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# Handbook of Occupational Hazards and Controls for Personnel in Diagnostic Imaging and Nuclear Medicine



### 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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# Occupational Health and Safety Hazards and Controls for Personnel in Diagnostic Imaging and Nuclear Medicine

## 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 (HCW) 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](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](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](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 for workers in Diagnostic Imaging and Nuclear Medicine, including those working in Ultrasound, Magnetic Resonance Imaging, Diagnostic Radiography, and Nuclear Medicine.

## Hazard Assessment Process

Personnel in Diagnostic Imaging and Nuclear Medicine (referred to in this document as DI and NM 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 a variety of individual factors including patient-related factors as well as environmental issues. 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), and 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 DI and NM 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 for DI and NM workers and methods to control them 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 biological hazards most frequently encountered by DI and NM workers.

**Note:**

The following chart provides basic information about control strategies for commonly occurring biological hazards. Administrative controls are based on the risk assessment. Worker education and good communication processes are important 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 Hazards	Summary of Major Control Strategies		
	Engineering	Administrative	PPE
<b>Exposure to airborne biological agents through contact with secretions from infectious patients (coughing, sneezing, etc.) or air contaminated with infectious biological agents</b>	Early detection of infection status. Isolation. Vaccines.	Compliance with all infection prevention and control practices. Immunization program. Worker education.	PPE based on the risk assessment may include eye protection, respiratory protection and other protective clothing.
<b>Exposure to droplets containing infectious biological agents through contact with patient secretions or contaminated environmental surfaces or equipment</b>	Early detection and communication of infection status. Isolation. Disinfection/sterilization of equipment. Vaccines.	Good housekeeping practices. Compliance with all infection prevention and control practices. Waste management procedures. Immunization program. Worker education.	PPE based on the risk assessment may include eye protection, respiratory protection and other protective clothing.
<b>Exposure to environmental biological contaminants from ventilation</b>	Maintenance of ventilation systems. Early spill clean-up.	Infection prevention and control practices related to building	Use of proper PPE when cleaning contaminated

<b>systems, water or food</b>	Preventive maintenance of ventilation systems and water supply systems with regular testing to ensure proper functioning. Early detection and remediation of mould.	maintenance and food preparation. Protocols for construction and renovation projects that reduce contamination. Worker education.	environmental surfaces, including gloves, respiratory protection, and eye protection.
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## Notes about controls for biological hazards

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Exposure to biological hazards may occur for any DI and NM workers in contact with patients. Controls include any mechanisms to reduce the potential for exposure to infectious agents and the immunization of all direct caregivers against infectious diseases to which they may be exposed.

### *Engineering Controls*

In the hierarchy of controls, the highest level of control is directed at the source. 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 proper design and maintenance of facilities, isolation rooms, the use of needleless systems and engineered needle stick prevention devices, 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.

### Safe Needle Devices

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.

### Isolation

In many health care facilities, patients with known or suspected infectious diseases are physically isolated from other patients to prevent transmission of infectious organisms. Isolation rooms must be specifically designed and constructed to protect the unique needs of patients who are placed in isolation as well as for health care worker (HCW) protection. Depending on the nature of the biological agents, the requirements for isolation rooms will vary in their physical design, furnishings, air handling systems and air pressurization of the room relative to adjacent areas.

### Negative pressure rooms

In addition to the requirements for isolation rooms used for droplet or contact isolation, negative pressure rooms may be required for patients with pathogens transmitted by the airborne route. These rooms should be well sealed to prevent the air from escaping into other areas. Anterooms should be incorporated as determined by assessment of risk. When isolating patients on airborne isolation, the design, operation and maintenance of air handling systems serving the room are critically important.

### Decontamination<sup>1</sup> of facilities and materials

Decontamination is a term used to describe procedures that remove contamination by killing microorganisms, rendering the items safe for disposal or use. Sterilization refers to the complete destruction or removal of all microorganisms by chemical or physical means, usually to provide sterile items for use. All contaminated materials must be decontaminated before disposal or cleaning for reuse. The choice of method is determined by the nature of the material to be treated. Disinfection refers to the destruction of specific types of organisms but not all spores, usually by chemical means. Disinfection is a means of decontamination. Surfaces must be decontaminated after any spill of potentially infectious materials and at the end of the working day. Work areas, patient rooms, and pieces of equipment may also require decontamination (i.e., prior to servicing, maintenance, between patients, transfer to other settings or reassignment).

### Local exhaust ventilation

Local exhaust ventilation removes contaminants at the source where the contaminant originates and can be very effective at controlling HCW exposure. The components of a local exhaust system include a hood into which contaminated air flows, ducting for

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<sup>1</sup> This section was modified from Laboratory Safety :CSMLS Guidelines, sixth edition; Gene Shematek & Wayne Wood; Canadian Society for

air to pass through, a fan to move the air, and an exhaust. For biological hazards, local exhaust ventilation is used in some instruments that create aerosols.

### General ventilation

General ventilation systems serving buildings must be maintained regularly and inspected for conditions that could adversely affect air quality provided to work spaces. Accumulations of water that could stagnate in humidification systems or drip trays may become sources of potential biological contamination of air handling systems that need regular monitoring and inspection. Biohazardous organisms may be carried through general ventilation systems, potentially distributing them to other workspaces in a facility. Ultraviolet germicidal irradiation units, and or HEPA filtration media incorporated into air handling systems may be warranted for special circumstances.

Mould growth in the indoor environment can be affected by relative humidity levels, which is a function of some general ventilation systems. High relative humidity levels may contribute to an increase in the growth of some moulds and lead to condensation developing on surfaces. Control of indoor relative humidity levels is an important factor in preventing mould growth.

### **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 DI and NM workers 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.

A comprehensive management system considers the continuum of infection prevention and control efforts across all sites and operations. It includes attention to patient, resident, visitor, contractor, volunteer and HCW safety. A comprehensive system should include the following components:

- A process that ensures comprehensive hazard assessments are conducted for all sites and tasks and appropriate controls are identified
- An infection prevention and control (IPC) plan with clear designation of roles and responsibilities
- Coordinated activities and policies related to IPC and OHS that ensure a consistent approach to infection prevention and control for patients and HCWs

- Consistent standards for the cleaning, disinfection and sterilization of equipment, procedures, and policies including Routine Practices, Additional Precautions, hand hygiene policies and facilities, patient risk assessments, communication protocols, decontamination of clothing and dedicated clothing
- Outbreak prevention and management
- Adequate staffing to comply with OHS and IPC policies and procedures; work scheduling
- Biomedical waste handling procedures and policies
- Supporting systems that include Engineering/Physical Plant, Housekeeping, Materials Management and Facilities Planning to ensure:
  - Adequate housekeeping and waste management services
  - Appropriate processes for cleaning, decontamination, disinfection and sterilization of patient care equipment
  - Purchasing processes to include consideration of safety factors
- A comprehensive surveillance and monitoring plan
- Record keeping and regular reporting of outcomes

*Routine practices and additional precautions*

Procedural controls may include procedures that relate to detection and follow-up of infectious diseases, the use of Routine Practices and Additional Precautions as directed, baseline health assessments and periodic screening of workers, hazard identification and control processes, and outbreak management procedures. Awareness of the infectious disease status of patients is another good control, though this is not always possible for DI and NM workers. All work procedures should include the consideration and control of the risk of exposure to workers. Routine Practices and Additional Precautions (where required) greatly assist in reducing the transmission of infectious agents from both known and unknown patient sources by treating all contacts as potential risks.

**Infection Prevention and Control Definitions:**

- **Routine Practices** include a recommended pattern of behaviours to form the foundation of limiting the transmission of microorganisms in all health care settings and is generally accepted care for all clients. Elements of Routine Practices are: hand hygiene: risk assessment related to client symptoms, care and service delivery, including screening for infectious diseases; risk reduction strategies through the use of PPE, cleaning environment, laundry, disinfection and sterilization of equipment , waste management, safe sharps handling, client placement and healthy workplace practices; and education of healthcare providers, clients and families, and visitors.
- **Additional precautions** are practices used to prevent transmission of infectious agents that are spread by direct or indirect contact with the client or client’s environment that are necessary in addition to Routine Practices for certain pathogens or clinical

presentations. These precautions include Contact Precautions, Droplet Precautions, and Airborne Precautions that are based on the method of transmission.

For more information: <http://www.health.alberta.ca/documents/IPC-MRSA-Standards-2008.pdf>

Routine Practices include being attentive to all routes of transmission. Awareness of routes of transmission has led to the development of a variety of transmission-route specific strategies. Most of these are well documented in infection prevention and control plans. In particular, hand hygiene is identified as the single most important administrative strategy in infection prevention and control. Other strategies include additional precautions designed to address infections transmitted through the “airborne” route, those transmitted through “droplets” and those transmitted through “contact”. It should be noted that though some infection prevention and control plans appear to provide sharp demarcations as to what size of particle is transmitted by which route (particularly by airborne and droplet); it is highly likely that there is a continuum of particle sizes produced at any time and the determination of transmission route is more a probability than a certainty. For this reason, one must be careful in defining control strategies based solely on particle sizes.

In some circumstances, identification of the specific organism responsible for the infection may take considerable time, during which patient care is required. In these cases, it is prudent to apply the most stringent precautions until evidence indicates that less are required. In cases where the transmission route or organism has not yet been identified, it is prudent to assume all routes of transmission may be possible, as this would drive the highest level of precautions available and appropriate. Once more information is known about the organism, precautions can be revised to take that knowledge into account.

Administrative controls related to the prevention of exposure to biological hazards include the development and implementation of infection prevention and control guidelines, including vehicle and equipment decontamination and safe work procedures. Surfaces must be decontaminated after any spill of potentially infectious materials. Specific written protocols must be developed and followed for each decontamination process. DI and NM workers must be trained in all decontamination procedures specific to their activities and should know the factors influencing the effectiveness of the treatment procedure.

### Chemical Disinfectants

Chemical disinfectants are used to decontaminate surfaces, reservoirs of infectious material, and to clean up spills of infectious material. The choice of chemical disinfectant must be made carefully based on:

- Types of organisms, suspected or known
- Items or surfaces to be decontaminated
- Hazards posed to the HCW by the disinfectant

- Cost of disinfectant
- Corrosiveness of disinfectant
- Shelf life and required dilution of disinfectant
- Material which inactivates the disinfectant

In many cases, the choice of disinfectant for specific uses may be standardized in the organization and made after evaluation by IPC and OHS professionals.

#### Considerations in the use of chemical disinfectants

- As much as possible, know what the possible contaminants are.
- Choose the disinfectant carefully. More than one may be required. Keep in mind the items to be disinfected, and the properties and limitations of the various available disinfectants. If more than one disinfectant is required, ensure that those selected are chemically compatible.
- Follow the manufacturer's directions for making the proper dilutions of the disinfectants.
- The effective life of disinfectants can vary depending on the formulations and the conditions of usage. Follow the manufacturer's directions.
- The effective exposure time that the disinfectant must be in contact with the contaminant will also vary with conditions of usage. Often overnight exposure may be recommended to ensure effective decontamination.
- Understand the health and safety hazards that may be posed by a particular disinfectant and ensure appropriate precautions are taken. Wear disposable gloves when using any disinfectants. Wear other personal protective equipment or clothing as necessary, depending upon the disinfectants. Consult Material Safety Data Sheets for details.
- HCWs with particular sensitivities to specific disinfectants should avoid using those disinfectants.
- Perform tests of the disinfectants to ensure effective disinfection.

#### Spill response procedures

The efficient and effective control of a biological spill requires that all staff members are trained in and have practiced the established spill response techniques. The materials and supplies that are necessary for spill clean-up and decontamination must be readily available to ensure timely spill response. Written spill response procedures should outline spill response actions and roles. The actual procedure used will vary with the size of the spill and the location of spill (including materials, equipment or environmental surfaces affected). All spill responses should be documented as incidents.

A biological spill kit should contain:

- Biological liquid solidifying agent
- Disinfectant - small quantities, made fresh daily if phenolics or hypochlorites (such as bleach)
- Forceps for picking up broken glass
- Paper towels, swabs, disposable and heavy-duty gloves
- Metal or polypropylene (autoclavable) dust pan
- Heavy-duty polyethylene bags
- High efficiency particulate respirators, shoe covers or rubber boots and full protective clothing if large spills may occur

Training

Training in biological hazards and controls should be provided to all health care workers (HCWs). Each HCW must understand the facility's IPC and OHS programs as they relate to their job duties. For newly hired HCWs, all relevant IPC and OHS policies and procedures must be provided before they start work. To ensure that HCWs understand and apply this information to their jobs, specific training should also be provided to address job-specific biological hazards. Periodic refresher training to reinforce policies and procedures and introduce any new practices will benefit all HCWs. Competency assessments should be provided for all training, and training records should be maintained.

HCW immunization and health surveillance

An immunization policy and program is a proactive mechanism to reduce risk of communicable diseases for HCWs. Each healthcare organization should have an immunization and health surveillance program in place that is appropriate to the size and type of workplace. Immunization and health surveillance programs should include:

- Education about vaccine-preventable diseases
- Risk assessment to determine the need for immunization or surveillance based on potential exposure
- Administration of immunizations (or referral for immunizations, as appropriate)
- Documentation and follow-up of any baseline health assessments, communicable disease status and immunizations

Ideally, the immunization and surveillance programs should provide easy, authorized access to HCW immune status records for follow up of exposure incidents and outbreaks. In some cases, immunizations or baseline testing may be required prior to commencement of work.

### Post-exposure follow-up management

Post-exposure management includes management of HCWs exposed to, colonized by, or infected with microorganisms; an outbreak management process for exposures and/or HCWs who are symptomatic or colonized with infectious disease; and access by Occupational Health professionals to utilize medical assessment and diagnostic services for timely follow-up for HCW exposures.

### **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.

### Gloves

Gloves are the most common type of PPE used for tasks performed in Diagnostic Imaging and Nuclear Medicine. Gloves are made from a variety of materials including latex, nitrile, neoprene, copolymer, and polyethylene and are available in various levels of thickness. When dealing with infectious materials, gloves must be waterproof. Most patient care activities require non-sterile gloves, whereas any invasive procedure should be performed using sterile surgical gloves. Latex gloves should be avoided due to the risk of latex allergy unless there is a demonstrated safety requirement for latex to be used. The Canadian General Standards Board (CGSB) certifies medical gloves, which is a key factor in selecting gloves for use in healthcare. 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<sup>2</sup>, 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.”*

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<sup>2</sup> Recommendations for Canadian Health Care and Public Service Settings; found at <http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/97vol23/23s3/index.html>

### Safe Practices for Glove Use<sup>3</sup>

- Wear medical gloves when there is a risk of contact with blood, body fluids or substances, mucous membranes, open wounds or skin lesions.
- Wear gloves that are certified by the CGSB.
- Wear gloves if you have any cuts or lesions on your hands or if you have dermatitis affecting your hands.
- Avoid latex gloves and powdered gloves to reduce sensitization or allergic reactions.
- Ensure that the gloves fit properly.
- Inspect gloves for holes or tears, discarding any damaged gloves.
- Put gloves on just before beginning the task, and remove them promptly when finished and before touching any environmental surfaces.
- Work from “clean to dirty” (touching clean sites or surfaces before dirty or contaminated ones).
- Do not touch your face or adjust PPE with contaminated gloves and avoid touching uncontaminated items such as light switches, telephones, etc. while wearing gloves.
- Change gloves when they become soiled, during lengthy procedures, and between patients.
- Remove gloves carefully according to the IPC guidelines and dispose of them properly.
- Wash hands before using and after removing gloves.
- Never reuse or wash single-use disposable gloves.

PPE is required when there is the potential for exposure of the face to splashes or sprays of infectious material. The selection of eyewear depends upon the tasks being conducted. Types of eye protection include safety glasses, goggles, visors, face shields and table mounted barrier shields. Regular prescription eyewear and contact lenses are not considered effective as PPE. Safety eyewear should fit the wearer, be clean and well maintained and stored. If necessary, goggles may be fitted with prescription lenses or worn over glasses. Face shields should cover the forehead, extend below the chin, and wrap around the side of the face. Masks protect the mucous membranes of the nose and mouth from exposure to large droplets that may contain infectious materials. Masks are commonly used to contain droplets at the source (for example, the HCW or patient with a cough). Masks should fully cover the nose and mouth and fit snugly. Masks worn by patients reduce exposure through droplet containment at the source, and respirators worn by health care workers reduce exposure to the respiratory system.

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<sup>3</sup> Modified from information provided in Preventing the Transmission of Blood Borne Pathogens in Health Care and Public Service Settings. Found at <http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/97vol23/23s3/index.html> (See Supplement)

*The Difference between a Surgical or Procedure Mask and a Respirator*

Surgical or Procedural Masks	Respirators (i.e. NIOSH approved N95)
<ul style="list-style-type: none"> <li>• Surgical Masks are <u>not</u> designed to seal tightly against the HCW's face or certified to prevent inhalation of small droplets/particles.</li> <li>• When the HCW inhales, contaminated small droplets can pass through gaps between the face and surgical mask.</li> </ul>	<ul style="list-style-type: none"> <li>• A fit-tested NIOSH approved respirator provides a proper seal at the HCW's face, forcing inhaled air to be pulled through the filter material and not through gaps between the face and the respirator.</li> </ul>
<ul style="list-style-type: none"> <li>• Surgical masks provide a physical barrier for protection from splashes of large droplets of blood or body fluids.</li> <li>• Surgical masks are used for several purposes including:               <ul style="list-style-type: none"> <li>○ Prevention of accidental contamination of patients wounds with pathogens normally present in mucus or saliva</li> <li>○ Placed on sick patients to limit spread of infectious respiratory secretions to others</li> <li>○ Protection from splashes or sprays of blood or body fluid</li> <li>○ Assist to keep HCWs contaminated hands from contacting their own mucous membranes.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Respirators are designed to reduce HCW's exposure to airborne contaminants.</li> <li>• Fit tested NIOSH approved respirators are used when required, based on hazard assessment.</li> </ul>

\*Adapted from OSHA (2007) *Guidelines on Preparing Workplaces for an Influenza Pandemic*

## Pertinent legislation related to respiratory protection

### **Respiratory Protective Equipment**

If a worker is or may be exposed to exposure to an airborne biohazardous material, the employer must assess the work site to determine if workers need to use respiratory protective equipment (RPE) and provide worker the appropriate RPE where indicated.

For more information refer to: [http://employment.alberta.ca/documents/WHS/WHS-LEG\\_ohsc\\_p18.pdf](http://employment.alberta.ca/documents/WHS/WHS-LEG_ohsc_p18.pdf)

OHS Code, Section 244

The employer must consider the nature and the exposure circumstances of any contaminants or biohazardous material. The employer must provide and ensure the availability of RPE appropriate to the worker's exposure circumstances. Where the hazard assessment identifies the need for RPE some of the requirements include:

#### **Training**

- Employer must ensure all workers receive appropriate education, instruction or training with respect to hazards they may be exposed to and procedures and controls used to reduce exposure.

#### **Code of Practice**

- If respiratory equipment is used at a work site, an employer must prepare a code of practice governing the selection, maintenance and use of the RPE. In the case of a health care worker who may be exposed to airborne biohazardous material, the code of practice includes training, done on at least an annual basis, on:

- information about the airborne biohazardous materials that workers may be exposed to including their potential health effects,
- the particular respiratory protective equipment used chosen, including information about its capabilities and limitations and how to test for a satisfactory fit, and
- how to properly put on and take off the RPE without contaminating oneself or other workers.

#### **Approval of Equipment**

- Employer must ensure that RPE required at a work site is approved by NIOSH or another standard setting and equipment testing organization, or combination of organizations, approved by a Director of Occupational Hygiene.

#### **Effective Face Seal**

- Employer must ensure that RPE that depends on an effective facial seal for its safe use is correctly fitted and tested in accordance with CSA standard (z94-4-02).

OHS Act, 33 and OHS Code, Part 18

## Chemical Hazards and Controls

This section will provide a brief overview of selected chemicals used in Diagnostic Imaging and Nuclear Medicine. This is not a textbook and will not delve into details about each chemical. Rather it will present information about health effects, and suggested “best practices” for controlling exposures. **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> ).

*Chemicals used for cleaning and disinfection*

Chemical (category or group)	Common Uses and Examples	Exposure and Health Effects Information	Controls	For more information:
<p>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.</p>				
<p><b>Alcohol hand sanitizers</b></p>	<p>Hand hygiene when water is not available and hands are not visibly soiled</p>	<p>May cause skin dryness. Product is flammable.</p>	<p><b>A-</b> Appropriate storage of product (away from ignition sources and incompatible products). Provision of hand cream to soothe hand dryness.</p>	<p><a href="http://www.ottawa.ca/residents/health/emergencies/pandemic/hand/faq_gel_en.html">http://www.ottawa.ca/residents/health/emergencies/pandemic/hand/faq_gel_en.html</a></p> <p><a href="http://employment.alberta.ca/documents/WHS/WHS-PUB_fex002.pdf">http://employment.alberta.ca/documents/WHS/WHS-PUB_fex002.pdf</a></p> <p><a href="http://www.municipalaffairs.alberta.ca/documents/ss/STANDATA/fire/fcb/97fcb026.pdf">http://www.municipalaffairs.alberta.ca/documents/ss/STANDATA/fire/fcb/97fcb026.pdf</a></p>
<p><b>Low Level Disinfectants</b></p>	<p>Chlorine compounds, alcohols, quaternary ammonium salts, iodophors, phenolic compounds, hydrogen</p>	<p>Most are eye, skin, and respiratory irritants, particularly when concentrated. Some products may produce sensitization. Toxic effects depending on nature of chemical. May react with other products</p>	<p><b>E-</b> Substitution with less harmful product. Properly designed and maintained ventilation systems. Automatic diluting machines. Closed systems.</p> <p><b>A-</b> Practice to purchase products in ready to use concentrations to minimize handling. Safe work procedures. WHMIS program and maintenance of</p>	<p><a href="http://ehs.virginia.edu/biosafety/bio_disinfection.html">http://ehs.virginia.edu/biosafety/bio_disinfection.html</a></p> <p><a href="http://www.cdc.gov/niosh/topics/chemical.html">http://www.cdc.gov/niosh/topics/chemical.html</a></p> <p><a href="http://cms.h2e-online.org/ee/hazmat/hazmatconcern/steril/">http://cms.h2e-online.org/ee/hazmat/hazmatconcern/steril/</a></p>

	peroxide used widely for disinfection; usually prepared and used in low concentrations.	to create hazardous products.	MSDSs. Worker education. Accommodation for sensitized workers or those with health issues.  <b>P-</b> Gloves and eye protection.	<a href="http://www.mtpinnacle.com/pdfs/disinfectant-selection-guidelines.pdf">http://www.mtpinnacle.com/pdfs/disinfectant-selection-guidelines.pdf</a>
<b>Glutaraldehyde</b>	High level disinfection of medical devices. 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.	<b>E-</b> Substitution with less harmful product. Properly designed and maintained ventilation systems. Local exhaust ventilation. Enclosed processes.  <b>A-</b> 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,  <b>P-</b> Gloves, eye protection, face protection, and chemical-resistant protective clothing. Respirators for use in the event of spills. Respirators if engineering controls are insufficient.	<a href="http://www.osha.gov/Publications/3258-08N-2006-English.html">http://www.osha.gov/Publications/3258-08N-2006-English.html</a>  <a href="http://www.osha.gov/SLTC/etools/hospital/hazards/glutaraldehyde/glut.html">http://www.osha.gov/SLTC/etools/hospital/hazards/glutaraldehyde/glut.html</a>  <a href="http://www.cdc.gov/niosh/docs/2001-115/">http://www.cdc.gov/niosh/docs/2001-115/</a>  <a href="http://www.sustainablehospitals.org/cgi-bin/DB_Index.cgi">http://www.sustainablehospitals.org/cgi-bin/DB_Index.cgi</a> .
<b>Hydrogen Peroxide</b>	Sterilization of medical devices and surfaces	Skin, eye and respiratory irritant. Oxidizer. May react with other products to create hazardous products. Fire hazard.	<b>E-</b> Substitution with less harmful product. Properly designed and maintained ventilation systems. May require local exhaust ventilation. Enclosed processes.  <b>A-</b> 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	<a href="http://www.cdc.gov/niosh/npg/npgd0335.html">http://www.cdc.gov/niosh/npg/npgd0335.html</a>

			<p>sensitized or may have health issues.</p> <p><b>P-</b> Gloves, eye protection and chemical-resistant protective clothing. Respiratory protection based on risk assessment.</p>	
<p><b>Ortho-phthalaldehyde (OPA)</b></p>	<p>High level disinfection of medical devices. Replaces glutaraldehyde containing disinfectants.</p>	<p>Eye and respiratory irritant and skin sensitizer. May cause skin discoloration. May react with other products to create hazardous products.</p>	<p><b>E-</b> Properly designed and maintained ventilation systems. May require local exhaust ventilation. Enclosed processes.</p> <p><b>A-</b> 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> <p><b>P-</b> Gloves, eye protection, face shield and chemical-resistant protective clothing.</p>	<p><a href="http://www.mtpinnacle.com/pdfs/Cydex.pdf">http://www.mtpinnacle.com/pdfs/Cydex.pdf</a></p> <p><a href="http://www.aspii.com/us/supports/material-safety-data-sheets">http://www.aspii.com/us/supports/material-safety-data-sheets</a></p> <p><a href="http://www.sustainablehospitals.org/cgi-bin/DB_Index.cgi">http://www.sustainablehospitals.org/cgi-bin/DB_Index.cgi</a></p>

Chemicals used in treatment

Chemical	Common Uses; Examples	Exposure and Health Effects Information	Controls	For more information:
<p>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.</p>				
<p><b>Radioactive material used for patient treatment</b></p>	<p>In Nuclear Medicine, technetium-99, gallium-67, iodine-131, xenon-133</p>	<p>May be mutagenic or carcinogenic, teratogenic or have reproductive effects, or affect target organs.</p> <p>Exposure may occur through inhalation, skin contact, skin absorption, ingestion, or injection. Inhalation and skin contact/absorption exposures may occur when reconstituting or making up the or administering the isotopes, handling contaminated materials, and disposing of isotopes or contaminated materials, including patient waste.</p>	<p><b>E-</b> Proper containment (isolation, segregated areas and dedicated equipment, local exhaust ventilation, biological safety cabinets, lined trays, etc.) when making up or using isotopes. Engineered needle stick prevention devices. Restricted access. Segregation of contaminated items.</p> <p><b>A-</b> Safe work procedures including spill procedures with consideration to the specific product and manufacturer's instructions. Log books for purchase and use of all radioisotopes. Good hygiene practices. Regular wipe tests for contamination. 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).</p> <p><b>P-</b> Eye protection and face shields when splashing is possible. Protective clothing (gowns) and gloves. Respirators may be required based on hazard assessment.</p>	<p><a href="http://www.cdc.gov/niosh/docs/2004-165/2004-165b.html#j">http://www.cdc.gov/niosh/docs/2004-165/2004-165b.html#j</a></p> <p><a href="http://www.cdc.gov/niosh/topics/hazdrug/">http://www.cdc.gov/niosh/topics/hazdrug/</a></p> <p><a href="http://www.cdc.gov/niosh/docs/2004-165/">http://www.cdc.gov/niosh/docs/2004-165/</a></p> <p><a href="http://www.cdc.gov/niosh/topics/anti-neoplastic/">http://www.cdc.gov/niosh/topics/anti-neoplastic/</a></p> <p><a href="http://www.mtpinnacle.com/pdfs/safe-handling-hazardous-drugs.pdf">http://www.mtpinnacle.com/pdfs/safe-handling-hazardous-drugs.pdf</a></p> <p><a href="http://www.osha.gov/dts/osta/otm/otm_vi/otm_vi_2.html">http://www.osha.gov/dts/osta/otm/otm_vi/otm_vi_2.html</a></p> <p><a href="http://www.ashp.org/DocLibrary/BestPractices/PrepGdlHazDrugs.aspx">http://www.ashp.org/DocLibrary/BestPractices/PrepGdlHazDrugs.aspx</a></p> <p><a href="http://www.osha.gov/dts/tib/tib_data/tib20011221.html">http://www.osha.gov/dts/tib/tib_data/tib20011221.html</a></p> <p><a href="http://www.irsst.qc.ca/en/_publicatio_nirsst_100390.html">http://www.irsst.qc.ca/en/_publicatio_nirsst_100390.html</a></p>

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## Chemical Wastes

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Chemical	Common Uses; Examples	Exposure and Health Effects Information	Controls	For more information:
<p>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.</p>				
<p><b>Radioactive waste materials</b></p>	<p>Waste radioactive materials can be generated in any area where chemicals are used, including used protective clothing.</p>	<p>Exposure routes of entry and health effects are dependent upon the nature of isotope used. Mixed wastes may pose multiple hazards.</p>	<p><b>E-</b> Designated waste storage and collection areas. Adequate ventilation. Use of bonding, grounding and explosion control.</p> <p><b>A-</b> Appropriate storage of products to decrease exposure and minimize fire hazards and chemical reactions. Policies and procedures for safe chemical disposal. Dosimetry program. Education of workers in the nature of the hazard.</p> <p><b>P-</b> As required based on specific hazard assessment.</p>	<p><a href="http://employment.alberta.ca/documents/WHS/WHS-PUB_fex002.pdf">http://employment.alberta.ca/documents/WHS/WHS-PUB_fex002.pdf</a></p>

*Other chemicals and substances*

Chemical	Common Uses; Examples	Exposure and Health Effects Information	Controls	For more information:
<p>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.</p>				
<b>Latex</b>	Used in gloves, medical devices, some respirators, elastic bands, balloons, etc.	Exposure can produce irritant contact dermatitis, allergic contact dermatitis, and allergic responses including immediate hypersensitivity and shock.	<p><b>E-</b> Substitution with less harmful product. Properly designed and maintained ventilation systems.</p> <p><b>A-</b> Purchasing controls to limit latex containing materials from entering facility. Safe work procedures. Education of workers in the nature of the hazard, hand washing after glove removal, proper glove donning and removal. Work reassignment for workers with latex allergies to areas where latex is not present. As per hazard assessment.</p>	<p><a href="http://www.worksafebc.com/publications/health_and_safety/by_topic/asets/pdf/latex_allergies.pdf">http://www.worksafebc.com/publications/health_and_safety/by_topic/asets/pdf/latex_allergies.pdf</a></p> <p><a href="http://www.ccohs.ca/oshanswers/diseases/latex.html#print">http://www.ccohs.ca/oshanswers/diseases/latex.html#print</a></p>
<b>Lead</b>	May be present in lead shielding for diagnostic imaging areas.	<p>Most exposures are by inhalation of dust and fumes and possible accidental ingestion if hands are contaminated.</p> <p>Effects may impact nervous system and reproductive system. May also affect digestive tract and anaemia.</p>	<p><b>E-</b> Local exhaust systems. Enclosed processes.</p> <p><b>A-</b> Regular medical monitoring of affected workers if there is the potential for overexposure. Safe work procedures. Education of workers in the nature of the hazard. Good housekeeping. Good hygiene practices. Equipment (including lead apron) maintenance programs.</p> <p><b>P-</b> Protective clothing, gloves, eye and face protection, and respirators based on</p>	<p><a href="http://employment.alberta.ca/documents/WHS/WHS-PUB_ch061.pdf">http://employment.alberta.ca/documents/WHS/WHS-PUB_ch061.pdf</a></p> <p><a href="http://www.cdc.gov/niosh/npg/npgd0368.html">http://www.cdc.gov/niosh/npg/npgd0368.html</a></p>

			hazard assessment.	
<b>Mercury</b>	Metallic mercury may be found in thermometers, pressure gauges (manometers), other medical devices	Exposure is through inhalation of vapours, ingestion and skin absorption. Skin sensitizer. Corrosive as liquid. Target effects to the nervous system, kidneys, cardiovascular and eyes.	<p><b>E-</b> 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.</p> <p><b>A-</b> Safe work procedures including spill 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> <p><b>P-</b> Protective clothing, gloves, eye and face protection, and respiratory protection based on hazard assessment.</p>	<p><a href="http://employment.alberta.ca/documents/WHS/WHS-PUB_ch003.pdf">http://employment.alberta.ca/documents/WHS/WHS-PUB_ch003.pdf</a></p> <p><a href="http://www.cdc.gov/niosh/npg/npgd0383.html">http://www.cdc.gov/niosh/npg/npgd0383.html</a></p> <p><a href="http://www.mtpinnacle.com/pdfs/MERCURY-USE-%20HOSPITALS-AND-CLINICS.pdf">http://www.mtpinnacle.com/pdfs/MERCURY-USE-%20HOSPITALS-AND-CLINICS.pdf</a></p>
<b>Personal care products, scents and fragrances</b>	A wide range of products including personal care items such as shampoos, soaps, perfumes, creams, deodorants, etc. Also contained in, cleaning products.	May cause a variety of mild to severe symptoms. Allergic, asthmatic and sensitive workers may experience reactions.	<p><b>E-</b> Elimination of scented products. Substitution with less harmful products. Properly designed and maintained ventilation systems.</p> <p><b>A-</b> Development, implementation and enforcement of scent-free policies. Signage in work areas where affected workers work. Worker education.</p>	<p><a href="http://www.ccohs.ca/oshanswers/hsprograms/scent_free.html">http://www.ccohs.ca/oshanswers/hsprograms/scent_free.html</a></p>

n this section the most commonly potential chemical exposure hazards encountered by DI and NM workers and methods to control them are presented. Employers should carefully evaluate the potential for exposure to chemical hazards in all tasks performed in Diagnostic Imaging and Nuclear Medicine 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 by DI and NM workers.

**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 tasks performed in Diagnostic Imaging and Nuclear Medicine. 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
<b>Exposure to radioactive material through its preparation and administration in Nuclear Medicine.</b> <b>Exposure to radioactive material through contact with contaminated articles or waste.</b>	Proper containment (isolation, segregated areas and dedicated equipment, local exhaust ventilation, biological safety cabinets, lined trays, etc.) when making up or using isotopes. Engineered needle stick prevention devices. Restricted access. Segregation of contaminated items.	Safe work procedures including spill procedures with consideration to the specific product and manufacturer’s instructions. Log books for purchase and use of all radioisotopes. Good hygiene practices. Regular wipe tests for contamination. 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).	Eye protection and face shields when splashing is possible. Protective clothing (gowns) and gloves. Respirators may be required based on hazard assessment.
<b>Exposure to glutaraldehyde or other cold sterilants for sterilizing equipment</b>	Substitution with less harmful product. Maintain adequate general ventilation. Local exhaust ventilation. Enclose	Safe work procedures including spill procedures. Worker training.	Chemical-resistant gloves, eye protection, face protection, and chemical-resistant

	processes.		protective clothing. Respirators for use in the event of substantial spills. Respirators if engineering controls are insufficient.
<b>Contact with mercury through broken mercury-containing devices</b>	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.
<b>Exposure to lead from shielding materials</b>	Enclose processes.	Regular medical monitoring of affected workers. Industrial hygiene monitoring. Develop safe work procedures. Educate workers in the nature of the hazard. Maintain good housekeeping. Maintain good hygiene practices. Equipment maintenance programs.	Protective clothing and gloves.
<b>Exposure to scented products that may induce sensitization</b>	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

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### *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 the following. (Controls for radioactivity will be further discussed in the physical hazards section.)

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

For DI and NM workers, chemical exposures may be limited by ensuring the facilities well designed, have effective ventilation, adequate storage for any chemicals used and have easily cleanable surfaces.

### Elimination

Elimination of a hazardous chemical from the healthcare workplace is always desirable but not always possible. For example, treatments and diagnostic reagents must still be prepared and administered, disinfectants are required when biological hazards are present and cleaning solutions are necessary to maintain hygienic conditions. In some cases, exposures can be eliminated by transferring specific processes or activities to another facility, or areas within a facility where better controls are available.

### Substitution

Some chemicals used in the healthcare environment are chosen based on tradition or cost. In recent years, efforts have been made to find less hazardous alternatives to some of the chemicals commonly used.

Some examples of substitution of chemical hazards in healthcare:

- Replacing mercury-containing devices (manometers, thermometers) with non-mercury containing alternatives
- Using accelerated hydrogen peroxide-based disinfectants instead of glutaraldehyde
- Using hydrogen peroxide-based cleaners rather than chlorine- based cleaners

When substituting a chemical for one that is currently in use, it is critical to ensure that the new chemical does not have properties that may make it more toxic or more flammable, etc.

### 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.

### **Administrative Controls**

#### Policies and procedures, training

As administrative controls, policies and procedures should be in place to ensure that there are safe work procedures for storing and using chemicals and discarding chemical wastes appropriately. DI and NM workers may come into contact with a number of chemicals through exposure to chemicals that may be used in treatment and disinfection procedures. Workplace Hazardous Materials Information System (WHMIS) training should be provided to all DI and NM workers. In addition, emergency call lines that provide expertise and advice regarding toxic chemicals should be made available.

#### WHMIS Program

A WHMIS program is an administrative control to reduce the risk of exposure to chemicals in the workplace and is a legal requirement for all employers who use controlled products in Alberta. To be effective, a WHMIS program must be relevant to the workplace, presenting information and training specific to the chemicals that are used in the workplace. The components of WHMIS include having current Material Safety Data Sheets for all products in the workplace, ensuring all products are appropriately labelled and ensuring that all workers are instructed on how to use the chemicals safely.

#### Exposure follow-up – emergency response equipment

Two types of exposure follow-up are considered as administrative controls. The first is the provision of appropriate emergency response equipment to reduce the impact of the exposure. The second is the medical follow-up for workers who have had a chemical exposure. In the first case, emergency response equipment for DI and NM workers usually refers to emergency eyewashes and drench hoses that can provide sufficient water to dilute the contaminant before it can cause extensive damage. Wherever chemical exposure could pose a hazard to eyes and skin, emergency wash devices are required. Appropriate signage that is easily visible must be provided to indicate where the eyewashes are kept.

### Medical follow-up of the exposed worker

A worker who has had a chemical exposure may require medical follow-up. Guidelines are available to provide information on the treatment and monitoring of workers with exposure to specific chemicals.

### Health Surveillance and Medical Monitoring in the Workplace

Health surveillance encompasses two types of individual health assessments. The pre-placement assessment considers the worker's personal health status as it relates to potential workplace exposures. It is useful to identify if workers have any allergies or sensitivities to products that they may need to work with. Another form of health surveillance is the on-going biological monitoring of workers who are exposed to certain chemicals or substances in the workplace, such as through dosimetry for potential radiation exposures.

### Chemical Waste Handling and Disposal

Chemical and radioactive wastes must be addressed with a good waste management system. Municipal and or Provincial codes address appropriate disposal requirements and aim to reduce contamination, possible injuries, illness or reactions related to chemical and radioactive exposures.

### Additional considerations for reducing risk of exposure

It is prudent to be aware of the need for modification of the work environment, conditions or required PPE for workers who may be medically vulnerable to the effects of some substances. Higher risk workers may include pregnant workers, workers with allergies or those who are sensitized to certain chemicals. Some common approaches to accommodate these workers include temporary reassignment to areas or tasks where the exposure potential is eliminated; work scheduling to reduce the amount of exposure, and changes to the PPE to accommodate limitations.

### **Personal Protective Equipment**

Personal protective equipment (PPE) is considered the lowest level of protection in the hierarchy of controls. This reflects the reliance on proper selection, fit, use and maintenance of the equipment by the organization and individual HCWs. PPE is often used in conjunction with other controls (engineering and administrative) to provide additional protection to workers. PPE is designed to protect the worker from exposure to chemicals by blocking access to the route of entry into the body. Gloves, aprons and other protective clothing reduce exposure through the dermal (skin) contact route. Eye and face protection reduce exposure through skin and mucous membrane contact. Respirators reduce exposure to the respiratory system.

## Gloves

Gloves are the most frequently used PPE by HCWs to prevent exposure to chemicals. 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<sup>4,5</sup>

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

<sup>5</sup> 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 HCWs 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)

### Respirators

According to the Alberta Occupational Health and Safety Code 2009<sup>6</sup>, 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 or exposed to an oxygen deficient environment. Employers are required to use engineering and administrative controls before using RPE (respecting the hierarchy of controls). Respirators may be required to protect HCWs from exposure to chemicals by inhalation.

### Protective Clothing

Chemical protective clothing is available as gowns, aprons, uniforms, coveralls, foot covers and full body suits. The choice of protective clothing relies on an accurate hazard assessment. Should protective clothing become contaminated with a chemical or damaged, the clothing must be removed and handled according to organizational procedures (disposal or proper decontamination). Residual chemicals such as acids on clothing may continue to present an exposure hazard. Workers must not wear clothing that is contaminated with chemicals home, as this may pose a danger to themselves and others.

### **Worker Decontamination**

If a worker is contaminated by a harmful substance at the worksite, the employer must ensure that only those items that have been properly decontaminated or cleaned are taken from the worksite by the worker.

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<sup>6</sup> Alberta OHS Code 2009, Part 18 – Personal Protective Equipment

## Physical Hazards and Controls

There are many potential physical hazards to which DI and NM workers may be exposed. The nature of the work may pose ergonomic hazards, exposure to ionizing and non-ionizing radiation, the potential for slips, trips and falls, cuts, and electrical hazards. In this section the physical hazards most commonly encountered by DI and NM workers and methods to control them are presented. Employers should carefully evaluate the potential for exposure to hazards for all tasks performed in Diagnostic Imaging and Nuclear Medicine and ensure that they have an effective hazard control plan in place. This information will be useful for inclusion into hazard assessments.

### Note:

The following chart provides basic information about control strategies for commonly occurring physical hazards in Diagnostic Imaging and Nuclear Medicine work. 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
<p><b>Ergonomic hazards associated with patient handling</b></p> <p>Refer to the “No Unsafe Lift Workbook” at <a href="http://employment.alberta.ca/documents/WHS/WHS-PUB_nounsafelift_workbook.pdf">http://employment.alberta.ca/documents/WHS/WHS-PUB_nounsafelift_workbook.pdf</a></p>	<p>Availability of adequate sizes and types of patient handling equipment. Ergonomic criteria incorporated into facility design</p>	<p>A comprehensive patient handling program that incorporates the principles of the “No Unsafe Lift Workbook”. Safe work procedures for patient handling activities. Worker education and awareness sessions. Risk assessment system for patient handling tasks. Early reporting of signs and symptoms of ergonomic concerns. Stretches and micro-breaks. Purchasing standards for patient handling equipment. Maintenance</p>	<p>Appropriate footwear with gripping soles and good support.</p>

<p><b>Ergonomic hazards associated with computer use or workstation design</b></p>	<p>Ergonomically designed workstations, chairs and equipment. Incorporate adjustable workstation to accommodate shared use by employees of various sizes.</p>	<p>of patient handling equipment. 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.</p>
<p><b>Ergonomic hazards associated with material handling of equipment and materials including lifting, carrying, pushing, pulling, etc. Use of pinch grip to handle X-ray cassettes.</b></p>	<p>Ergonomically designed storage areas with adequate space. Ergonomically designed equipment and containers. Provision of appropriate materials handling equipment such as carts, stretchers, beds, trolleys, etc. Replacement of X-ray cassettes and developing X-ray film with digital technology.</p>	<p>Safe work procedures including proper lifting, pushing and pulling procedures. Worker education and awareness sessions. Early reporting of signs and symptoms of ergonomic concerns. Stretches and micro-breaks. Purchasing standards for ergonomically designed equipment, containers etc. Purchasing standards for material handling equipment. Maintenance program for equipment.</p>
<p><b>Ergonomic hazards associated with positioning the X-ray tube including awkward postures and high forces</b></p>	<p>Purchase x-ray equipment with mechanical assistance and remote controls to move the x-ray tube. Use automatic tables.</p>	<p>Safe work procedures should include moving the x-ray tube in a slow, steady rate. Lower the tube before moving it into position whenever possible. Maintain equipment to decrease forces required to move the x-ray tube and equipment. Worker education and awareness sessions. Early</p>

		reporting of signs and symptoms of ergonomic concerns. Stretches and micro-breaks.	
<b>Ergonomic hazards associated with the use of ultrasound transducer include repetitive movements, high duration, awkward and sustained postures and high forces. Potential for compression forces if worker rests elbow or forearm on hard surface while scanning. Awkward postures associated with the position of the monitor and keyboard.</b>	Provide ergonomically designed ultrasound transducers (lightweight, appropriate size, balanced, slip resistant surface, and designed to allow a power grip with the wrist in a neutral posture). Provide a system to support transducer cables during the exam. Provide appropriate seating that incorporates armrests or cushions to support the arm while scanning. Consider alternative seating such as sit/stand seats or saddle seats. Provide adjustable exam tables. Provide an adjustable and portable work surface for the monitor and keyboard.	Safe work procedures including proper ultrasound, lifting, pushing and pulling procedures. Worker education and awareness sessions. Early reporting of signs and symptoms of ergonomic concerns. Stretches and micro-breaks. Vary work posture. Position patient and equipment to minimize ergonomic hazards. Purchasing standards for ergonomically designed ultrasound equipment, transducers, seating, etc. Maintenance program for equipment.	Select appropriate gloves that fit the worker comfortably and are textured and thin.
<b>Exposure to ionizing radiation during diagnostic or therapeutic radiology</b>	Workplace design to provide distance between worker and source. Appropriate shielding materials (permanent where possible). Immobilizing devices to restrain/position patients. Audible signals on machines when exposure is ended. Interlock systems.	Radiation safety program. Worker education. Safe work procedures to reduce exposure time (procedures requiring fewer workers in area, use fast film speed and short exposure times, etc.). Scheduling. Radiation safety program. Exposure monitoring program	Lead gloves, aprons, etc. as required.
<b>Exposure to ionizing radiation through administration of radio-labelled therapeutic agents</b>	Use of needlestick prevention devices. Shielding in the preparation of reagents or therapeutic agents	Radiation safety program. Worker education. Safe work procedures (proper labelling of all substances, proper disposal of all waste products, etc.) Radiation safety program	Gowns, gloves, and eye protection
<b>Exposure to ultrasound</b>	Room design. Equipment maintenance.	Worker education. Limit number of workers in room. Safe work procedures (including placement and holding of applicator, operation of equipment to reduce	

		exposure, etc.) Appropriate signage.	
<b>Exposure to magnetic fields while performing Magnetic Resonance Imaging</b>	Workplace design. Isolation/enclosure of worker. Interlock systems. Equipment maintenance.	Worker education. Pre-screening of patients for metal objects. Access limitations. Audible and visible warning signals.	Protective clothing (insulated gloves) where necessary based on hazard assessment.
<b>Falling hazards associated with slips, trips and falls</b>	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.
<b>Electrical hazards arising from use of electrical cords and appliances</b>	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.	

## About Radiation

### *Radiation*

Ionizing radiation has sufficient energy to impact atoms of molecules, creating ions, which can cause molecular changes to body cells. The health effects of ionizing radiation depend on several factors, including the total amount of radiation absorbed, the time period, the dose rate and the particular organ exposed. Ionizing radiation affects individuals by depositing energy in the body which can damage cells or change their chemical balance. In most cases, exposure to ionizing radiation may not result in any adverse health effects. In other cases, the irradiated cell may survive but become abnormal, temporarily or permanently, and eventually may be cancerous.<sup>7</sup>

<sup>7</sup> US Department of Labor – OSHA; Federal Registers: Occupational Exposure to Ionizing Radiation 70:22828 – 22835; [http://www.osha.gov/pls/oshaweb/owadisp.show\\_document?p\\_table=FEDERAL\\_REGISTER&p\\_id=18341](http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=FEDERAL_REGISTER&p_id=18341)

Non-ionizing radiation occurs at lower energy levels. Non-ionizing radiation does not have enough energy to disrupt the structure of atoms or molecules. However, it may have biological effects such as heating or initiating photochemical reactions. Non-ionizing radiation includes ultraviolet light, visible light, infrared light, microwaves, radio waves and electricity. It causes damage based on the wavelength of the radiation, with effects including heating, skin burns, and eye damage. Examples of non-ionizing radiation found in healthcare include lasers, ultrasound, ultraviolet radiation, radiofrequency and microwave radiation. Magnetic fields used in some devices such as magnetic resonance imaging (MRIs) can cause serious incidents to patients and workers by pulling ferromagnetic items into the bore of the magnet.

The Alberta *Radiation Protection Act* specifies obligations of employers and workers with regards to radiation protection. These include:

- The general responsibility for all parties to take reasonable precautions to protect people from radiation exposure
- The responsibility of the worker to use all protective devices and equipment and to wear protective clothing provided by the employer
- The responsibility of the employer to inform workers of radiation hazards and controls.

*Radiation Protection Act R-2 RSA 2000*

The *Radiation Protection Act* addresses the installation and maintenance of radiation equipment (x-ray and laser), inspections of this equipment and facilities, the required notifications of any overexposures, and quality assurance programs. The Radiation Protection Regulation establishes limits for exposure to ionizing and non-ionizing radiation, and requires radiation workers to notify their employers of their pregnancy. The regulation also prohibits anyone under 18 from using ionizing radiation equipment except in certain circumstances, and describes Registration Certificate requirements. Part 3 of the Regulation describes protection measures for the use of radiation equipment.

Nuclear Medicine and Radiation Oncology departments and researchers who use radioactive materials are governed by the *Nuclear Safety and Control Act (Canada)*. This Act is enforced by the Canadian Nuclear Safety Commission (CNSC), which issues licenses for the possession of radioactive sources. These licenses set out the criteria for compliance with the Regulations made under the *Nuclear Safety and Control Act*.

- General Nuclear Safety and Control Regulations
- Radiation Protection Regulations
- Nuclear Substances and Radiation Devices Regulations

These can be viewed at [www.nuclearsafety.gc.ca/eng/lawsregs/](http://www.nuclearsafety.gc.ca/eng/lawsregs/).

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### *Ionizing Radiation*

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Ionizing radiation is produced by radioactive decay (the rearrangement of atoms) or x-ray machines and particle accelerators.

Depending upon the wavelength, frequency and energy of the radiation, it may penetrate the body to varying degrees.

The major types of ionizing radiation are alpha and beta particles and X-rays and gamma rays. Alpha and beta particles are slower moving than X-rays and gamma rays. Alpha particles cannot penetrate the skin, so do not pose a high external hazard, but if they gain access into the body through ingestion or inhalation, they may pose a serious health hazard. Beta particles can travel through the air and can penetrate the skin and may produce harmful effects if the worker is exposed externally or internally. Alpha and Beta particles can carry different levels of energy. While one source of Beta radiation may not be considered dangerous others can present a significant hazard. Gamma rays and X-rays can penetrate tissue and may result in damage. Effects of exposure to ionizing radiation may be short-term or long-term and depend on the type and dose of radiation. Effects can range from the reddening of skin to tissue damage of varying degrees, cancer and in extreme cases, death. Ionizing radiation may be used in

- Diagnostic radiology
- Nuclear medicine (diagnostic and therapeutic)
- Radiation Oncology (external beam and implants)
- Areas where radioactive materials are stored or discarded.

### *Assessment of ionizing radiation hazards*

Exposure to ionizing radiation is assessed through the monitoring of individual worker exposures and the environment. Several different types of dosimeters can assess individual employee exposures. Thermoluminescent dosimeters (TLDs) and optically stimulated luminescence dosimeters (OSLs) are the most widely used. Both can measure X-rays as well as gamma and beta

radiation. It should be noted that the effects of radiation doses are cumulative over time in organs or tissues. Wipe tests are often performed to determine the degree of loose radioisotope contamination on surfaces. Wipe tests are performed on nuclear sealed sources as part of semi-annual leak tests, on shipment containers of any open source nuclear materials, and on work surfaces where open source nuclear materials have been handled. Contamination monitoring can be performed with a hand held meter as long as the probe can detect the target isotope at the action level set by the CNSC. This is common in laboratories or in Nuclear Medicine where radioactive materials are used.

Survey meters are used to conduct radiation protection surveys to identify where radiation is present and to quantify the exposure rate from various sources. There are specific types of survey meters available to measure the various types of radiation. Scalers are used to quantify the amount of radiation in a sample (such as an air sample or wipe sample). Scalers are usually set to measure the sample for a specified period of time. Radiation spectrometers assist the user in determining the types of radiation present by measuring the energy spectrum of the radiation.

Bioassays may also be used to monitor a worker's internal exposure to radiation. Urine samples are assessed for workers using tritium and thyroid monitoring is performed for workers using radioiodine.

Did you know?

All healthcare organizations must determine the appropriate type and methods of monitoring based on exposure criteria set forth in legislation. In Alberta, the Maximum Annual Dose Limits for ionizing radiation can be found in Schedule 1 of the Alberta Radiation Protection Regulation.

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### *Non-Ionizing Radiation*

Non-ionizing radiation used in Diagnostic Imaging and Nuclear Medicine includes magnetic resonance imaging (MRI) and ultrasound.

#### *Magnetic Resonance Imaging (MRI)*

Magnetic Resonance Imaging (MRI) is a diagnostic procedure that uses three types of magnetic fields to visualize physical and chemical properties of tissues in the body. These include a strong static magnetic field, a radiofrequency (RF) field, and a magnetic field gradient that is switched on and off during the imaging procedure. MRI is used extensively in cancer diagnosis and monitoring of treatment, functional assessments of heart muscle for heart-attack patients, assessment of patients after a stroke, as well as mapping out brain function to improve brain surgery outcomes.

Major safety concerns associated with MRIs relate to the strength of the magnetic fields and the action of the magnets on ferromagnetic objects. Magnetic fields can pull ferromagnetic items into the machine's bore, causing injury or death to the patient as well as serious damage to the magnet and imaging equipment. The health effects of worker exposure to magnetic fields are currently under investigation, however workers wearing cardiac pacemakers may be at risk.

More information about MRI safety can be found at [www.mrisafety.com](http://www.mrisafety.com).

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.

### *Ultrasound*

Some examples of ultrasound use in healthcare include the use of ultrasound in motion detectors, cleaning baths, medical imaging, and for the destruction of kidney stones (lithotripsy). Hazards associated with ultrasound exposure include; nausea, headaches, tinnitus, pain, dizziness, and fatigue on exposure to audible high-frequency radiation above 10 kHz.<sup>8</sup> Temporary hearing loss and threshold shifts are also possible from high-frequency ultrasound radiation.

Low-frequency ultrasound radiation may produce local effects when a person touches parts of materials being processed by ultrasound. The hands are often involved in the area where ultrasound acts most strongly. Exposure to powerful sources of ultrasound may result in damage to peripheral nervous and vascular structures at contact points. The most commonly encountered health effects for sonographers do not relate to the ultrasound, but rather to biomechanical factors contributing to musculoskeletal injuries.

Operator safety precautions to reduce occupational ultrasound exposure are provided in Health Canada's *Guidelines for the Safe Use of Diagnostic Ultrasound*: <http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/01hecs-secs255/index-eng.php>

<sup>8</sup> NIOSH Publication 88-119 *Guidelines for Protecting the Safety and Health of the Healthcare Worker* Available at <http://www.cdc.gov/niosh/docs/88-119/control.html>

## Notes about controls for physical hazards

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### *Engineering Controls*

#### Ergonomic hazards

One of the most commonly encountered physical hazards for DI and NM workers involves biomechanics of lifting and transferring when moving patients. This is particularly evident for staff using portable imaging devices in patient rooms or emergency rooms. Engineering controls include patient lifting devices appropriate to the required lift and for the patient, the use of ramps where possible, and ergonomically designed work areas. Hazards of manually handling residents could be reduced by a program that includes:

- Policies for risk assessment and control
- Having adequate equipment
- Having adequate staffing
- Ongoing resident handling training
- Management commitment
- Staff involvement
- Incident investigation, follow-up and communication

According to the No Unsafe Lift! Workbook,<sup>9</sup> three key risk assessments are required to determine what procedures or equipment should be used for patient handling. These are a workplace assessment, a patient assessment and a task assessment. For workplaces, key considerations include:

- Types of patients
- Special needs patients
- Equipment available and accessible
- The existence of patient care plans that include handling requirements
- Languages required for effective communication
- Workload issues

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<sup>9</sup> No Unsafe Lift! Workbook, Alberta Employment and Immigration. Available at [http://employment.alberta.ca/documents/WHS/WHS-PUB\\_nounsafelift\\_workbook.pdf](http://employment.alberta.ca/documents/WHS/WHS-PUB_nounsafelift_workbook.pdf)

- Workers wearing appropriate clothing and footwear
- Communication protocols for patient status information
- Patient lifting and transfer plans
- Trained staff
- Preventive and reparative maintenance programs for equipment in place
- Sufficient space to perform tasks, including use of mechanical lifts
- Walkways free of clutter
- Floor surfaces in good order
- Stable, suitable furniture
- Adequate lighting for tasks

For patients, key factors include;

- Capability to bear weight, move normally, tolerate basic tasks
- Patient conditions that may impact risk such as history of falls, impaired movement, pain, loss of sensation, skin issues, communication issues, medical equipment used, surgical conditions, sensory deficiencies, mental state (confusion), aggression, etc.
- Types and frequency of transfers, lifts, repositioning required

For a task assessment, consideration should be given to whether the task needs to be done, as well as the risks associated with the tasks. These may include

- Static positions that may be required
- Duration of task
- Awkward postures for caregivers
- Task requiring extended reach
- Restrictions posed by protective equipment
- Inflexibility of time for task

Other engineering controls related to manual materials handling include:

- Eliminate the need to push/pull/carry
- Provide handles to objects to be lifted.
- Ensure that friction between the floor and the cart wheels is low.

- Minimize the distances over which objects are to be pushed, pulled, or carried (change the layout of the workplace if necessary).
- Utilize carts or wheeled devices designed for the specific application.

### Radiation

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

### *Elimination and substitution*

In some cases, short-lived isotopes can be substituted for isotopes with a longer half-life.

### *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.

### *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.

### *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. An example of interlock system is one that prevents the operation of a piece of equipment unless critical safety features are engaged.

### *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, adequate lighting should be available. Cords and other tripping hazards should not be in the path of traffic. Non-slip flooring should be provided. The following are common engineering controls used to reduce the risk of slips, trips and falls in patient treatment areas:

- Designing testing and treatment areas and equipment layout to minimize cords and to accommodate equipment without creating tripping hazards
- Designing patient care and treatment areas with adequate space to accommodate portable equipment without creating tripping hazards
- Providing adequate storage space to minimize the storage of equipment in hallways
- Keeping hallways clear of obstructions
- Using cord covers over electrical cords, as necessary
- Utilizing non-slippery surfaces on the whole steps or at least on the leading edges.
- Performing regular maintenance to keep stairs in good repair. Ensure nothing is sticking out of surfaces on the stairs, handrails or banisters (e.g. nails or splinters).
- Maintaining lighting levels
- Using angular lighting and colour contrast to improve depth perception.

### *Electrical Hazards*

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 rather than 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.

## ***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:

- Ensure all aspects of a No Unsafe Lift! Program<sup>10</sup> are implemented.
- Establish ergonomic purchasing standards for tools and equipment, including patient lifting devices and vehicles.
- Provide procedures for patient assessments.
- Conduct user trials to test new equipment and tools with input from workers.
- Maintain equipment, vehicles and tools to optimize their operation.
- Provide training programs to educate workers regarding biomechanical risk factors, signs and symptoms and safe work practices (including proper lifting methods and proper use of lifting devices).
- Provide self assessment tools to identify and control biomechanical hazards.
- Optimize work shift scheduling to minimize extended work hours and overtime.
- Design break schedules to reduce biomechanical hazards.
- Encourage monitoring and early reporting of the signs and symptoms of musculoskeletal injuries (MSIs).

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<sup>10</sup> No Unsafe Lift! Workbook, Alberta Employment and Immigration. Available at [http://employment.alberta.ca/documents/WHS/WHS-PUB\\_nounsafelift\\_workbook.pdf](http://employment.alberta.ca/documents/WHS/WHS-PUB_nounsafelift_workbook.pdf)

## 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 both ionizing and non-ionizing radiation and are trained in the safe work procedures necessary to prevent exposure. Some administrative controls include having a radiation safety program, a laser safety program, safe work practices, monitoring exposures, and proper disposal practices. Minimize contact with body substances from patients receiving treatment with radionuclides.

## *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. "Designated" radiation equipment includes:

- Diagnostic or therapeutic x-ray equipment
- Particle accelerators
- Cabinet x-ray equipment
- Diffraction and analytical x-ray equipment
- Class 3B and 4 lasers

No person shall install or operate designated radiation equipment unless a registration certificate has been issued by the Director (College of Physicians and Surgeons of Alberta).

A registration certificate may be made subject to any restrictions deemed necessary for the protection of workers and the general public

*Radiation Protection Act R-2 RSA 2000*

## *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<sup>11</sup>. When nuclear

<sup>11</sup> Accessible at [http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/safety-code\\_35-secure/section-a1-eng.php](http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/safety-code_35-secure/section-a1-eng.php)

materials are being used the requirements for the radiation safety program are set by the Canadian Nuclear Safety Commission (CNSC).

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

### *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.

### *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.

### *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.

### *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.

### **Monitoring of worker ionizing radiation exposure**

An employer shall ensure that

- (a) radiation workers who use or are exposed to the use of any ionizing radiation equipment described in subsection (2) are provided with and use an appropriate device, provided by a dosimetry service provider licensed by the Canadian Nuclear Safety Commission, to monitor their personal exposure to ionizing radiation,
- (b) the records obtained from the monitoring are kept for at least 5 years, and
- (c) the workers are informed of and have access to these records.

*Alberta Radiation Protection Regulation, Part 1, Section 4*

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.

### *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:

- Education of workers and enforcement of the use of proper footwear
- Timely clean-up of any spills
- Eliminate the use of extension cords that may pose tripping hazards
- Keep walkways free of clutter

### Electrical Hazards

A major component of an electrical safety program is worker training.

Extension cords are used in many applications for temporarily supplying power. Considerations to follow when using extension cords include:

- Protect cords from damage; do not allow vehicles 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.

### ***Personal Protective Equipment Controls***

#### Ergonomic hazards

The most important personal protective equipment to control ergonomic hazards is appropriate footwear with gripping soles and good support.

#### 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.

Protective clothing is 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.

A special case occurs in Nuclear Medicine where workers may come into contact with patients who have been injected with radioactive material and are awaiting their diagnostic procedure. If possible the best practice is to schedule Nuclear Medicine procedures following all other exams or enough time prior to allow physical decay and excretion of the radioactive material. If scheduling restrictions are not possible e.g. due to the patient's medical condition the ALARA principal would indicate the provision of PPE to the worker, even though the radiation exposure from singular or even multiple nuclear medicine patients for a short period is very small.

### *Trips, Slips and falls*

The use of appropriate footwear by DI and NM workers is essential to prevent trips, slips and falls. Workers should be required to wear flat shoes with non-slip soles that offer good support.

## Psychological Hazards and Controls

Each department should systematically conduct hazard assessments for tasks performed each type of worker 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 any healthcare setting, 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
<b>Abuse by clients or members of the public</b>	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	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	Ability to request support. Use of counselling services.

	panic buttons. Video surveillance.	alone policies. Reporting procedures for incidents and near misses. Use of nametags.	
<b>Abuse by co-workers</b>	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.
<b>Hazards related to working alone</b> <ul style="list-style-type: none"> <li>• <b>Threat of violence</b></li> <li>• <b>Medical emergencies when alone</b></li> </ul>	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.	
<b>Stress related to critical incidents</b>		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.
<b>“Technostress” related to the introduction of new technology</b>	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.

<b>Substance abuse as a response to excessive workplace stressors</b>		Worker involvement in substance abuse policy and procedures development. Worker education about 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.	Increase awareness of substance abuse signs and symptoms. Communication with counsellors. Report to family physician. Participate in treatment programs and return to work programs.
<b>Depression, anxiety, sleep disorders, other mental illness as a response to excessive workplace stressors</b>		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.
<b>Hazards related to impacts of aging on workers</b>		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.
<b>Hazards related to shiftwork and hours of work</b>	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.).	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

		<p>Work designed so that critical tasks are not conducted at ends of shifts or “low points” in shift. Quality breaks are in place. Policies to encourage the reporting of concerns associated with fatigue. Thorough investigation of incidents and near misses with fatigue as a possible cause.</p>	<p>sedatives are minimized.</p> <p>Alertness strategies are utilized (e.g. bright lighting levels, regular short breaks, communication with co-workers, etc.).</p>
<b>Stress related to work-life conflict</b>		<p>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.</p>	<p>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.</p>
<b>Exposure to nuisance or irritating noise levels that may induce stress</b>	<p>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.</p>	<p>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.</p>	
<b>Exposure to poor indoor air quality that may induce stress</b>	<p>Proper ventilation system design. Ventilation system</p>	<p>Contractor requirements to reduce air contamination. Selection of low-</p>	

maintenance activities.  
Isolation/segregation of work processes that may create contaminants.

pollutant cleaning chemicals. Cleaning schedules. Infection prevention and controls standards. Rules regarding the 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.

## Notes about controls for psychological hazards

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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 Diagnostic Imaging and Nuclear Medicine:

- 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 department 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<sup>12</sup>**

- 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 7 AM, 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.

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<sup>12</sup> Adapted from Government of the U.K; Health and Safety Executive; Managing shift work HSG256; 2006;  
[www.hse.gov.uk/pubns/priced/hsg256.pdf](http://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 DI and NM workers

The following is a partial list of OHS-related competencies produced by the Canadian Association of Medical Radiation Technologists. The complete competency profiles can be found at

[http://www.camrt.ca/abouttheprofession/currentcompetencyprofiles/rad\\_study\\_kit03.pdf](http://www.camrt.ca/abouttheprofession/currentcompetencyprofiles/rad_study_kit03.pdf).

### **Radiation Therapy**

#### **A2 Use proper transfer techniques**

- A2.1 Assess the patient to identify the required transfer technique
- A2.2 Identify and use the equipment and resources for a safe transfer
- A2.3 Assist patient to move comfortably and safely by the use of accepted principles of body mechanics

#### **A3 Practice procedures to prevent/manage incidents**

- A3.1 Report potential safety hazards in the work area
- A3.2 Modify the immediate environment to reduce or eliminate hazards
- A3.3 Ensure the proper operation of safety devices
- A3.4 Maintain a clean, tidy and functional work area
- A3.5 Record and report irregularities in the functioning of therapeutic medical equipment
- A3.6 Dispose of sharps and biohazardous materials in appropriate containers
- A3.7 Determine the nature and gravity of an incident and take action according to established policies and protocols
- A3.8 Implement the established emergency procedure in the event of a disaster (e.g., fire, bomb threat)
- A3.9 Operate therapeutic medical equipment adhering to guidelines established by the manufacturer
- A3.10 Use safe procedures when moving and operating ancillary equipment (e.g., safety glasses, brakes)
- A3.11 Wear attire which minimizes the chance of entanglement with equipment and complies with WCB regulations
- A3.12 Practice the regulations related to workplace hazardous materials

#### **A5 Practice infection control**

- A5.1 Practice body substance/universal precautions and use measures to minimize spread of infection
- A5.2 Implement medical/surgical asepsis procedures as required

A5.3 Practice isolation/reverse isolation techniques for identified patients

**Nuclear Medicine** ([http://www.camrt.ca/abouttheprofession/currentcompetencyprofiles/nm\\_study\\_kit06.pdf](http://www.camrt.ca/abouttheprofession/currentcompetencyprofiles/nm_study_kit06.pdf))

**B1 Comply with Radiation Protection Regulations**

- B1.1 Comply with applicable CNSC regulations and standards
- B1.2 Maintain accurate written records of all radioactive material transfers
- B1.3 Adhere to prescribed regulations in the packaging and transport of radioactive materials
- B1.4 Dispose of radioactive material in accordance with CNSC regulations
- B1.5 Perform sealed source leak tests and maintain records

**B2 Perform Radiation Protection Procedures**

- B2.1 Follow established radiation safety protocols for the routine receipt, storage and handling of radioactive materials
- B2.2 Use proper procedures for radioactive materials that pose special hazards (e.g. 131I, 32P, 18F)
- B2.3 Use personal radiation monitoring devices in an appropriate manner
- B2.4 Apply ALARA principles of time, distance and shielding to reduce radiation exposure

**B3 Perform Radiation Surveys**

- B3.1 Perform thyroid screening (bioassays) and evaluate results
- B3.2 Perform wipe tests and evaluate results
- B3.3 Perform area radiation surveys and evaluate results
- B3.4 Perform routine personal monitoring procedures

**B4 Perform Decontamination Procedures**

- B4.1 Report radioactive spills to appropriate personnel
- B4.2 Implement emergency procedures as required until radiation safety personnel arrives
- B4.3 Monitor the level of radioactivity around radioactive spills, on hands and clothing to determine the need for decontamination
- B4.4 Perform surface and personnel decontamination using appropriate radiation protection techniques
- B4.5 Survey spill area to ensure that contamination has been reduced to acceptable levels
- B4.6 Record details of radioactive spills and corrective action taken

B4.7 Restrict access to areas which have not been decontaminated to permissible levels

### **B5 Dispose of Radioactive Waste**

B5.1 Maintain a low level and secure storage area to allow for the decay of radioactive waste

B5.2 Follow established radiation safety protocols for the storage/disposal of radioactive waste

B5.3 Deface or remove radiation symbols on containers before disposal

B5.4 Maintain a waste storage and disposal log according to CNSC regulations

### **C1 Store and Handle Materials**

C1.1 Receive, store and log radiopharmaceuticals

C1.2 Implement specific monitoring procedures when a shipment of radiopharmaceuticals appears damaged

C1.3 Store radioactive and non-radioactive supplies and kits

### **F2 Use Appropriate Safe Work Habits**

F2.1 Provide a clean, safe environment for both the patient and technologist

F2.2 Employ proper body mechanics when transferring, lifting, turning or transporting a patient

## **Magnetic Resonance Imaging** ([http://www.camrt.ca/certification/canadian/summaryofclinicalcompetence/Summary\\_MR.pdf](http://www.camrt.ca/certification/canadian/summaryofclinicalcompetence/Summary_MR.pdf))

### **B 1 Provide a safe environment to minimize the risk of adverse events to the patient and to staff**

B1.1 Provide a safe, clean and comfortable environment

B1.2 Transport the patient safely using equipment based on the patient's physical and cognitive status and resources available

B1.3 Transfer the patient safely using equipment and techniques based on patient's physical and cognitive status

B1.4 Employ proper body mechanics to prevent harm to self and patient

### **B 4 Implement infection control practices**

B4.1 Understand transmission mode of nosocomial infections (host, agent and environment)

B4.2 Utilize routine practices for preventing the transmission of infection in health care

B4.3 Apply principles of asepsis

B4.4 Apply protocols when handling and disposing contaminated and biohazardous materials such as sharps and body fluids

- B4.5 Adhere to protective environment protocols with patient who have compromised immunity
- B4.6 Adhere to protocols when caring for patients with antibiotic resistant organisms
- B4.7 Adhere to transmission based precautions for airborne, droplet and contact modes of transmission

### **C 1 Apply MR safety practices with respect to MR screening**

- C1.1 Ensure that the patient screening forms are completed
- C1.2 Demonstrate an understanding of the magnetic properties of foreign objects
- C1.3 Determine whether foreign objects in/on the patient's body constitute a contraindication to MR
- C1.4 Determine exceptions to contraindications during the screening process
- C1.5 Determine patient's pregnancy status and take appropriate action
- C1.6 Screen MR personnel and support staff
- C1.7 Assess and remove any ancillary contraindicated objects from the patient, MR personnel and Support Staff
- C1.8 Identify the safety considerations related to the presence of ferromagnetic equipment/accessories (MR compatible or MR safe) in the magnetic field

### **C 2 Apply safety guidelines with respect to MR bio-effects**

- C2.1 Provide hearing protection to the patient and attending individuals
- C2.2 State the Canadian government MR safety standard regulations for radiofrequency (RF), static magnetic fields and gradient magnetic fields
- C2.3 Demonstrate an understanding of potential bio-effects of the static magnetic fields
- C2.4 Demonstrate an understanding of potential bio-effects of the time varying (gradient) magnetic fields
- C2.5 Demonstrate an understanding of potential RF bio-effects and specific absorption rate (SAR)
- C2.6 Utilize safe practice in RF coil and equipment cable placement

## **Ultrasound**

The following is a partial list of OHS-related competencies produced by the Canadian Association of Registered Diagnostic Ultrasound Professionals. The complete competency profile can be found at <http://www.cardup.org/docs/ncp.pdf>

### **3.1 Ensure patient safety.**

- b Transport and / or move patient.
- c Assess patient's ability to tolerate examination.

- d Employ aseptic technique as required.
- e Employ sterile technique and infection control methods as required.
- f Assess and monitor patient's physical and mental status prior to and during examination.
- g Recognize and respond to emergency situations.
- h Administer first aid or provide life support in emergency situations.
- i Perform cardiopulmonary resuscitation.
- j Demonstrate awareness of patient's accessory equipment (eg intravenous fluid, suction equipment, oxygen) and take action as required.

**6.1 Ensure safety of work environment.**

- a Maintain clean and orderly work area.
- b Recognize hazardous conditions in the work area, and act when required.
- d Demonstrate awareness of fire and disaster plans.
- e Locate emergency equipment.
- g Employ universal precautions for infection control.

**6.2 Protect self from work-related hazards.**

- a Employ proper body mechanics when transferring, lifting, turning or transporting patient.
- b Practice musculoskeletal injury prevention techniques.
- c Follow Workplace Hazardous Materials Information System (WHMIS) protocols.

## 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 Employment and Immigration; No Unsafe Lift! Workbook; 2008 [http://employment.alberta.ca/documents/WHS/WHS-PUB\\_nounsafelift\\_workbook.pdf](http://employment.alberta.ca/documents/WHS/WHS-PUB_nounsafelift_workbook.pdf)

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 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>

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

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](http://www.comh.ca/publications/resources/dwf/Work_Depression.pdf)

Bolus, N.E.; *Review of Common Occupational Hazards and Safety Concerns for Nuclear Medicine Technologists*; Journal of Nuclear Medicine Technology; Volume 36; Number 1; 2008; 11-17; <http://tech.snmjournals.org/cgi/content/full/36/1/11>

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

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

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

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

Canadian Centre for Occupational Health and Safety (CCOHS), *OSH Answers – Electrical Safety Basic Information*; updated June 1, 2000; [http://www.ccohs.ca/oshanswers/safety\\_haz/electrical.html](http://www.ccohs.ca/oshanswers/safety_haz/electrical.html)

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

Canadian Centre for Occupational Health and Safety (CCOHS), *OSH Answers – OHS Legislation in Canada; Due Diligence*; <http://www.ccohs.ca/oshanswers/legisl/diligence.html>

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

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

Canadian Centre for Occupational Health and Safety; *OSH Answers – Ionizing Radiation*; [http://www.ccohs.ca/oshanswers/phys\\_agents/ionizing.html](http://www.ccohs.ca/oshanswers/phys_agents/ionizing.html)

Canadian Nuclear Safety Commission; *Keeping Radiation Exposures and Doses “As Low as Reasonably Achievable,”* G129 Revision 1; October 2004; <http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/01hecs-secs255/index-eng.php>

Canadian Nuclear Safety Commission; *Laws and Regulations*; 2009-07-15; <http://www.nuclearsafety.gc.ca/eng/lawsregs>

Canadian Standard Association; Standard Z432-04: *Safeguarding of Machinery*; [http://ohs.csa.ca/standards/equipment\\_machinery/Machine\\_Safety/Z432-04.asp](http://ohs.csa.ca/standards/equipment_machinery/Machine_Safety/Z432-04.asp) or view at <http://ohsviewaccess.csa.ca/>

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

Government of Alberta; *Radiation Protection Act R-2 RSA 2000*; [http://www.qp.alberta.ca/574.cfm?page=R02.cfm&leg\\_type=Acts&isbncln=9780779724376](http://www.qp.alberta.ca/574.cfm?page=R02.cfm&leg_type=Acts&isbncln=9780779724376)

Government of Alberta; *Radiation Protection Regulation 2003*; [http://www.qp.alberta.ca/574.cfm?page=2003\\_182.cfm&leg\\_type=Regs&isbncln=0779731042](http://www.qp.alberta.ca/574.cfm?page=2003_182.cfm&leg_type=Regs&isbncln=0779731042)

Government of the U.K, Health and Safety Executive; *HSE Information Sheet; Slips and trips in the health services*; 09/03; <http://www.hse.gov.uk/pubns/hsis2.pdf>

Health Canada *Best Advice on Stress Management in the Workplace, Part 1*, 2001; retrieved from [www.hc-sc.gc.ca/ewh-semt/pubs/occup-travail/stress-part-1/index-eng.php](http://www.hc-sc.gc.ca/ewh-semt/pubs/occup-travail/stress-part-1/index-eng.php)

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

Health Canada, Environmental and Workplace Health; *National Dose Registry*; 2007-12-20; [http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/safety-code\\_35-securite/section-a1-eng.php](http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/safety-code_35-securite/section-a1-eng.php)

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## 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 DI and NM workers.
3. Identify significant chemical hazards that may impact DI and NM workers.
4. Identify significant physical hazards that may impact DI and NM workers.
5. Identify potential psychological hazards that may impact DI and NM 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 hazard, identify possible engineering, administrative and personal protective equipment controls.

## APPENDIX 4 - Test Your Knowledge

1. In what way can DI and NM workers be exposed to biological hazards?
2. What is meant by the “hierarchy of controls”?
3. Give three examples of engineering controls.
4. Give three examples of administrative controls.
5. Give three examples of personal protective equipment.
6. Describe the major physical hazards that DI and NM workers may be exposed to?
7. List at least five factors that are important in controlling exposure to ionizing radiation.
8. How are workers monitored for exposure to ionizing radiation?
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 chemicals?

### **Test Your Knowledge - Answers**

1. DI and NM workers 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. Preventive maintenance of equipment, shielding, 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. Lead aprons, protective eyewear, gloves, lab coats, respirators, etc.
6. Ergonomic, radiation, slips, trips, falls, burns
7. Type of radiation, shielding, isolation, waste disposal, worker monitoring, decontamination procedures, needlestick prevention devices, etc.
8. Personal dosimetry is used for monitoring worker exposure.
9. Criteria for the selection of eye protection include:
  - a. Level of protection required.
  - b. Comfort of the wearer.
  - c. Secure fit that does not interfere with vision or movement.
  - d. Ease of cleaning and disinfection.
  - e. Durability.
  - f. Compatibility with prescription glasses and other PPE that must be worn at the same time (e.g. respirators).
10. Administrative controls may include 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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