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Title: **X-Ray Safety Manual** **Site(s):** **Shared Health**

Document #:	**300-80-001**	**Version #:**	**01**
Section:	**Diagnostic Imaging**	**Subsection:**	**Radiation Safety**

Approved by: *Approval on file*	Dr M Essig	**Date:**	31-OCT-2023
		Effective Date:	29-NOV-2023

Details of Recent Revision

New Document

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GLOSSARY

CAMRT	*Canadian Association of Medical Radiation Technologists*. CAMRT is the national professional association and certifying body for radiological, nuclear medicine, and magnetic resonance imaging technologists and radiation therapists. https://www.camrt.ca/
CCMB	*CancerCare Manitoba*. CCMB is the provincially mandated cancer agency and is responsible for setting priorities and long-term planning for cancer and blood disorders. https://www.cancercare.mb.ca/home/
CPSM	*College of Physicians and Surgeons of Manitoba*. CPSM self-regulates the medical profession in Manitoba. The role of CPSM is to protect the public as consumers of medical care and to promote the safe and ethical delivery of quality medical care by physicians in Manitoba. https://cpsm.mb.ca/
Effective Dose	A dose quantity used in radiation protection that provides a measure of the overall risk to humans from exposure to ionizing radiation. The units of effective dose are Sieverts (Sv) and typical values are usually expressed in milliSieverts (mSv).
Equivalent Dose	A dose quantity used in radiation protection that accounts for the biological effects of exposure to different types of radiation. The units of equivalent dose are Sieverts (Sv) and typical values are usually expressed in milliSieverts (mSv).
ICRP	*International Commission on Radiological Protection*. The ICRP is an independent, international organization that advances for the public benefit the science of radiological protection, in particular by providing recommendations and guidance on all aspects of protection against ionizing radiation. https://www.icrp.org/index.asp
MRT	*Medical Radiation Technologist*. MRTs are healthcare professionals who provide imaging services. They are responsible for using medical ionizing radiation equipment to produce diagnostic images.
Sv	*Sievert*. An SI unit of measure for the radiation quantities equivalent dose and effective dose. This unit is used only for radiation protection purposes. Typical values are usually expressed in milliSieverts (mSv) where one mSv is 1/1000th of a Sievert (Sv).

1 INTRODUCTION

This manual provides practical guidance on the safe operation of diagnostic x-ray imaging systems for medical radiation technologists (MRT's) and other health care providers who may operate such equipment in Manitoba. X-ray imaging systems must only be used in such a way that the health and safety of staff, patients, and the public are protected, and must be operated in compliance with all relevant federal and provincial regulations and accreditation standards.

Acts and Regulations:

Federal - The Radiation Emitting Devices Act:

https://laws.justice.gc.ca/eng/acts/R-1/

Provincial - Manitoba X-ray Safety Regulations 341/88R:

https://web2.gov.mb.ca/laws/regs/current/_pdf-regs.php?reg=341/88%20R

Accreditation Standards:

The College of Physicians & Surgeons of Manitoba has established accreditation standards for diagnostic imaging facilities through the Manitoba Quality Assurance Program:

http://www.cpsm.mb.ca/accredited-programs/the-manitoba-quality-assurance-program-manqap-1

Guidance:

Health Canada provides guidance on the safe use of radiation-emitting equipment in Safety Code 35: Radiation Protection in Radiology – Large Facilities:

https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/radiation/safety-code-35-safety-procedures-installation-use-control-equipment-large-medical-radiological-facilities-safety-code.html

1.1 Terminology

In this document, the word **"must"** means that a recommendation is essential to meet currently accepted standards of protection, while the word **"should"** means that a recommendation is highly desirable and is to be implemented where practice

2 RELEVANT ORGANIZATIONS AND CONTACT INFORMATION

Radiation Protection is a department of the Division of Medical Physics, CancerCare Manitoba (CCMB), providing leadership on the radiation protection responsibilities that fall within the regulatory jurisdiction of the province. The Radiation Protection Officers of Radiation

Protection, CCMB are provincially appointed as inspectors with responsibility for ensuring compliance with provincial regulations. Radiation Protection, CCMB also provides expertise on all aspects of radiation safety.

Imaging Physics is a department of the Division of Medical Physics, CCMB, supporting health care professionals using medical imaging equipment in maximizing patient benefit and reducing patient risk. Imaging physicists provide expertise on system specification and purchase, acceptance testing, quality assurance, protocol development, image optimization, and troubleshooting.

For all inquiries about Radiation Protection inspections, radiation protection of patients, staff, and the public, facility shielding, or any general radiation safety concerns, please contact:

Radiation Protection
CancerCare Manitoba
675 McDermot Avenue
Winnipeg, MB
R3E 0V9
https://www.cancercare.mb.ca/Research/medical-physics/radiation-protection-services
CCMBMPX-raycompliance@cancercare.mb.ca Email
204-787-4145 phone
204-775-1684 fax

For inquiries about acceptance and annual testing of diagnostic x-ray imaging systems, equipment quality assurance, protocol optimization, or fluoroscopy training for non-radiologist physicians, please contact:

Imaging Physics
CancerCare Manitoba
(mailing address as above)
https://www.cancercare.mb.ca/Research/medical-physics/imaging-physics
204-787-4145 phone
204-775-1684 fax

For inquiries about diagnostic x-ray imaging system maintenance, please contact:
Clinical Engineering
Shared Health
clinicalengineering@wrha.mb.ca
204-787-3678 phone

3 RADIATION SAFETY AND ALARA

The core principles of radiation protection are justification, optimization, and limitation. Justification is the requirement that the expected benefit of a medical imaging procedure using ionizing radiation outweighs any potential harm. Optimization is the requirement that the likelihood of exposure, the number of persons exposed, and the magnitude of individual exposures are all kept as low as reasonably achievable (ALARA). Limitation is the requirement that the total annual radiation dose to occupationally exposed staff or to members of the public resulting from planned exposures does not exceed regulated limits. There are no regulated limits for radiation dose to patients from medical exposures, so long as all such exposures are justified.

The ALARA principle states that doses should be kept as low as reasonably achievable. In the context of radiation exposure for staff, the implementation of ALARA means that exposure to ionizing radiation should be minimized. In the context of radiation exposure for patients, ALARA means that the amount of radiation used for a given procedure should be appropriate for the clinical requirements.

The core practices of radiation protection are time, distance, and shielding. The amount of time that the radiation beam is on, or the amount of time spent in proximity to the beam, should be minimized. This does not mean that procedures should be rushed, but rather that they should be carried out efficiently, using all available tools to minimize the amount of time that the beam is on. Staff and other persons in the x-ray room during an exposure should maximize their distance from the x-ray beam and the patient. Staff and other persons in the x-ray room during an exposure should also make use of appropriate personal protective equipment and shielding.

4 X-RAY SAFETY POLICIES

4.1 Policies on X-ray Imaging Facilities and Equipment

4.1.1 X-ray Room Shielding

X-ray facilities must be shielded such that the estimated radiation doses to occupationally exposed staff and the public will be less than 1 milliSievert (mSv) per year. Radiation Protection, CCMB is responsible for the determination of shielding requirements for a given facility prior to installation of new x-ray imaging equipment, as well as verification of shielding efficacy post-installation. When a new facility is being designed or an existing facility is being renovated, the owner or representative must contact Radiation Protection, CCMB and provide all information requested for determining shielding requirements for the facility.

4.1.2 Installation of New X-ray Imaging Equipment

All medical x-ray equipment, and accessories, purchased or leased in Canada must conform to the requirements of the Radiation Emitting Devices Act and Regulations and the Food and Drugs Act's Medical Devices Regulations for diagnostic x-ray equipment and must be licenced by Health Canada.

All new diagnostic x-ray imaging systems must be registered within 30 days of arrival on-site with Radiation Protection, CCMB. This registration will remain valid until any of the following occur, at which time a new registration request must be submitted:

- There is a change in ownership of the equipment, or
- The equipment is relocated, or
- The x-ray generator is replaced, or
- The entire system is replaced, or
- The equipment is decommissioned and removed.

Mobile C-arm or Mini C-arm Fluoroscopy Systems:
All locations within a facility where a mobile C-arm or mini C-arm fluoroscopy system will be used must be identified at the time of initial *Registration of X-ray Equipment* with Radiation Protection, CCMB. If the facility wishes to use a mobile C-arm or mini C-arm fluoroscopy system in a location not identified in the initial *Registration of X-ray Equipment* form, Radiation Protection, CCMB, must be notified prior to use or at the earliest opportunity in the case of emergency use. Please note, if a mobile C-arm or mini C-arm fluoroscopy system is moved to a different facility (or if there is a change in ownership/department within the same facility), the submission of a *Registration of X-ray Equipment* form is required and Radiation Protection, CCMB, must be notified.

Mobile X-ray Systems:
If a mobile X-ray system is moved to a different facility (or if there is a change in ownership/department within the same facility) not identified on the initial *Registration of X-ray Equipment* form, the submission of a new form is required and Radiation Protection, CCMB, must be notified. In addition, If a mobile X-ray system is used in the case of an emergency in an atypical location, Radiation Protection must be notified at the earliest opportunity.

Please contact Radiation Protection, CCMB, CCMBMPX-raycompliance@cancercare.mb.ca

All new diagnostic X-ray imaging systems must meet CCMB Imaging Physics acceptance testing requirements.

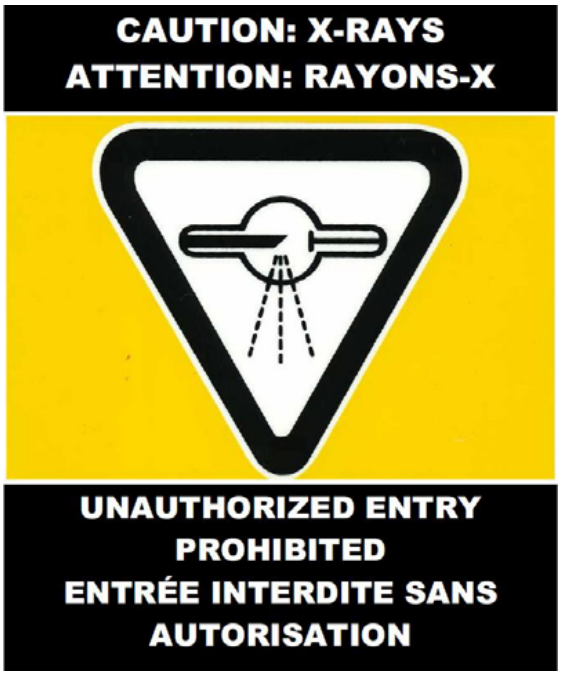
All new diagnostic x-ray imaging systems must meet Radiation Protection, CCMB radiation safety requirements, including completion of an initial Radiation Protection inspection.

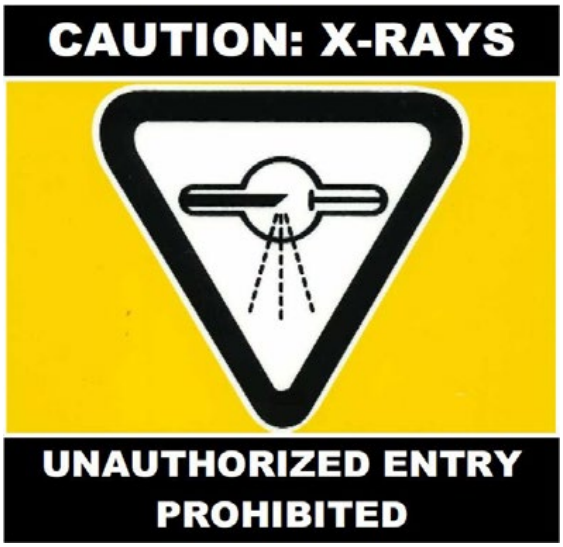
4.1.3 X-ray Room Doors

All x-ray room doors must be kept closed while an x-ray procedure is in progress.

4.1.4 Radiation Warning Signs

Radiation warning signs must be posted on all entrance doors of any room containing operational x-ray equipment. The x-ray control panel must bear a permanent and conspicuous sign warning that hazardous x-radiation is emitted when the equipment is in operation and prohibiting unauthorized use. If needed, please consult with Radiation Protection, CCMB to confirm that the signage at your facility meets requirements.





4.1.5 Quality Assurance Program

Facilities must establish and maintain a quality assurance (QA) program for diagnostic x-ray imaging systems. A QA program for diagnostic x-ray imaging equipment should include the following elements:

- Acceptance testing of equipment that is new, has undergone major modifications, or has been relocated (other than mobile systems),
- Regular equipment quality control (QC) activities,
- Regular preventive maintenance (PM) activities,
- Regular Radiation Protection inspections, and
- Associated administrative and training procedures for these activities.

Acceptance Testing

Acceptance testing is the process of verifying that new or modified diagnostic x-ray equipment meets established specifications and performance criteria. Measurements acquired during acceptance testing also provide baseline values for future quality control tests. Acceptance testing of new or modified diagnostic x-ray equipment in Manitoba must meet requirements determined by CCMB Imaging Physics.

Quality Control

Quality control is a set of periodic tests designed to detect changes in x-ray equipment performance. This periodic testing enables a facility to recognize when changes in x-ray equipment function have compromised diagnostic image quality or increased risk, allowing for

prompt corrective action. An ongoing QC program must be implemented for any diagnostic x-ray imaging system in consultation with CCMB Imaging Physics.

Preventive Maintenance

Regular PM activities help to prevent equipment from failing unexpectedly, as well as ensuring that equipment performance is within operational specifications. Preventive maintenance and repair work on x-ray equipment may be performed only by appropriately trained individuals using appropriate test equipment and repair methods. These staff may be from original equipment manufacturers, third party service companies or a hospital. Service personnel must carry appropriate acts and omissions insurance coverage. Any individual conducting service must provide written documentation of the work performed that at a minimum includes a brief description of the work/tests performed and the parts replaced.

Radiation Protection Inspections

Radiation Protection inspections are performed to ensure that diagnostic x-ray imaging systems and auxiliary equipment are compliant with applicable regulations and standards. Safety measures such as protective equipment and shielding are also examined to ensure that they are present and provide the required protection.

Radiation Protection inspections are conducted by the Radiation Protection Officers of Radiation Protection, CCMB and must be completed for any new installation or for equipment that has undergone substantial modifications. Ongoing Radiation Protection inspections of existing facilities must also be carried out at regular intervals.

4.2 Policies on Staff Working with X-ray Imaging Equipment

4.2.1 Incident Reporting

Any MRT or clinician operating an x-ray imaging system who knows or suspects that they, or anyone else, have been involved in any abnormal situation, shall immediately report the incident to their supervisor. If the incident involves unintended exposure of a staff member to ionizing radiation, the operator or supervisor must contact Radiation Protection, CCMB at the earliest opportunity. Unintended exposures to staff are accidental occupational doses in which they are exposed primary or secondary radiation without protective apparel.

4.2.2 Authorization to Operate Equipment

Operators of x-ray imaging equipment must have appropriate training, education and/or certification to perform x-ray procedures within their scope of practice, as required by Manitoba X-ray Safety Regulation 341/88R. Specific qualifications may be required by the employer or by relevant professional organizations, such as the Canadian Association of Medical Radiation Technologists (CAMRT). Non-radiologist physicians who operate mobile fluoroscopy equipment must receive appropriate training and be listed in a registry maintained by the Program Review Committee of the College of Physicians and Surgeons of Manitoba

(CPSM). Fluoroscopy training for non-radiologist physicians is provided by CCMB Imaging Physics.

4.2.3 Occupational Annual Dose Limits

Dose limits for medical radiation technologists, the public, and technologists in training are based on recommendations from the International Commission on Radiological Protection (ICRP) Publications 103 and 118. Annual dose limits for technologists in training are the same as for the public.

Table 2: Prescribed annual dose limits for medical radiation technologists and the public

Applicable Organ or Tissue	Medical Radiation Technologist (mSv)	Members of the Public and MRTs in Training (mSv)
Whole Body†	20	1
Lens of the Eye‡	20	15
Skin‡	500	50
Hands and Feet‡	500	50

† Effective dose
‡ Equivalent dose

4.2.4 X-ray Personal Protective Equipment

The use of lead and lead-equivalent personal protective equipment is key to ensuring that staff dose levels are kept ALARA. Lead aprons and thyroid shields are the primary items of protective equipment. Lead gloves and glasses may be appropriate in certain circumstances. X-ray personal protective equipment must provide attenuation as shown in Table 3.

Table 3: Attenuation requirements for x-ray personal protective equipment

Garment	Peak X-ray Tube Voltage	Lead Equivalence (mm)
Apron	Less than 100 kV	0.25
Apron	Between 100 and 150 kV	0.35
Apron	150 kV or higher	0.50
Thyroid Shield	Any	0.50
Gloves	Any	0.25
Glasses	Any	0.25

Lead Aprons and Thyroid Shields

Lead aprons must be provided to all staff who are required to be in an x-ray room and outside of the shielded control booth during exposures. Thyroid shields must be provided to any staff who will be working bedside or close to the x-ray beam or patient. Lead aprons should be properly hung on designated hangers. They must not be folded. Cracks in the lead lining can develop at the fold, reducing the useful life of the apron.

Lead Gloves and Radiography

In general, there should be no need for anyone other than the patient to be exposed to the primary radiation beam during a radiographic exam. In some circumstances, a staff member, parent, or caregiver may be required to hold or assist a patient during an exposure – see Section 4.3.5 for further information. In such cases, it may be appropriate for the person assisting or holding the patient to wear lead gloves if their hands will be adjacent to, or in, the primary radiation beam.

Lead Gloves and Fluoroscopy

A clinician may need to work with their hands near the x-ray beam in certain fluoroscopic procedures. Two types of lead gloves are available, heavy gauntlet-style gloves and lighter, more flexible gloves. The heavy gloves provide greater protection but significantly reduce manual dexterity. The lighter gloves allow for some protection from scattered radiation while preserving dexterity. Neither type of glove should be inserted into the primary x-ray beam, as the fluoroscopy system will react to the presence of strongly attenuating material by increasing the dose rate, leading to higher patient dose levels and increased scatter.

Lead Glasses

Eye protection must be made available to all staff who have the potential to exceed the 20 mSv dose limit to the eyes. Currently, the individuals that have the potential to receive appreciable eye doses are the primary operator and their first assistant in the high dose procedures of interventional radiology and cardiology.

Inspection of X-ray Personal Protective Equipment

New protective lead garments (aprons, thyroid shields, and gloves) must be inspected prior to first use and annually thereafter. Existing protective lead garments must be inspected annually. Instructions for inspection of protective lead garments are given in Appendix A.

4.2.5 Personal Dosimeters

All staff who work with ionizing radiation are to be assigned a whole-body personal dosimeter if they are likely to receive a dose in excess of 1/20th of the prescribed annual dose limit for radiation workers. Those who are assigned a dosimeter are responsible and accountable for using it according to its intended purpose.

General Guidelines:

1. Personal dosimeters are to be worn during working hours only.

2. Personal dosimeters are to be worn securely on the torso or collar region underneath protective lead clothing.

3. When not in use, dosimeters are to be stored in a controlled location, well away from any ionizing radiation source.

4. Personnel are to only wear the dosimeter that has been assigned to them. Personal dosimeters are not to be borrowed or loaned.

5. Dosimetry services operate on a continual wear and exchange cycle. Personal dosimeters are worn for a specified amount of time (usually a quarterly basis) and then returned to Health Canada to be processed and analyzed. A replacement dosimeter is provided during this exchange and return period; therefore, staff are to ensure that their personal dosimeter is accessible during this process.

6. Managers are to review National Dosimetry Services exposure reports when received to ensure that occupational radiation exposure levels are below recommended annual dose limits. Exposure reports contain personal employee information and therefore should be kept confidential.

7. National Dosimetry Services exposure reports are to be kept for the lifetime of the facility.

8. Radiation Protection, CCMB is to be provided with National Dosimetry Services exposure reports upon request.

9. Any lost, misplaced, or missing dosimeters are to be reported to the manager or the facility's dosimetry coordinator.

10. Accidental occupational exposures or any unusually high doses are to be reported to Radiation Protection, CCMB upon discovery. Information regarding the details of this occurrence is to be provided for review and if necessary, an investigation will be conducted.

4.2.6 Guidance for Pregnant X-Ray Workers

Dose Limits and Monitoring for Pregnant Medical Radiation Technologists

From the time that pregnancy is declared until the end of term, the whole-body effective dose limit for pregnant MRTs is **4 mSv**.

Based on the recommendation from the International Commission on Radiological Protection (ICRP) Publication 103, the working conditions of a pregnant worker, after declaration of pregnancy, should be such as to ensure that the additional dose to the embryo/fetus would not exceed an effective dose of **1 mSv** during the remainder of the pregnancy. The methods of protection at work for persons who are pregnant should provide a level of protection for the embryo/fetus like that provided for members of the public.

The annual dose limit for students and/or technologists in training is **1 mSv**. This annual dose limit should be used as a guideline should a student and/or technologist in training declare pregnancy.

When pregnancy is declared, the pregnant MRT's manager must review the most recent National Dosimetry Services exposure reports to determine whether the MRT's current and future work duties are compatible with the recommended dose limits. If the exposure reports indicate a consistent history of negligible occupational dose readings, and no increase in occupational dose is expected, then no modifications to the MRT's work duties are required. If the exposure reports indicate the potential for exceeding the dose limits given above, the manager and MRT must review safe radiation protection practices and consider modifying assigned work duties to limit the occupational radiation exposure levels for the duration of the pregnancy.

If the pregnant MRT has any concerns regarding safe radiation practice in their assigned work duties, they are to consult with their manager.

The manager is to review National Dosimetry Services exposure reports at the end of each wearing period to ensure that employee's occupational dose readings are within recommended limits.

Radiation Protection, CCMB can provide specific information on personal dosimeter monitoring during pregnancy. They can also provide general advice on personal dosimeters and radiation safety.

Dose Monitoring for Other Pregnant Staff Members

All pregnant health care workers other than MRT's who may be occupationally exposed to ionizing radiation should consult with Radiation Protection, CCMB regarding dose monitoring or any other concerns related to radiation protection during pregnancy.

4.3 Policies Regarding Patient Exposures

4.3.1 Incident Reporting

Any MRT or clinician operating an x-ray imaging system who knows or suspects that they, or anyone else, have been involved in any abnormal situation, shall immediately report the incident to their supervisor. If the incident involves unintended exposure of a patient to ionizing radiation, the operator or supervisor must contact Radiation Protection, CCMB at the earliest opportunity.

4.3.2 Identification of Patients Prior to Exposure

The operator responsible for exposing a patient to ionizing radiation must verify the identity of the patient prior to the procedure. If the wrong patient has been exposed, the operator must immediately contact their immediate supervisor and submit an incident report. The operator or their immediate supervisor must also notify Radiation Protection, CCMB at the earliest opportunity.

4.3.3 Identification of Anatomy to be Imaged Prior to Exposure

The operator responsible for exposing a patient to ionizing radiation must verify the anatomy to be imaged on the requisition prior to the procedure. If the incorrect anatomy has been imaged, the operator must immediately contact their immediate supervisor and submit an incident report. The operator or their immediate supervisor must also notify Radiation Protection, CCMB at the earliest opportunity.

4.3.4 Unintended Exposures Due to Equipment Malfunction

If an x-ray imaging system malfunctions during an exposure, and the operator responsible has reason to believe that the patient has been exposed to a radiation dose greater than intended for the given exam, or has been exposed without an image being recorded, the operator must immediately contact their supervisor and submit an incident report. The operator or their immediate supervisor must also notify Radiation Protection, CCMB at the earliest opportunity. The operator should record as many relevant facts about the exposure as possible, including but not limited to: exposure parameters, anatomy being imaged, patient size, weight, and age. Information provided will be used to provide an estimate of dose delivered to patient. The system in question should not be used until the cause of malfunction has been identified and rectified.

Examples of such an incident would include failure of the back-up timer during a radiographic exam using automatic exposure control, or power failure mid-exam resulting in the need to repeat the entire procedure.

4.3.5 Pregnancy Screening

All patients who have internal reproductive organs aged 11-55 must be asked by the MRT performing the exam if there is a chance of pregnancy. If the patient is unable to respond, the MRT must ask the ordering physician and, if necessary, the patient's primary care provider to confirm pregnancy status.

The MRT performing the exam must ensure that the pregnancy screening section on the ordering requisition is filled out correctly and that the information has been transferred to the Radiology Information System (RIS). If pregnancy cannot be confirmed, pregnancy testing will be required prior to the radiographic examination.

If there are any contraindications or suspected risks associated with pregnancy for a given exam (e.g., injection of pharmaceuticals or contrast media), the radiologist responsible must be consulted prior to the examination.

Based on current national and international guidance, shielding the patient's abdomen will not provide any significant benefit to the patient or fetus. However, if the patient insists that shielding be used, it may be provided as long as clinical imaging objectives are not compromised. For further information regarding patient shielding, please refer to the Shared Health website:

https://sharedhealthmb.ca/services/diagnostic/patient-shielding/

4.3.6 Patients Who Discover That They Are Pregnant After an X-ray Examination

If a patient discovers that they are pregnant after they have an x-ray examination, any staff member who is informed of this must report it immediately to the radiologist responsible. The radiologist may consult with the ordering physician as needed. If an evaluation of the potential radiation risk to the patient or fetus is required, Radiation Protection, CCMB should be contacted as soon as possible.

The staff member who was originally informed must complete an incident report and inform their immediate supervisor or manager.

4.3.7 Patient Shielding

Based on current national and international guidance, patient shielding is not required for x-ray examinations. If the patient or caregiver requests that shielding be used, it may be provided so long as clinical imaging objectives are not compromised. For further information, please refer to the Shared Health website:

https://sharedhealthmb.ca/services/diagnostic/patient-shielding/

As with lead protective garments, patient shields must be inspected when new and annually thereafter, refer to Appendix A for inspection instructions.

4.3.8 Holding of Patients

Holding devices are the preferred method of support where there is a need to support patients. Caregivers or others called to assist if holding devices are impractical must be provided with protective aprons, thyroid shields, and gloves and be positioned to avoid the direct beam. Persons who periodically hold a patient (e.g., a family member or personal caregiver) will not require the assignment of a dosimeter.

To minimize lifetime exposure, no single person should be identified to regularly hold a patient during x-ray examinations. Radiology staff are thus discouraged from acting in this capacity on a regular basis. Pregnant staff should never hold patients.

4.3.9 Who May Be Present in the X-ray Room During a Procedure

Only those persons whose presence is essential for the successful completion of the x-ray procedure may be present in the room during the procedure. The MRT responsible will determine who must be present to successfully complete the procedure. Only individuals required for the medical procedure or for training will be permitted in the x-ray room during an exposure. For some pediatric procedures, it may be beneficial for a parent or caregiver to be present in the room, at the discretion of the MRT responsible.

Individuals present in the x-ray room during any exposure must wear appropriate protective equipment if outside of the shielded control booth.

4.3.10 Repeat/Reject Analysis

All facilities should conduct regular repeat/reject analyses for all radiographic systems in use.

4.3.11 Mobile Radiography

Mobile radiography units must only be used if the condition of the patient is such as to make it inadvisable for the examination to be carried out with a stationary unit in the main x-ray department, or if the stationary unit is temporarily out of service.

During operation, the x-ray beam should be directed away from public occupied areas.

The operator of the mobile x-ray unit must wear an apron and must stand as far from the tube as possible while retaining control of the unit, and out of the direct beam.

Prior to initiating the exposure, the operator must ensure that all persons in the vicinity maintain a safe distance and position relative to both the x-ray beam and the patient, to the

extent practicable. All persons other than the operator should be at least 3 meters away from the x-ray tube and patient.

4.3.12 Determination of Appropriate Exposure Parameters

Medical radiation technologists and radiologists at a given facility have the expertise and training to determine the most appropriate exposure parameters (such as AEC chamber selection in radiography, pulse rate in fluoroscopy, or reconstructed slice width in CT) for a given examination at their facility. Appropriate exposure parameters must be determined and updated in consultation between the MRTs and the radiologists. CCMB Imaging Physics and Radiation Protection should be consulted as needed. Technique charts for radiography and protocol manuals for CT, listing exposure parameters for each exam type, should be established, and reviewed annually.

5 USEFUL RESOURCES

Helpful information on patient and staff safety for medical exams using ionizing radiation is available from national and international professional and guidance organizations. Links to selected resources are provided below.

Canada Safe Imaging is a collaborative undertaking to provide guidelines and tools for patient radiation safety:

https://canadasafeimaging.ca/

The Canadian Association of Medical Radiation Technologists (CAMRT) provides Best Practice Guidelines:

https://camrt-bpg.ca/

The Canadian Organization of Medical Physicists (COMP) provides useful pamphlets on child and adult x-ray and CT exams for patients, parents, and caregivers, available here:

https://comp-ocpm.ca/english/publications/publications.html/information-for-patients

The International Atomic Energy Agency (IAEA) provides a variety of resources on their Radiation Protection of Patients website:

https://www.iaea.org/resources/rpop

The website also has information for health professionals. The “10 Pearls” series of posters are particularly useful, as they summarize best practices for minimizing both patient and staff dose:

https://www.iaea.org/resources/rpop/resources/posters-and-leaflets

6 APPENDIX: INSTRUCTIONS FOR INSPECTION OF LEAD GARMENTS AND SHIELDS

Lead protective garments and shields must have a radiographic inspected on arrival when new, and annually thereafter. Inspection results must be documented and be provided to Radiation Protection, CCMB, upon inspection. A sample inspection report is provided at the end of this section. A fillable form can be obtained by emailing, Radiation Protection, CCMB at CCMBMPX-raycompliance@cancercare.mb.ca.

It should not be assumed that new lead garments or shields are free of defects. Visual examination is not sufficient to ensure integrity of shielding. New lead garments and shields should be examined under x-ray soon after arrival and returned to the supplier if defects are found.

Each lead garment and shield in inventory at a given facility should be assigned an identification number. Details of the inventory numbering system are left to the individual facility.

6.1 Inspection Procedure

1. Identify the inventory number assigned to the item.
2. Visually inspect all protective garments to ensure they are in good working condition (eg: no ripped seams, no faulty fasteners, etc.)
3. If a fluoroscopy unit is available, examine the entire item using fluoroscopy. Look for radiation leakage that indicates breaks in the lead lining.
4. If a fluoroscopy unit is not available, manual radiography techniques for checking the integrity of lead are as follows:
   Aprons: 80 kVp @ 3.2 mAs
   Thyroid/Gonadal: 80 kVp @ 3.2 mAs
   Gloves: 80 kVp @ 20 mAs
5. CT scan tomograms/scout views can also used for the inspection of lead garments. It is important to check the pixel resolution of the scout view since the scout/planning view can be lower than the stated scan resolution (a pixel resolution of 5 mm may not demonstrate a tear <5 mm). A recommended exposure would be 70 to 80 kVp and a low mA setting to help protect the tube (where possible, manually set the exposures and avoid using AEC).
6. Examine all images and look for radiation leakage that indicates breaks in the lead lining.
7. The primary standard is described as the “I would wear this myself” test.
8. Aprons are to be rejected if the area of the sum of defects exceeds 670 mm^2, equivalent to a single defect with a diameter of 29 mm. However, the apron or collar should be rejected if a single defect in the vicinity of the thyroid or of the reproductive organs exceeds the equivalent of a 5 mm diameter circle.
9. Stitching holes at the rear of wrap-around garments may be acceptable if the observer judges them to be small and not distended.
10. A few small pinholes may be acceptable if they pass the observer’s criteria of “I would wear this myself”. A pinhole itself does not pose a risk, the question to be asked is ‘how many pinholes’ and ‘is there is a chance that a pinhole or a cluster of pinholes will become a tear’.

11. Protective garments constructed from synthetic materials may have a mottled look. They must meet the “I would wear this myself” test – otherwise reject at time of delivery.
12. Record the garment identification number, observer’s name, date, and test results on the log sheet. Provide a copy to Radiation Protection, CCMB at the time of inspection. Retain the log sheet for 2 years.
13. Rejected lead garments or shields should be marked with the date of rejection. Lead is a hazardous substance and lead garments and shields must be disposed of in an environmentally responsible manner – contact the facility’s environmental officer for instructions.

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Inspection of Lead Garments and Shields

Purpose: Lead protective garments and shields must be inspected on arrival when new, and annually thereafter. Inspection results must be documented and be provided to Radiation Protection, CCMB, upon inspection.
Retain log sheet for 2 years. (See instructions page 3)

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1.0	Date Submitted:	Date:	
2.0	Facility Name:	Name:	
		Dept:	
3.0	Facility Address:	Street:	
		City|Town:	Postal Code:
4.0	Submitted by:	Name:	Designation:
		Dept:	Email:

Shield | Garment ID No.:	Type of Lead Garment | Shield	Condition (Pass or Fail):	Condition of Outer Cover (Pass or Fail):	Hangers Used (Yes or No):	Defect:	Date Rejected:	Comments:

Sample *Inspection of Lead Garments and Shields* Log