, November, 1999 http://www.cdc.gov/niosh/docs/2000-108/

Roark, John; *The Proper Fit for PPE*, Infection Control Today Magazine, Nov. 2004. http://www.infectioncontroltoday.com/articles/407/407_4b1topics.html

University of Kentucky, Environmental Health and Safety; *Fact Sheet – Centrifuge Safety*; http://ehs.uky.edu/ehs/biosafety/centrifuge.html

University of Minnesota, Environmental Health and Safety*; Bio Basics Fact Sheet: Centrifuge Safety*; http://www.dehs.umn.edu/PDFs/centrifuge.pdf

University of the State of New York, Chemical Storage Guidelines http://www.emsc.nysed.gov/ciai/mst/pub/chemstorguid.html

WorkSafeBC*; Laboratory Safety Handbook*; 2008 Edition; http://www.worksafebc.com/publications/health_and_safety/by_topic/assets/pdf/laboratory_handbook.pdf

WorkSafeBC; Understanding the Risks of Musculoskeletal Injury (MSI); 2008; *http://www.worksafebc.com/publications/Health_and_Safety/by_topic/assets/pdf/msi_workers.pdf*

APPENDIX 3 - Learning Objectives for this Module

1. Understand the need for and the procedure for conducting hazard assessments and risk evaluations.
2. Identify significant biological hazards that may impact laboratory workers.
3. Identify significant chemical hazards that may impact laboratory workers.
4. Identify significant physical hazards that may impact laboratory workers.
5. Identify potential psychological hazards that may impact laboratory workers.
6. Identify the hierarchy of controls that should be implemented to control hazards in the workplace.
7. Identify engineering controls and describe how they work.
8. Provide examples of administrative controls.
9. Describe the important considerations when selecting personal protective equipment.
10. For each type of hazards, identify possible engineering, administrative and personal protective equipment controls.

APPENDIX 4 - Test Your Knowledge

1. In what way can laboratory staff be exposed to biological hazards?

2. What is meant by the “hierarchy of controls”?

3. Give 3 examples of engineering controls.

4. Give 3 examples of administrative controls.

5. Give 3 examples of personal protective equipment.

6. What type of filter is used in a biological safety cabinet?

7. When can general exhaust room ventilation be used to control chemical hazards?

8. Name the five criteria for choosing the proper gloves to use.

9. Name the six criteria for selecting appropriate eye protection.

10. What administrative controls can be put in place to reduce the risk of exposure to hazardous drugs?

Test Your Knowledge - Answers

1. Laboratory staff may be exposed to biological hazards through contact with patients, members of the public or through contaminated products or contaminated ventilation systems.
2. The hierarchy of controls refers to a preferred order of controls for implementation. The highest level is engineering controls, because these control the exposure at the source. The next level is administrative controls, which relies on worker compliance. The least effective and lowest level of control is personal protective equipment, because if the equipment fails the worker is likely to be exposed.
3. Fume hoods, biological safety cabinets, preventive maintenance of equipment, safety engineered medical devices, segregated areas, automated procedures, ergonomically designed work stations, machine guarding, etc.
4. Training, policies, safe work procedures, restricted access, appropriate staffing, purchasing diluted solutions, signage, purchasing standards, etc.
5. Protective eyewear, gloves, lab coats, respirators, etc.
6. A HEPA (High Efficiency Particulate Air) filter is used in a BSC.
7. Only when the chemicals are non-toxic; local exhaust ventilation such as a fume hood or a biological safety cabinet must be used with toxic chemicals.
8. Criteria for glove selection include:
    - The nature and concentration of the chemicals.
    - The amount of time the gloves will be exposed to the chemical.
    - Dexterity required to perform the task.
    - Extent of protection needed (to wrist or higher).
    - Decontamination and disposal requirements.
9. Criteria for the selection of eye protection include:
    - Level of protection required.
    - Comfort of the wearer.
    - Secure fit that does not interfere with vision or movement.
    - Ease of cleaning and disinfection.
    - Durability.
    - Compatibility with prescription glasses and other PPE that must be worn at the same time (e.g. respirators).
10. Administrative controls may include safe work procedures including spill procedures with consideration to the specific product and manufacturer's instructions; waste handling procedures; education of workers in the nature of the hazard; availability of appropriate equipment and PPE; accommodation for workers with special needs (pregnant workers, persons with sensitivities or other health issues).

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