University of Guelph

Human Resources

Environmental Health and Safety

X-RAY SAFETY MODULE

Prepared by

Radiation Safety Officer(s)

Approved by the Radiation Safety Committee

50 Stone Road East, Guelph, Ontario, N1G 2W1

Table of Contents

1. Introduction:

X-ray devices are regulated based on their use (non-medical vs. medical), operating energies, and how the X-Rays are produced. X-ray sources operating at very high energies (above 1 MeV) are subject to licensing under the Canadian Nuclear Safety Act. However, the Canadian Nuclear Safety Commission does not regulate X-ray emitting devices. X-rays sources are normally under the jurisdiction of provincial governments. In Ontario, the use of X-Ray emitting devices not used on humans are governed by the Ontario Ministry of Labour (MOL) under O.Reg. 861 X-Ray Safety. Each X-Ray emitting device must be registered with the MOL prior to its use and the registration must be amended should the unit be moved, replaced, or disposed. Safety considerations for the use of X-Ray emitting devices used on humans are governed by the Ontario Ministry Health and Long-Term Care (MOHLTC) under the Healing Arts and Radiation Protection Act and regulations. Each X-Ray emitting device (human use) must be registered with the MOHLTC prior to its use and the registration must be amended should the unit be moved, replaced, or disposed.

- MOL: R.R.O 1990 Regulation 861
- MOHLTC: Healing Arts and Radiation Protection Act and regulation.

1.1 Scope of this Module:

The scope of this manual is to define the X-Ray Safety Program for the use of X-Ray devices within the University of Guelph. The module outlines the regulatory and safety requirements during the course of registration, operational and decommissioning phase of an X-Ray device. Most X-ray devices at the University are either for veterinary or analytical (research) purposes.

The X-Ray safety program is managed by the Radiation Safety Officer(s) on behalf of the department of the Environmental Health and Safety. Please refer to Appendix A for X-Ray safety program's organizational chart.

2. Roles and Responsibilities:

The following outlines the roles and responsibilities of the Radiation Safety Officer (RSO), Permit Holder and Operators during the lifecycle of an X-Ray device.

2.1 Radiation Safety Officer:

The Radiation Safety Officer shall:

1. Act as the agent of the institution in respect to X-ray registration including verifying the shielding requirements, submitting the application to the Ministry and coordinating any amendments made to an existing, approved facility;
2. Establish, implement, and maintain a safety control and assessment program in conjunction with the Permit Holder, Operators and the Radiation Safety Committee;
3. Annually review and survey X-ray emitting devices and rooms as applicable for radiation leakage and if required take corrective measures;
4. Implement a personnel monitoring program and conduct a quarterly review of occupational radiation exposures;
5. Ensure radiation safety instruments are calibrated and serviced as required;
6. Approve the purchasing, use and disposal of X-ray emitting devices through the issuance of internal permits;
7. Provide appropriate radiation protection training is provided for all the users working with the X-ray emitting devices;
8. Maintain required records;
9. Ensure that each internal permit is amended when necessitated by changes to facilities, equipment, policies, procedures or personnel;
10. Investigate incidents or accidents involving X-rays and as applicable, report to the Ontario Ministry of Labour or Ministry of Health and Long Term Care.
11. Ensure X-Ray worker notification is provided in writing for all X-Ray workers.

2.2 Permit Holder/Principal Investigator:

There must be at least one person designated for each X-Ray device as the permit holder/principal investigator to undertake responsibility for:

1. Ensuring that the equipment is maintained properly, functions correctly and that maintenance is performed by competent personnel;
2. Contacting the RSO prior to the purchase or disposal of an X-Ray device;
3. Ensuring that the equipment is used correctly and only by competent personnel;

4. Establishing safe operating procedures for the equipment and ensuring that personnel are adequately instructed in them. Furthermore, ensure that the operators are compliant with these procedures;
5. Prescribing rules of radiation safety and ensuring that personnel are made aware of them;
6. Ensuring that the facility complies with all applicable regulatory requirements;
7. Establishing safe working conditions according to the recommendations of this safety module and the statutory requirements of federal or provincial legislation where applicable as well as University policies and procedures;
8. Carrying out routine checks of equipment and facility safety features;
9. Keeping records of radiation surveys, including summaries of corrective measures recommended or instituted;
10. Declaring which personnel are working with X-Rays and in consultation with the RSO designate them as X-Ray workers;
11. Organizing participation, where necessary, in a personnel radiation monitoring service.
12. Ensuring that all occupationally exposed persons wear personal dosimeters during radiological procedures or when occupational exposures are likely;
13. Reporting each known or suspected case of excessive or abnormal occupational exposure to the Radiation Safety Officer through the University incident reporting process;
14. Ensuring that all safety devices recommended by this module are in good condition (included but not limited to personal protective equipment, interlocks, signage and warning lights);
15. Ensuring that appropriate warning signs are properly located, and
16. Ensuring that all the operators (including Permit Holder) participate in the X-Ray safety training and refresher training as required.

2.3 X-Ray Equipment Operators/Users:

All operators must:

1. Be aware of the radiation hazards associated with their work and of their duty to protect themselves and others;
2. Follow all the safety procedures implemented by the Radiation Safety Officer and the Permit holder;
3. Complete the required X-Ray safety training and the refresher training as required;
4. Have a thorough understanding of the safe working methods and special techniques;
5. A female operator should be encouraged to notify the Occupational Health and Wellness and or the RSO of her condition in writing if she believes herself pregnant. All pregnant X-Ray workers moved to an appropriately modified schedule with specified TLD or OSL monitors.

6. Perform annual inspections of the lead protective clothing and keep a record of the inspection.

2.4 X-Ray Operators-in-Training:

All operators-in-training and personnel not experienced in the use of X-ray equipment must work only under the direct supervision of a qualified operator. Dose equivalent limits for students and operators-in-training should not be greater than the limits set for members of the public. (Please refer to Table-3 in Section 3.1 for the dose limits).

3. X-Ray Safety Program:

3.1 ALARA

The ALARA Principle acronym for As Low As Reasonably Achievable is used in radiation protection for ensuring that every possible effort is used to keep radiation exposures far below the regulated dose limit. The University of Guelph is committed to the concept of maintaining doses ALARA and to take appropriate measures to reduce doses where practical considering socioeconomic factors, benefits to public health and current technologies available. The University is committed to maintaining radiation exposures from radiation emitting devices to students, faculty, staff and the general public to ALARA.

1. Each Permit Holder/Principal Investigator is expected to design, implement and maintain their internal procedures to reduce exposures of radiation to ALARA

2. All personnel are expected to practice the ALARA principle in their work practices.

The annual dose limits as set by ICRP for all the X-Ray workers are specified in Table 3.

Table 3: X-Ray Worker Dose Limits:

	X-Ray Worker	Members of Public
Whole Body	20 mSv**	1 mSv
Head	150 mSv	15mSv
Extremities	500 mSv	50mSv
Skin	500 mSv	50mSv
Lens of the Eye	20 mSv	5 mSv
Pregnant Workers	4 mSv	1 mSv

** NEWs are allowed up to 50 mSv in a year and total dose in a five-year dosimetry period is 100 mSv. The average annual dose limit in the 5-year period is 20 mSv.

Source: ICRP 60, 103, 109

3.2. X-Ray Worker Designation:

At the University of Guelph, only trained workers are authorized to work with X-Ray sources. A person is informed of their X-Ray worker status only after they complete the appropriate X-Ray safety training. The following guidelines must be followed by the X-Ray workers:

a) Participate in the X-Ray Safety Training conducted through the Environment Health & Safety Department and maintain the training status by completing the refresher training every 3 years.

b) Fill in and sign the X-Ray worker declaration form. (See Appendix B)

c) Be able to demonstrate safe working techniques and understand the hazards and risks associated with electromagnetic radiation (X-Rays).

d) Understand and demonstrate general and workplace specific safety procedures during the daily use of an X-ray device.

e) Provide EHS with all the necessary documentation for the issuance of a dosimeter.

The Radiation Safety Officer as per the Occupational Health and Safety Act and Ontario Regulation 861 (X-Ray Safety) will notify all X-Ray workers in writing of their status as X-Ray worker and maintain their written acknowledgment form.

3.3 X-Ray training:

All X-Ray users (including the Principal Investigators) must participate in the University's Radiation Safety training course prior to handling or working with any X-Ray source. X-Ray users must participate in refresher training at least every 3 years. Passing the quiz with a mark of 75% or greater will suffice as having completed the refresher course. X-Ray user training is provided by the Environment Health & Safety Department at the University of Guelph.

Further to the X-Ray training, all X-Ray users must also complete the practical hands on training for the equipment that they would be working with. It is the responsibility of the Principal Investigator/Permit Holder to organize training and ensure no untrained individuals operate the device. All training records should be kept by the Principal Investigator/Permit Holder and will be audited during routine inspections conducted by the RSO.

3.4 Ascertaining and Recording Dose to X-Ray workers:

Please refer to sections 2.3.4 and 2.4.4.2 of the University of Guelph Radiation Safety Manual (RSM) for the policies and procedures on ascertaining and recording dose to X-Ray workers. Each X-Ray worker will be provided a TLD/OSL dosimeter and are required to wear it at all times while performing any X-Ray work. Furthermore, please refer to Appendix A8 of the Radiation Safety Manual to follow the correct procedures on how to wear a dosimeter. All workers wearing protective lead clothing should always wear the dosimeter inside of the protective lead clothing such that correct exposure is registered.

3.5 Ascertaining and Recording Dose to Pregnant Workers:

Please refer to sections 2.3.4 and 2.4.4 of the Radiation Safety Manual for the policy and procedure on ascertaining and recording dose to pregnant workers. The same policies and procedures would also apply to X-Ray workers. It should be noted that even though CNSC does not oversee the X-Ray safety program at the University these regulations are enforced by the Ministry of Labour via the Occupational Health and Safety Act "X-Ray Safety Regulation 861".

3.6 Action Levels:

It should be noted that all the workers working with X-Ray will receive far less than the regulatory limits set in Table 3 - X-Ray worker dose limits. As per the University's commitment to maintain ALARA corrective actions will be taken at significantly lower exposure levels. As best practice, the action level for all X-Ray workers has been set at 2 mSv. Sections 2.3.5 and 2.4.5 (RSM), policies and procedures pertaining to action level will be applied for the X-Ray exposures as well. X-Ray workers who receive a dose equal to or above the action level will be notified in writing and appropriate actions will be taken to reduce exposure.

4. Purchasing & Registering New X-Ray Devices:

All X-Ray devices used in any space at the University of Guelph should satisfy the following requirements:

- All new medical x-ray equipment and accessories sold or used in Canada (Veterinary, or Human use), must conform to requirements of the Radiation Emitting Devices Act and the Food and Drugs Act. The requirements are specified in the Radiation Emitting Devices Regulations and the Medical Devices promulgated under these two acts respectively.
- It is the responsibility of the manufacturer or the distributor to conform to the applicable regulations.
- Similarly, all new analytical x-ray equipment must also conform to the Radiation Emitting Devices regulations at the time of sale.
- Furthermore, the X-Ray device must be CSA or Ontario Hydro approved.

To ensure that the X-Ray devices satisfy the aforementioned conditions please contact the RSO before purchasing the device(s).

4.1 X-Ray Registration:

Once the intended use of the proposed X-Ray device is identified, the device must be registered with the MOL or the MOHLTC. Most of the X-Ray devices in use at the university are for non-human use and as such they are registered with the Ministry of Labor. Please refer to Appendix E for X-Ray registration process flowchart for both mobile and fixed X-Rays.

To avoid delays, please ensure that the RSO is notified at least **eight weeks** prior to the desired first use of the device since the Ministry can take anywhere up to four to six weeks (in some cases more) to complete the registration process

4.1.1 Registering for a Permanent Location:

The design of a typical X-Ray location used in Veterinary practice or analytical purposes must take into account the safety of the operating personnel and the personnel surrounding the vicinity of the X-Ray facilities. Therefore, the facility should be shielded such that:

- The radiation levels in controlled areas that are routinely occupied by X-Ray workers should not result in an exposure of greater than 20 mSv/year to any operating personnel.
- And the radiation levels in uncontrolled areas must not result in an exposure greater than 1 mSv/year.
- Furthermore, the shielding required to reduce radiation levels to acceptable level may be determined on the basis of distance, nominal X-Ray tube voltage, and workload. To ensure the radiation levels are always below the acceptable limits, the maximum expected workload should be used.

The quantity of the shielding required (concrete or lead) should be confirmed by the Radiation Safety Officer as per Appendix II of the X-Ray Safety Code 20a. Once completed, *Form 2-Application for the review of permanent X-Ray location (Appendix C)* along with the floor plan of the room will be submitted to the Ministry.

4.1.2 Registering a Mobile X-Ray Source:

The registration process of a Mobile X-Ray Source differs slightly, and the equipment should be registered using *Form 1-Application of Registration* with the MOL (Please see Appendix C). The room where the mobile X-Ray would be stored should be clearly identified along with the purpose for which the X-Ray source will be used. Any device that is supposed to be used as a portable device outdoors should be registered as a Mobile X-Ray source.

Note that mobile X-Ray sources used in permanent locations would be treated as permanent installation and should also be registered using Form 2. In addition, the travel of the X-Ray device within the room must be clearly identified in the map. Lastly, multiple applications for the same facility should be coordinated if possible to facilitate an expedite review by the ministry.

4.1.3 Registration Application Self-Checklist (MOL- Non-Human Use):

To facilitate the registration process, please confirm all the points listed below are accounted for in the floor plan and the application form. This checklist is intended to work as a guideline for completion of application package prior to the submission.

4.1.3.1 Application Form:

- The shielding you have proposed is adequate.
- The number or identifying name of the x-ray room(s) for which approval of installation is clearly indicated.
- The name of the manufacturer and the model number of the x-ray device(s), the anticipated maximum workload, the maximum tube voltage, and the maximum tube current is provided.
- The name of the Permit Holder/Principal Investigator is identified.
- The qualifications of the Permit Holder/Principal Investigator are provided.
- The occupancy factors of the adjacent spaces, including spaces above and below the x-ray room(s) are provided.
- The thickness and nature of materials that form the boundaries of the x-ray room(s) is included.
- Calculations supporting the proposed shielding are included in the submission. These calculations are based on Appendix II, X-Ray Safety Code 20a.
- The percentage of the working day each adjacent space is occupied is included.
- The percentage of the exposure time, the useful beam is projected toward each adjacent space is included.

4.1.3.2 Floor Plan:

- The name of the owner(s) is recorded on the plan.
- The full address/location of the x-ray unit(s) is recorded on the plan.
- The thickness and nature of the shielding installed is indicated on the plan.
- The floor plans are provided in duplicate (if submitting in hardcopy).
- The floor plans are drawn to a scale of not less than one to one hundred.
- The compass point North is clearly identified.
- The location of the X-Ray source and its limit(s) of travel are indicated on the floor plan.
- The location of the control booth or the exposure switch is indicated.
- The type and location of the safety devices such as warning lights, interlocks, and cut-off switches are indicated.
- The information on the forms/plans correspond.

Once the application is completed it will be submitted to the Ministry of Labour by the Radiation Safety Officer.

4.1.4 Registering for Human Use (MOHLTC):

If the intended use of the X-Ray device is on humans, the permit holder must fill out *Form 2- Application for Approval of X-Ray Installation* and submit it to the Radiation Safety Officer (Please see Appendix D). The RSO will then complete the shielding calculations and complete Form 3 in conjunction with the Permit Holder and the final application consisting of both Forms 2 and 3 will then be sent to the Ministry of Health and Long-Term Care for approval.

The application forms can be found on the MOHLTC website.

5. X-Ray Safety (Engineering Controls):

This section addresses the safety requirements for open beam and closed beam X-Ray devices.

- Open beam X-Ray devices are defined as an X-Ray source where individuals could accidentally place themselves in path of the primary beam during normal operation. (Example: Diagnostic Imaging X-Ray Devices).
- Closed beam X-Ray devices have all the possible X-Ray paths completely enclosed so that no part of the human body can be exposed during normal operation (Example: Electron microscopes, Cabinet X-Ray devices).

Based on the definitions, it is quite clear that more extensive safety mechanisms are required for open beam X-ray sources and hence it is imperative the guidelines in section 5.1 are followed while designing and operating an open beam facility.

5.1 Open Beam X-Ray Devices:

The following general recommendations should always be considered during the design and the operational phase of an open beam X-Ray device.

1. The radiation beam must always be directed toward adequately shielded or unoccupied areas.
2. The radiation beam and scattered radiation should be attenuated as closely as possible to the source.
3. Based on the energy, flux and beam orientation, the floors, walls, ceilings and doors must be built with materials providing adequate radiation protection to workers.
4. The shielding should be constructed to form an unbroken barrier. Care should be taken in the use of shielding materials, especially lead, which must be adequately supported to prevent “creeping”.
5. When necessary, a control booth must be provided for the protection of the operator. Mobile protective barriers are not considered adequate as a control booth except for facilities requiring no shielding at 1 meter from source.
6. The control booth should be located, whenever possible, such that the radiation has to be scattered at least twice before entering the booth. In facilities where the radiation beam may be directed toward the booth the shielding of the booth must be that of a primary barrier (example, lead).
7. The control booth should be positioned so that during an irradiation no one can enter the radiographic room without the knowledge of the operator.

8. Warning signs must be posted on all entrance doors of radiographic room. The warning signs must incorporate the X-radiation warning symbol and should incorporate the words “Unauthorized Entry Prohibited.”
9. If an animal is required to be restrained or supported by hand, a protective apron and gloves, providing shielding equivalent to at least 0.5 millimeter of lead, shall be worn by any person providing the restraint or support.
10. All personal protective equipment including aprons, gloves, and screens (lead or lead equivalent) are to be checked annually to ensure that they are in good condition.

5.2 Cabinet X-Rays/Closed Beam:

1. A cabinet X-Ray device should be adequately shielded to ensure that the leakage radiation does not exceed 5 µSv per hour at a distance of 5 centimeters from any accessible external surface.
2. Whenever the device is engaged, there should be an audible beeping warning sound indicating that the X-Ray device is in use.
3. In addition to the beeping sound there should be a flashing red light visible from 360 degrees on the top of the device indicating that the X-Ray device is engaged.
4. Leak testing must be performed annually by the operators to confirm the integrity of the shielding.

5.3 Warning Lights, Signs and Interlocks:

1. A label must be affixed to the control panel of every X-ray source capable of producing an air kerma rate greater than 5 µGy/h at any accessible point. The label must identify the device as a source of X-rays, and it should caution against unauthorized use.
2. A high radiation area is one in which the air kerma may exceed 100 µGy in any one hour. For permanent installations, all doors, panels and gates giving access to the high radiation area must be provided with locks or interlocks. Interlocks connected to a warning light are required for open beam X-Ray sources (Exceptions to this must be approved by the Radiation Safety Officer).
3. Access to high radiation areas must be controlled, both for fixed and for portable or mobile X-ray sources.
4. If locks are used, the operator of the X-ray source will be responsible for ensuring that the area is vacated and that the locks are engaged before energizing the source. Interlocks must be designed so that the source cannot be energized until all interlocks are engaged and so that the source is adequately shielded, or the production of X-rays is stopped if an interlock is opened during operation of the source.
5. If an X-ray source is being used in a portable or mobile mode, access control is achieved by erecting barriers and posting warning signs to delimit the high radiation area. The barriers and signs must be conspicuous and their meaning clear. In addition, the operator should maintain

continuous visual surveillance of the high radiation area to ensure that it is kept clear of workers (and members of the public) during X-ray production.

6. Each X-Ray room must be clearly identified with a warning sign and the warning signs must be posted at all entrance doors of the X-Ray room. The warning signs must incorporate the X-radiation warning symbol and should incorporate the words “Unauthorized Entry Prohibited” along with “Caution: X-Rays” and its French equivalent. Figure 8, shows an example of a typical warning sign while Figure 9, shows the symbol used to identify an X-Ray source.
7. Every X-ray source shall have a similar warning sign on the control panel, in close proximity to the “ON/OFF” switch (See Figure 9 or 10).
8. A warning light shall be mounted near each X-ray tube in such a way as to be clearly visible from any direction from which the tube can be approached indicating when X-rays are being produced.

Figure 8: X-Ray Warning Sign (Door)

Figure 9: Warning Sign (Console)

Figure 10: Symbol for the X-Ray Source

5.4 Acceptance Testing/Commissioning (MOL):

Once the X-Ray device is received and an approved registration from the Ministry is received, acceptance testing shall be done prior to putting the device in operation. As part of the acceptance testing confirm:

- That the device fulfills all the manufacturer, regulatory and facility requirements.
- All the safety systems are installed according to the plan and the device is placed correctly in the room.
- The device works as advertised and the relevant device specific training is passed on from the manufacturer.
- A radiation survey of the new X-Ray device should be performed before the device is put into operation to ensure the shielding installed is fulfilling its intended purpose. Please contact the Radiation Safety Officer for this survey.

6. Administrative Controls:

6.1 Internal Permits:

An internal permit is to be issued by the Radiation Safety Officer on behalf of the Department of Environmental Health and Safety once a new location or device is registered with the Ministry as applicable. The permit will be valid until the end of the device's life cycle and is to be updated if there is any amendment or change made to the operations or location. A copy of the internal permit is to be kept in the approved location where a particular X-Ray device is to be used (Please refer to Appendix F for a sample copy of internal permit).

Furthermore, it should be noted that compliance must be maintained at all times and each internal permit will be subjected to routine internal inspections. The RSO has the authority to revoke or amend the permit in the event compliance is not maintained.

6.2 Inspections:

To ensure compliance and maintenance of permits, the RSO shall perform annual audits. The equipment and the facilities are to be inspected based on the inspection checklist in Appendix-G. Furthermore, to encourage increased safety awareness all the X-Ray workers are encouraged to keep the following safety cloud in mind while performing any work on an X-Ray device.

Figure 11: X-Ray Safety cloud

6.3 Record Keeping:

The following records shall be maintained by the Principal Investigator/Permit Holder at all times:

- Records of radiation surveys (leak testing), including summaries of corrective measures recommended or instituted.
- List of all the X-Ray workers (Students and Principal Investigator) should be maintained for each unit.
- Training Records (including the training date) for all the workers.
- Maintenance and servicing records for the equipment.
- Daily exposure/workload records.
- Incident Reports and corrective measure taken as a result.

The dosimetry records for the X-Ray workers will be maintained by the Radiation Safety Officer.

7. Decommissioning and Disposal of X-Ray Devices:

Prior to any disposal of an X-Ray source the Permit Holder must complete the form found in Appendix-H and submit it electronically to the Radiation Safety Officer.

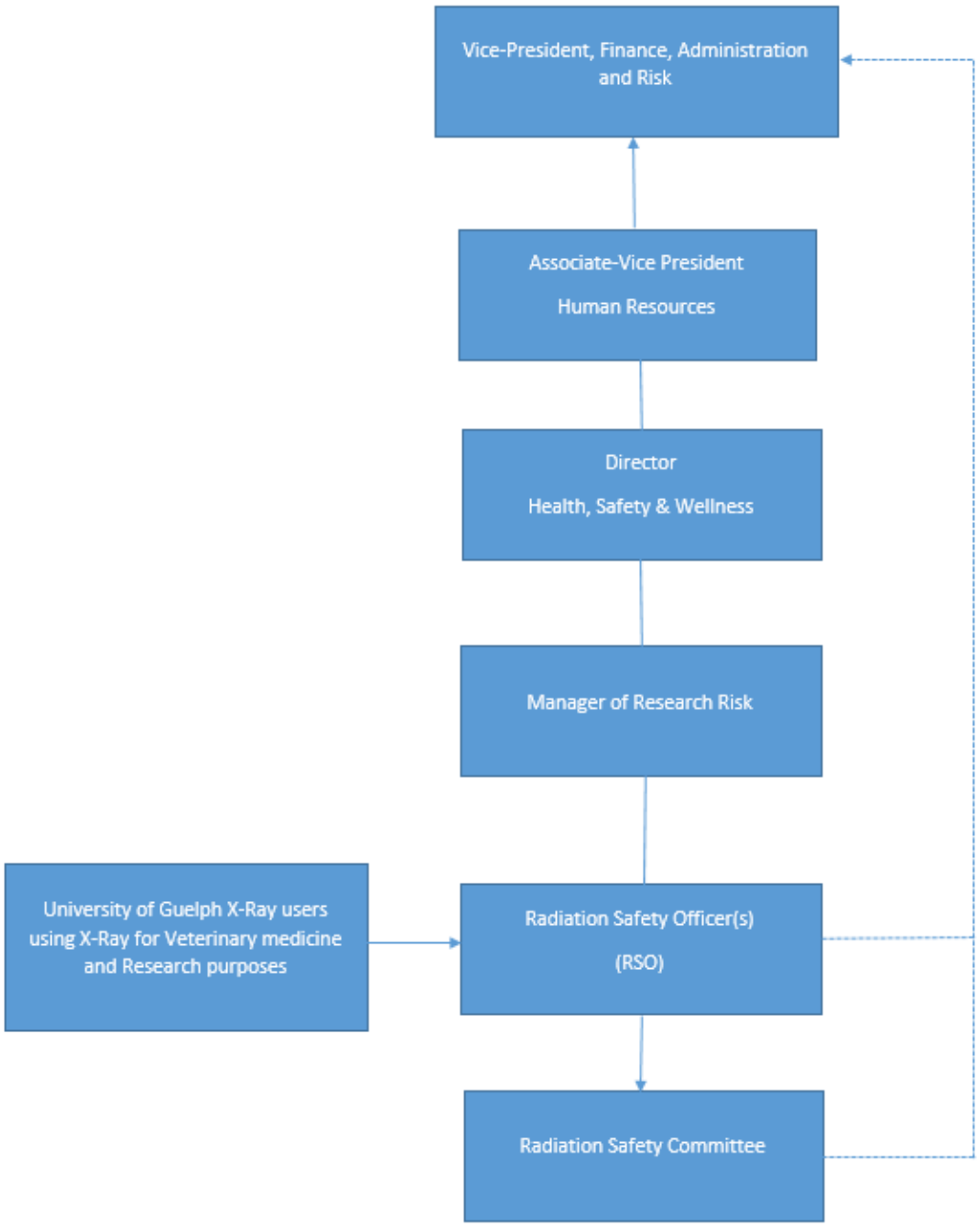
The following procedure must be followed for the disposal of the X-ray equipment.

The Permit Holder should first contact the manufacture to determine if it can be returned. For the disposal of an X-ray device, the permit holder with the aid of RSO shall observe the instructions provided by the manufacturer. In a case where a manufacturer is no longer in the business of manufacturing, selling or servicing X-ray equipment, the following procedures should be followed during the disposal process.

- Make the X-Ray device in-operable by severing the power cables.
- Must be confirmed if the tube transformer capacitor contains PCB. If this exists, the device must be disposed of as a hazardous waste.
- The X-ray tube must be disposed of as a hazardous waste since it may contain beryllium, lead, or any other heavy metals.
- To understand the procedures for the disposal of hazardous waste, please refer to the Environmental Health and Safety website.
- Remove all X-Ray signage and permits from the room.
- All hazardous waste shall be disposed of as per the regulatory requirements and all applicable documents will be maintained by the EHS department/Lab Safety officer.

Note: Please refer to Appendix I for regulations pertinent to X-Ray waste disposal.

APPENDIX A: *Organizational Chart for X-Ray Safety:*



APPENDIX B: *Notification of X-Ray Worker Status:*

X-Ray Worker Name:

Sex: M ☐ F ☐

In accordance with the Occupational Health and Safety Act and Ontario Regulation 861 (X-ray Safety), this is to inform you that you have been designate an X-ray Worker. An X-ray Worker is defined by the Ontario Regulation 861 as a worker who, as a necessary part of the worker's employment, may be exposed to X-rays and may receive a dose equivalent in excess of the annual limits (1 mSv per annum whole body).

The University of Guelph however stresses adherence to the ALARA policy of maintaining doses: As Low as Reasonably Achievable. Our procedures and policies are directed towards your safety, ensuring that the potential for exposure is minimized. The University of Guelph designate all the users working with X-Ray equipment as X-Ray workers and as such must participate in a Health Canada approved dosimetry program.

You must be familiar with the following documents that are provided to you:

1. Dose limits as outlined in Ontario Regulation 861;
2. Dose limits for Pregnant X-ray Workers as outlined in Ontario Regulation 861. Your rights and obligations should you become pregnant;
3. The risks associated with radiation to which you may be exposed during the course of your work, including the risk associated with the exposure of an embryo and fetus;
4. Your expected radiation dose levels.
5. Please refer to https://www.ontario.ca/laws/regulation/900861 for these regulations.

I understand the risk, my obligations and the radiation dose limits and levels that are associated with being designated an X-ray Worker.

X-ray Worker Signature:_____

Date:_____

RSO Name:_____

RSO Signature: _____

Date:_____

APPENDIX C: *MOL Registration Forms*

(For current forms please refer to MOL website)

Ontario Ministry of Labour Radiation Protection Service

Note: Insert "X" in all applicable boxes

Form 1 - Application for Registration
O. Reg. 861/90, X-ray Safety
Occupational Health and Safety Act

Registration No.

The undersigned, as employer [ ] or as agent for the employer [ ] applies for registration with the Radiation Service Of the Ministry of Labour.

A. The employer is:
Name | Telephone No.

Business Address | City | Postal Code

B. The person to whom correspondence should be addressed is as at "A" [ ] , or is:
Name | Telephone No.

Position or Title

Address | City | Postal Code

C. The general nature of the employer's business is (check one category only)
[ ] Industrial and Commercial [ ] Veterinarian [ ] Research and Development
[ ] Education and Training [ ] Other (Please Specify) _____

D. As of the date of this registration, the employer is in possession of the following x-ray sources at the locations indicated (for portable or mobile units indicate where normally stored.)

Make	Model	Location (Room, Building, Street, City)	Date Installed

Dated at | this | day of | 20

Signature of Applicant | Name (please type or print)

0189 OH 07 (11 86)

Ontario Ministry of Labour Radiation Protection Service

Note: Insert "X" in all applicable boxes

Form 2 - Application for Review Of Permanent X-ray Location

O. Reg. 861/90, X-ray Safety
Occupational Health & Safety Act

Registration No.

Part A: General

The undersigned, as
[ ] Employer [ ] Owner [ ] Contractor [ ] Architect [ ] Engineer [ ] Agent
applies for review of a permanent x-ray location. The application covers a total of _____x-ray sources in_____rooms. It is accompanied by related floor plans in duplicate and by one completed Part B for each x-ray facility for which review is sought.

1. The name of the x-ray facility for which review is sought is

2. The employer is:
Name | Telephone No.

Address | City | Postal Code

3. The employer's registration number is_____the employer is not registered [ ]

4. This application is submitted for the following reason
[ ] Opening of a new facility [ ] Relocation of sources
[ ] Replacement of old sources in existing facilities [ ] Additional sources
[ ] Acquisition of existing facility from:
Previous Owner's Name | Registration No.

[ ] Change of shielding provisions, structure, or safety devices
[ ] Compliance with Inspector's direction

Operation is expected to commence on | Date | 19

5. The x-ray source(s) will be (or are at present) located as at 2 [ ], or at:
Address | City | Postal Code

6. The person who exercises (or will exercise) direction over the safe use and operation of the x-ray source at the above location is the [ ] employer, or is:
Name | Telephone No.

Position

Relevant Qualifications

7. The drawings and specifications were prepared by:
[ ] Employer [ ] Architect [ ] Other (specify)
Name | Telephone No.

Address | City | Postal Code

8. The information set out in this application and in each Part B accompanying this application is accurate to the best of my knowledge.
Dated at | this | day of | 20

Signature of Applicant | Name (please type or print)

0245 OH 07 (11/86)

Part B: Specific

Note: One copy of Part B required for each x-ray source for which review is sought.

1. This sheet refers to x-ray source number _____ of _____ x-ray sources located in the room Designated as _____ and so marked on the accompanying drawings.

2. This x-ray source is used for

It is identified by:	Make/Model	Serial No.

And has the following operating characteristics:

a) the maximum rated tube voltage is_____kilovolts

b) the maximum rated tube current is_____milliamperes

c) the anticipated maximum workload is_____milliampere - minutes per week.

3. The composition of the boundaries of the room, including windows and doors, are (give material types and thicknesses):

Floor		Ceiling
Walls	North	
	East	
	South	
	West	

	Occupancy (see note 1)		Usage Factor (See note 2)
Direction	Type	Per Cent	Per Cent
Down			
Up			
North			
East			
South			
West			

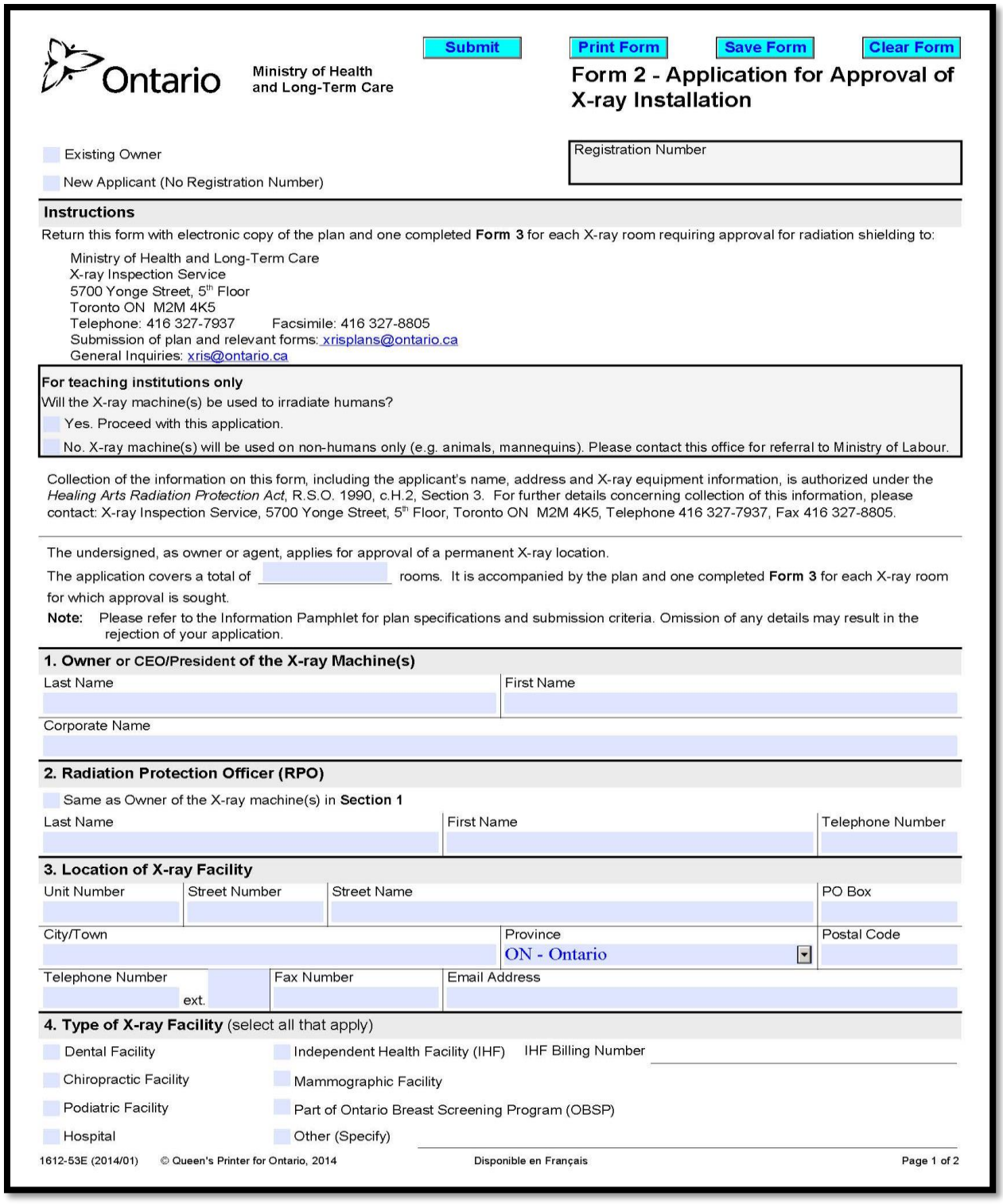
Note 1: Occupancy type is the nature of use of the area in the indicated direction relative to the x-ray source (e.g. office, waiting room, parking lot, etc.) Occupancy per cent is the fraction, expressed as a percentage, of the time the area will be occupied while the source is on (omit if unknown.)

Note 2: The usage factor is the fraction of the time the beam will be pointed in the direction indicated, as a percentage of the total time the source is on. For uncollimated, panoramic, or multiple beams, the sum may exceed 100 per cent.

The information given in this Part must correspond with that given on the accompanying floor plans.

APPENDIX D: *MOHLTC Registration Forms:*

(for current forms please refer to MOHLTC website)



Ontario

Ministry of Health and Long-Term Care

Submit | Print Form | Save Form | Clear Form

Form 2 - Application for Approval of X-ray Installation

☐ Existing Owner

☐ New Applicant (No Registration Number)

Registration Number

Instructions

Return this form with electronic copy of the plan and one completed **Form 3** for each X-ray room requiring approval for radiation shielding to:

Ministry of Health and Long-Term Care
X-ray Inspection Service
5700 Yonge Street, 5th Floor
Toronto ON M2M 4K5
Telephone: 416 327-7937 Facsimile: 416 327-8805
Submission of plan and relevant forms: xrisplans@ontario.ca
General Inquiries: xris@ontario.ca

For teaching institutions only

Will the X-ray machine(s) be used to irradiate humans?

☐ Yes. Proceed with this application.

☐ No. X-ray machine(s) will be used on non-humans only (e.g. animals, mannequins). Please contact this office for referral to Ministry of Labour.

Collection of the information on this form, including the applicant's name, address and X-ray equipment information, is authorized under the *Healing Arts Radiation Protection Act*, R.S.O. 1990, c.H.2, Section 3. For further details concerning collection of this information, please contact: X-ray Inspection Service, 5700 Yonge Street, 5th Floor, Toronto ON M2M 4K5, Telephone 416 327-7937, Fax 416 327-8805.

The undersigned, as owner or agent, applies for approval of a permanent X-ray location.

The application covers a total of _____ rooms. It is accompanied by the plan and one completed **Form 3** for each X-ray room for which approval is sought.

Note: Please refer to the Information Pamphlet for plan specifications and submission criteria. Omission of any details may result in the rejection of your application.

1. Owner or CEO/President of the X-ray Machine(s)

Last Name | First Name

Corporate Name

2. Radiation Protection Officer (RPO)

☐ Same as Owner of the X-ray machine(s) in **Section 1**

Last Name | First Name | Telephone Number

3. Location of X-ray Facility

Unit Number | Street Number | Street Name | PO Box

City/Town | Province: ON - Ontario | Postal Code

Telephone Number ext. | Fax Number | Email Address

4. Type of X-ray Facility (select all that apply)

☐ Dental Facility
☐ Chiropractic Facility
☐ Podiatric Facility
☐ Hospital
☐ Independent Health Facility (IHF) IHF Billing Number
☐ Mammographic Facility
☐ Part of Ontario Breast Screening Program (OBSP)
☐ Other (Specify)

1612-53E (2014/01) © Queen's Printer for Ontario, 2014 Disponible en Français Page 1 of 2

UNIVERSITY of GUELPH

5. Reason for Application (select all that apply)

- Opening new facility (specified in **Section 3**)
- Relocating existing facility to new facility specified in **Section 3**

Provide address of facility that is closing

Registration Number			
Unit Number	Street Number	Street Name	PO Box
City/Town	Province: ON - Ontario		Postal Code

- Complying with an inspector's direction
- Making equipment changes within existing facility specified in **Section 3**
  - ☐ Adding new equipment
  - ☐ Moving equipment
  - ☐ Replacing equipment
  - ☐ Making changes to the installation of existing equipment. Specify changes on **Form 3**.

6. Computerized Tomography (CT) Installation Only

This application is for installation of a:

- CT Scanner (non-dental)
  - ☐ CT Letter of Designation attached
- Dental CT Scanner
  - ☐ Letter of Request for CT Letter of Designation attached
  - ☐ RCDSO issued CT Provisional Facility Permit attached

7. Return of Approved Plans

As of October 1, 2013, all approved plans are returned to the applicant via electronic mail.

Name and address of applicant:

- Same as **Section 1** (Owner) and **Section 3** (Location)
- Different from **Section 1** and **Section 3**

Last Name	First Name	
Corporate Name		
Unit Number	Street Number	Street Name	PO Box
City/Town	Province: ON - Ontario		Postal Code
Telephone Number ext.	Fax Number	Email Address	

8. Attestation

I attest that the information in this form is complete and accurate and that I am the owner or a delegate of the owner, authorized to submit this form.

Signature of Applicant	Date (yyyy/mm/dd)
X	

UNIVERSITY of GUELPH

Ontario — Ministry of Health and Long-Term Care

Submit | Print Form | Save Form | Clear Form

Form 3 - X-ray Equipment and Shielding Specifications

The Healing Arts Radiation Protection Act. 1990.

Registration Number

Instructions

Submit one completed Form 3 for each X-ray room, along with Form 2 and the plan to xrisplans@ontario.ca. It is not mandatory to include your shielding assumptions (e.g., shielding calculations), relevant X-ray machine manual or user guide, scatter radiation data (SRD), and dose linear product numbers (3D/CBCT scanners) with your submission. However, doing so may result in less shielding being required.
Please ensure all appropriate areas are signed.

Equipment Identification

This form refers to X-ray room number _____ of _____ X-ray rooms for which approval is sought in this application.

The applicant identifies this room as _____ and it is so marked on the drawings.

This X-ray room will have _____ X-ray machine(s) installed.

The X-ray machine(s) installed in this room have _____ X-ray tube(s).

Make	Model	Year of Manufacture

Are the X-ray equipment parts (Image Receptor, X-ray Tube and X-ray Generator) supplied as one integrated unit by one manufacturer?

☐ Yes ☐ No (complete table)

	Make	Model
Image Receptor		
X-ray Tube		
X-ray Generator		

Type / Use of X-ray machine (select all that apply)

Dental

☐ Intra-oral ☐ Panoramic ☐ Dental Computerized Axial Tomography (e.g., CBCT, 3D)

☐ Cephalometric ☐ Other (specify) _____

Medical

☐ Radiographic ☐ Radiographic Mobile ☐ Fluoroscopic ☐ Fluoroscopic Mobile

☐ Mammographic ☐ Bone Mineral Density ☐ Radiation Therapy ☐ Computerized Axial Tomography

☐ Angiography ☐ Skull Unit ☐ Other (specify) _____

X-ray machine to be installed in this room

The maximum rated tube voltage is (kVp)	The maximum rated tube current is (mA)

Specify anticipated maximum workload for each modality that the X-ray machine can support.
Examples of modalities include intra-oral, panoramic, cephalometric, CBCT, 3D, radiographic, fluoroscopic, etc.

Mode	Type	Number of exposures per week	Maximum weekly workload (milliampere-minutes per week) Primary tube	Auxiliary tube (if applicable)
	☐ Digital ☐ Film			
	☐ Digital ☐ Film			
	☐ Digital ☐ Film			

RPO Attestation
I attest, as the Radiation Protection Officer (RPO), that the **workload** values of the X-ray machine are accurate for my facility.

RPO Name	RPO Signature	Date (yyyy/mm/dd)

Important - The following information must be reconciled with your plan. The application cannot be processed without it.
State all measurements in metric units.

Room Construction

Item		Partitions Height (m)	Partitions Length (m)	Material Composition (excluding framing) Material 1	Material 2	Cabinet	Material Thickness(mm) Material 1	Material 2	Lead Height (m)	Lead Thickness (mm)
Floor		m	m				mm	mm		mm
Walls	North	m	m				mm	mm	m	mm
	East	m	m				mm	mm	m	mm
	South	m	m				mm	mm	m	mm
	West	m	m				mm	mm	m	mm
Ceiling		m	m				mm	mm		mm
Door	1	m	m				mm	mm		mm
Door	2	m	m				mm	mm		mm
Control booth wall		m	m				mm	mm		mm
Control booth window		m	m				mm	mm		mm

  Disponible en français

UNIVERSITY of GUELPH

Adjacent Spaces

Space behind, (underneath, over)		Adjacent space occupied by	For what percentage of your working day is the space occupied? (%)	What percentage of the exposure time are the primary beam and auxiliary beam pointed toward this space? Primary %	Auxiliary % (if applicable)
Floor					
Walls	North				
	East				
	South				
	West				
Ceiling					
Control booth					

Additional Shielding Information

Is there any additional shielding incorporated into the X-ray equipment or accessories (e.g. shielded and interlocked enclosures, leaded tables, chest-stands or other backdrops, etc.)

- No
- Yes (specify)

Submission of the following information regarding your image receptor is not mandatory but may result in less shielding being required if provided.

Type of shielding at image receptor	Thickness of shielding at image receptor	Leakage current at image receptor
	mm	mA

Will the primary beam be fully intercepted by the image receptor?

- No
- Yes

Additional Comments

Are you making any changes (alterations) to the installation of existing X-ray equipment specified on page 1?
(e.g., replacing image receptor, tube head, etc.)

- No
- Yes (specify change(s) made)

Please provide any additional information regarding the X-ray equipment and plan.

Note: Any subsequent changes and/or alterations made to the X-ray equipment, its use, location, or to the surrounding environment require re-approval. Please submit a new plan to this office **before** making any of the above changes.

On your plan, please include the limits of travel of the X-ray tube and image receptor within the room, the position and limits of rotation of the chair (dental only), and the room dimensions.

Attestation - I attest that the information contained in this form is complete and accurate and that I am the owner or a delegate of the owner, authorized to submit this form.

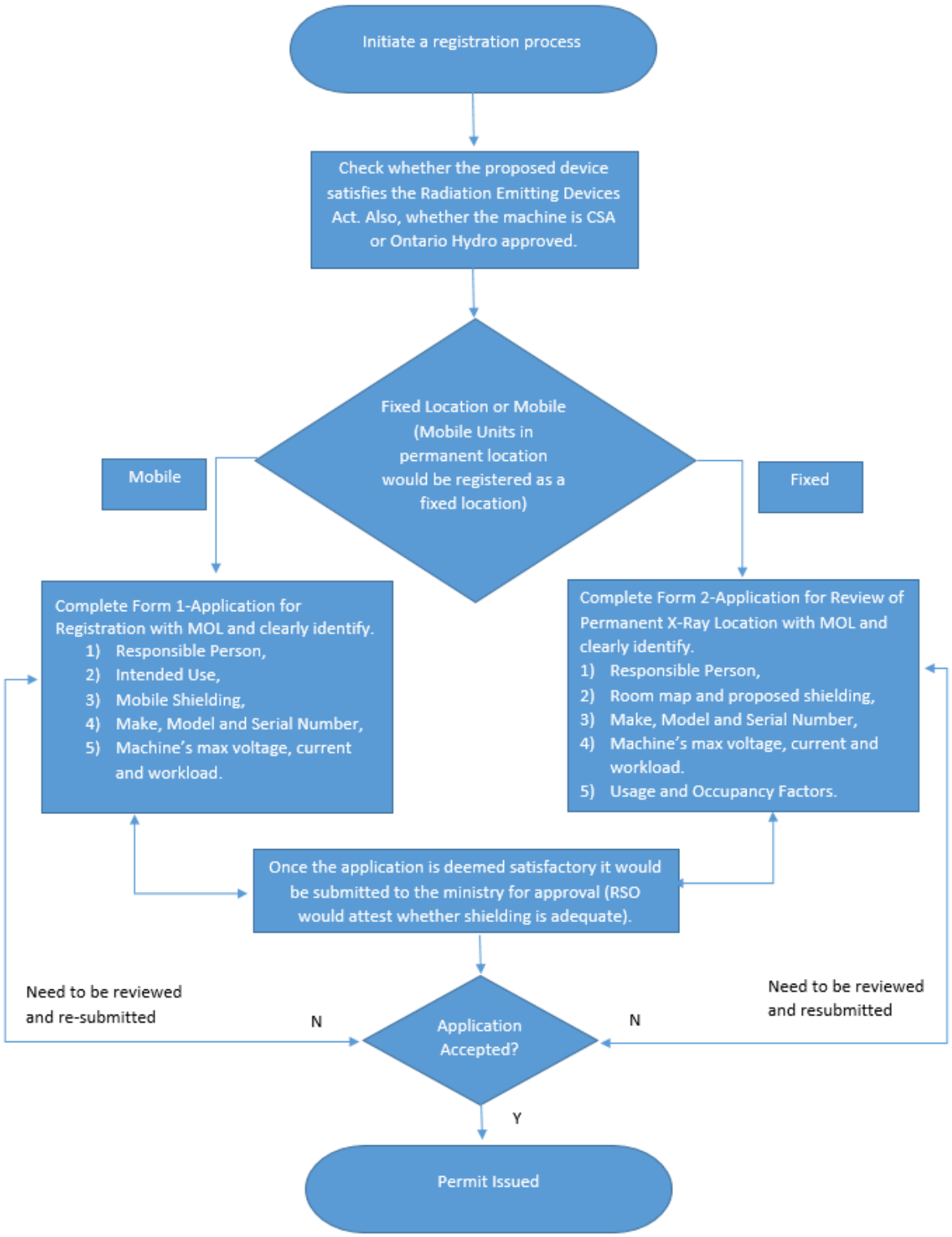
Applicant Name	Applicant Signature	Date (yyyy/mm/dd)

Ministry Use Only (Examiner's notes)

6615-53E (2014/02)

Page 2 of 2

APPENDIX E: *Registration Process Flowchart:*



APPENDIX F: *Sample X-Ray Permit*:

University of Guelph Department of Environmental Health and Safety	**X-Ray User Permit** **Permit Number: 1-604**
Permit Holder:	
Karan Virdi 50 Stone Road East, Ontario, Guelph N1G 2W1 Alexander Hall, Room 172 C	
Permit Validity:	
Effective Date:	September 30th, 2017
Expiry Date:	End of X-Ray machine life or Until Amended.
Approved X-Ray Devices:	
X-Ray Device Make and Model	Philip Veradius
X-Ray Serial Number	123
Approved Locations:	
Building, Building # & Room number:	Alexander Hall, 131, Room No. 172 C
Approved Usage:	
Diagnostic Imaging.	
Fixed Shielding Specifications:	
North Wall: 6 Inch concrete with large window *East Wall*: 6 Inch concrete with wooden door (metal frame) *South Wall*: 6 Inch concrete block *West Wall*: 6 Inch concrete block with wooden door (metal frame)	
Portable Shielding Specifications (If Required):	
Lead curtains wheeled in as necessary. Lead gown, collars and gloves.	
Conditions of Approval:	
➢ As per Occupational Health and Safety Act, Regulation 861 and UofG Policies and Procedures on operation and handling of X-Ray sources. ➢ X-Ray machine must be used at a minimum distance of 2 meters from the wall.	
Types of Workers Authorized to work on the machine:	
1) Researchers 2) Students	
Dosimeters Issued Under this Permit:	
☒ Yes	☐ No
Signature of Approval: _____RSO	_____ RSC Chair

APPENDIX G: *RSO Inspection Checklist*:

Rating: Yes= ✓ No=✖ Not applicable=NA Unknown=?

X-Ray Inspection Checklist:

Permit Holder: _____ **Permit Number:** _____ **Date:** _____

Building: _____ **Room Number:** _____ **Auditor:** _____

Safety Features		
Inspection Item	**Rating**	**Comments**
All Interlocks/Locks Functioning.		
Key Lock control installed to control the device.		
X-Ray ON/OFF switch available and required to energize the device.		
X-Ray source warning if the output greater than 5 µGy.		
Open beam devices equipped with means to prevent access to primary beam.		
Lead gowns, collars, or gloves in good condition and inspected.		
Unused beam ports permanently blocked off with lead.		
Standard Operating Procedures maintained and updated (Technique chart posted).		
Training		
X-Ray training completed by all the X-Ray workers.		
Device training completed by all the X-Ray workers.		
Records		
Daily workload records being reliably kept.		
Authorized workers list with their training dates kept up to date.		
Maintenance records kept up to date.		
Dosimetry		
Dosimetry badges are worn properly and stored appropriately.		
X-Ray workers aware of their annual doses.		
All incidents reported to the RSO in writing.		
Registration		
X-Ray permit posted in the room.		
Any amendment to the permit requirements reported to the RSO.		
Competent Person/Supervisor identified.		
Warning Lights/Signs		
Door sign is posted and displays correct contact information.		
Registration certificate posted near the X-Ray device.		
X-Ray warning signs posted near the X-Ray device.		
Control panel has a fail-safe visible indicator, in close proximity to the X-Ray on/off switch that clearly indicates when X-Rays are being produced.		
Separate fail-safe flashing light indicators are present to indicate when an X-Ray tube is energized and when X-Rays are being produced.		
X-Ray warning symbol and caution wording posted on the control panel.		

APPENDIX H: *Decommissioning and Decontamination Form*:

Equipment Decontamination and Decommissioning Report Print Form

(For equipment that has been used with or contains hazardous materials)

Type of equipment:

Owner of equipment:

Department:

Serial number/I.D. number:

Original location of equipment (bldg & room no.):

Future location of equipment (bldg & room no.) if applicable:

Equipment to be disposed? Yes ☐ No ☐

This equipment was used with the following hazardous materials:

Biological ☐ Chemical ☐ Radioactive ☐

Other ☐ Please specify:

This equipment contains or has contained the following hazardous materials as part of its design (e.g. CFCs, pump oil, asbestos, etc.):

Decontamination:

Completed? Yes ☐ Not required ☐

If not required, explain why:

I certify that this piece of equipment has been decontaminated or does not require decontamination:

Printed name Signature Date

Decontaminated with:

Comments:

If refrigerants were present, attach reclaim form confirming removal. Reclaim form no.:

The equipment listed above is approved for disposal, reuse or relocation:

Department Chair Date EHS Representative Date

APPENDIX I: *Regulations pertaining X-Ray waste disposal*:

The Ministry of the Environment and Climate Change (MOECC) has jurisdiction over the disposal of an x-ray device. The disposal of x-ray equipment, as a waste, is governed by Ontario Regulation 347 under the Environmental Protection Act. Lead and Beryllium windows would be classified as hazardous waste. The equipment or parts within it may be classified as hazardous waste if it fails the Leachate toxic test for contaminants listed in Schedule 4 of Regulation 347. (For example any lead shielding components). Also there maybe parts within the equipment that would be classified as PCB waste as defined in Regulation 362. If the equipment to be disposed is found to be hazardous the generator must be registered with the MOECC and the waste management of it, must be by a certified carrier and receiver.

The following additional information on PCBs is provided to help you understand some of the MOECC requirements however you are advised to contact the MOECC to confirm the requirements and obtain further clarification.

The transformer oil should be tested to determine if it contains PCBs. If the PCB concentration is greater than 50 ppm, both the oil and the transformer casing are PCB waste. Depending on the concentration above 50 ppm, the transformer casing may possibly be decontaminated, but this has to be done by an MOECC approved waste management company. If properly decontaminated, the transformer can be sent to a scrap dealer for metal recovery. If the transformer cannot be decontaminated, it too would have to be sent for off-site disposal by an MOECC approved waste management company. The PCB oil would also have to be disposed of off-site by an MOECC approved waste management company.