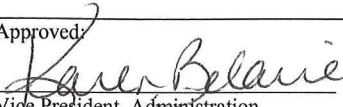
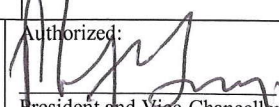
	<b>McMaster University</b> <b>Risk Management</b> <b>Manual</b>	<b>RMM #: 701</b> <b>Title: X-ray Safety Program</b>		<b>Date: July 2007</b> <b>Page: 1 of 18</b>
<b>Submitted:</b> Senior Health Physicist	<b>Approved:</b> Chair, HPAC	<b>Approved:</b>  Vice President, Administration	<b>Authorized:</b>  President and Vice-Chancellor	

## 1 PURPOSE

- 1.1 This entry in the McMaster University Risk Management Manual specifies the X-ray Safety Program implemented by McMaster University (the University) for X-ray work in University facilities and work areas where X-ray devices are in use. This X-ray Safety Program is designed to satisfy the requirements of Regulation 861/90 made under the Occupational Health and Safety Act of Ontario and to incorporate best practices in the control of X-ray hazards in the workplace.
- 1.2 The overall objectives of the X-ray Safety Program are:
  - Prevent deterministic effects (radiation injuries).
  - Minimize the probability of stochastic effects for workers by requiring that doses be maintained as low as reasonably achievable (ALARA).
  - Achieve compliance with the Ontario Occupational Health and Safety Act, Regulation 861/90.

## 2 SCOPE

- 2.1 This entry applies to all activities involving the installation, operation, relocation, and decommissioning of X-ray devices in campus facilities and work areas.
- 2.2 This program applies to all persons working with or in proximity to X-ray devices which are owned or controlled by the University, including but not limited to: faculty, staff, undergraduate students, graduate students, post-doctoral fellows, visiting professors, volunteers and contractors.

## 3 RELATED DOCUMENTS

- 3.1 Regulation 861/90, Occupational Health and Safety Act
- 3.2 X-ray Safety Manual

## 4 DEFINITIONS

- 4.1 **ACL** Administrative Control Level. A University established limit related to the X-ray safety program. ACL's are set below corresponding Regulatory limits.
- 4.2 **ALARA** As Low As Reasonably Achievable, social and economic factors being taken into account.



- |      |                       |  |
|------|-----------------------|--|
| 4.3  | Authorized X-ray User | A person registered with the Health Physics Department who has completed required training and who is authorized to operate X-ray devices owned or controlled by the University.   |
| 4.4  | X-ray Worker          | As defined in Regulation 861/90, means 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 set forth in Column 4 of the Schedule of the Regulations. |
| 4.5  | Absorbed dose         | As defined in Regulation 861/90 means the mean energy per unit mass imparted by ionizing radiation to matter.  |
| 4.6  | Dose Equivalent:      | As defined in Regulation 861/90, dose equivalent means the product of absorbed dose and a quality factor where the quality factor is a measure of the biological effectiveness of the radiation, and is assigned the value of 1.0 for X-rays.            |
| 4.7  | Gray                  | As defined in Regulation 861/90, means:<br><br>a unit of absorbed dose and is realized when one joule of energy has been imparted per kilogram of material.  |
| 4.8  | Sievert:              | As defined in Regulation 861/90, means a unit of dose equivalent and for X-rays the dose equivalent measured in Sieverts is numerically equal to the absorbed dose measured in Grays.  |
| 4.9  | Ensure                | Take every reasonable precaution to achieve the stated objective.  |
| 4.10 | HPAC                  | The <u>Health Physics Advisory Committee</u> .   |
| 4.11 | X-ray Supervisor      | The person responsible for an X-ray device.<br><br>X-ray Supervisors may be any of the following:<br><br>(a) A Faculty Member at McMaster University<br><br>(b) A Manager or Senior Manager in a University Department                                   |
| 4.12 | X-ray Device          | (a) as defined in Regulation 861, an electrically powered device the principal purpose of which is the production of X-rays (ALSO X-ray machine).  |
| 4.13 | X-ray Work            | Work with X-ray devices that may involve setting up, maintaining, reconfiguring apparatus, changing samples and gathering data .   |
| 4.14 | XRSP                  | The <u>X-ray Safety Program</u> defined in this document and in X-ray safety procedures issued by the Health Physics Department.   |
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## 5 RESPONSIBILITIES

### 5.1 The Health Physics Advisory Committee (HPAC):

The HPAC receives its authority from the President and Vice Chancellor of McMaster University. With respect to the X-ray Safety Program, the HPAC is charged with the following responsibilities:

- Informing the President and Senior Management of the hazards related to the use of X-ray devices and to regulate their use as requested by the President.
- Establishing and continually reviewing an adequate radiation safety program at McMaster University.
- Maintaining the University's compliance with radiation protection regulations promulgated by federal, provincial and local authorities.

Note: The HPAC has no authority with respect to patient safety in medical diagnostic or therapeutic procedures.

### 5.2 The Health Physics Department

Under the direction of the Senior Health Physicist, the Health Physics Department is responsible for

- Facilitating the implementation of this X-ray Safety Program.
- Obtaining and maintaining Ministry of Labour registrations for X-ray devices.
- Providing services that may be required to meet the objectives of this program including (but not restricted to):
  - (a) registration and authorization of workers
  - (b) X-ray safety training programs
  - (c) consultation and advice on X-ray safety
  - (d) administration of the dosimetry programs
  - (e) commissioning, inspecting, and decommissioning X-ray facilities
  - (f) X-ray surveys and monitoring
  - (g) calibration and short term loan of radiation protection instruments
  - (h) maintaining an inventory of X-ray devices
  - (i) maintaining X-ray protection records
  - (j) preparing and maintaining policies and procedures related to the XRSP
  - (k) prescribing medical examinations under the direction of the HPAC's Medical Consultant.
  - (l) maintaining a list of Authorized X-ray users
  - (m) maintaining a list of X-ray Workers.





- Issuing stop-work orders when required as defined in Section 6.

### 5.3 X-ray Supervisors:

Each X-ray supervisor is responsible for the following:

- Providing adequate facilities, equipment, instruments, supervision and written instructions to control radiation hazards and to comply with the XRSP
- Implementing all required X-ray safety procedures within the facilities under their control
- Directing all persons working in the facility to incorporate XRSP requirements and ALARA considerations in all radiological work, and monitoring staff for compliance.
- Immediately terminating unsafe work and ensuring that unsafe acts and conditions are reported to Health Physics
- Notifying Health Physics when any Authorized User in the facility becomes pregnant.

### 5.4 Competent Persons

Each competent person is responsible for the following:

- Requiring that work with X-ray devices is conducted in a safe manner and in accordance with this XRSP. In particular, ensuring:
  - (a) that Health Physics is informed of any changes to the X-ray device, with respect to experimental apparatus, location and orientation of X-ray device, interlocks or other safety components.
  - (b) compliance with posted X-ray Safety Rules
  - (c) work is conducted only by Authorized X-ray Users who have completed required training with Health Physics
  - (d) all required protective equipment and devices are used as required by the X-ray Safety Manual
  - (e) immediately informing Health Physics of any incident that could have resulted in exposure to the primary beam or exposures exceeding the public dose limit.

### 5.5 Authorized X-ray Users

Each Authorized X-ray Users is responsible for:

- Complying with the requirements of the HPAC and the X-ray Safety Program.





- Taking all reasonable and necessary precautions to ensure that work is conducted in a safe manner.
- Following all procedures, posted instructions and established practices designed to achieve safety in radiological work
- Seeking assistance from supervision or Health Physics when unsure of how to proceed safely with a task
- Using prescribed personnel protective equipment, devices and dosimeters
- Immediately alerting supervision and Health Physics to any unsafe condition or act
- Notifying Health Physics in writing immediately upon confirmation of pregnancy.

5.6 Departmental Chairs, Directors or Equivalent Senior Managers are responsible for:

- Being the X-ray Supervisor for projects involving the use of X-ray devices in undergraduate and graduate teaching within their academic unit or Department.

5.7 The Vice-President (Administration) is responsible for:

- Determining overall staffing and budget levels for the Health Physics Department.
- Monitoring, in conjunction with the HPAC, the performance of the Health Physics Department to ensure the adequate implementation of the X-ray safety program in the University

5.8 The Vice-President (Research and International Affairs) is responsible for:

- Providing funding for the operation of this X-ray Safety Program at levels approved through the normal budgetary process of the University.

5.9 Physical Plant Department is responsible for:

- Maintaining facilities and laboratories in campus buildings

5.10 Hamilton Health Sciences (HHS):

Under the agreement between the University and HHS regarding use and occupancy of the Health Sciences Centre (HSC), HHS is responsible for:

- Maintaining facilities and laboratories in the HSC
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- 5.11 McMaster University Security Services is responsible for
- Providing consultation and advice regarding security of X-ray facilities
  - Conducting regular security patrols of campus buildings
  - Conducting, in conjunction with Health Physics, security audits of approved working areas and facilities
  - Providing a continual dispatch service and alerting the on-call Health Physics staff member to any reported or suspected X-ray emergency or incident.

## **6 X-RAY SAFETY PROCEDURES**

### **6.1 Registration**

6.2 No X-Ray device shall be operated unless it is approved by Health Physics nor until registration with the Ministry of Labour has been completed.

6.2.1 Health Physics shall maintain a list of active X-ray devices and shall provide the list annually to the HPAC.

6.2.2 Health Physics shall review and maintain a record of X-ray safety procedures for each X-ray device.

### **6.3 User Authorization and X-ray Worker Designation**

6.3.1 No person shall perform work with X-ray devices unless that person is approved by Health Physics as an Authorized X-ray User.

6.3.2 Supervisors shall post a current list of Authorized X-ray Users in their facilities.

6.3.3 All Authorized X-ray Users who may be exposed to X-rays and may receive a dose equivalent in excess of the annual limits set out in Table 2 shall be designated as X-ray Workers as defined by Regulation 861.

6.3.4 Individuals designated as X-ray Workers shall submit to medical examinations prescribed by Health Physics as advised by the Medical Consultant to the HPAC.

### **6.4 X-ray Safety Training**

6.4.1 All Authorized X-ray Users and others with unsupervised access to X-ray facilities and X-ray devices shall receive X-ray Safety Training that prepares them to perform their duties safely in routine and upset conditions. Health Physics has the lead responsibility to develop and conduct this training.

6.4.2 X-ray Safety Training shall be designed to augment task and job specific training provided by X-ray Supervisors. X-ray safety aspects of work shall be incorporated in all task specific training provided by X-ray Supervisors.

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- 6.4.3 All X-ray Safety Training shall be approved by the Senior Health Physicist and authorized by the HPAC.
- 6.4.4 Short term visitors are exempt from X-ray Safety Training requirements provided they are escorted at all times while in posted areas and provided that they do not perform radiological work.
- 6.4.5 Authorized X-ray Users shall complete X-ray Safety Training which addresses the following:
- Meaning of designation as an X-ray Worker
  - Risks and Hazards of X-Radiation
  - The X-ray Safety Program and X-ray Safety Procedures
  - Management of X-ray Exposures
- 6.4.6 Persons other than Authorized X-ray Users who have unsupervised access to X-ray facilities or X-ray devices shall complete X-ray Safety Training which addresses the following:
- Risks and Hazards of X-Radiation
  - General X-ray hazards within facilities
  - Safe Work Practices within posted areas
- 6.4.7 Contractors and maintenance and support staff from Physical Plant and other University departments, performing work in an X-ray area shall have their work reviewed by the X-ray Supervisor for the purpose of determining X-ray safety and X-ray safety training requirements. Where there is a reasonable probability of encountering X-ray fields, Health Physics shall be consulted prior to commencing the work.
- 6.5 **Dose Limits**
- 6.5.1 All doses shall be maintained As Low as Reasonably Achievable, social and economic factors being taken into consideration (ALARA).
- 6.5.2 Regardless of the dose level established through any ALARA optimization, all doses shall be maintained less than the applicable Regulatory Dose Limits reproduced in Table 1, Table 2 and Table 3 during normal operations.
- 6.5.3 All work shall be conducted such that no person exceeds the applicable Administrative Control Levels (ACLs) for dose in Table 1, Table 2 and Table 3 without the prior written authorization of the HPAC.
- 6.6 **Pregnancy**
- 6.6.1 Every X-ray User who becomes aware that she is pregnant shall immediately notify the Senior Health Physicist in writing.
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- 6.6.2 Upon notification, Health Physics shall review the duties of the worker and prescribe adjustments as required to conform to the Dose Limits in Table 2 and the general restrictions below. The X-ray Supervisor is responsible for arranging any accommodation required that will not occasion costs or business inconvenience constituting undue hardship to the University.
- 6.6.3 Duties shall be such that there is no reasonable probability for an accidental exposure exceeding the Regulatory Dose Limits in Table 2 .

#### 6.7 **Personnel Monitoring and Dosimetry**

- 6.7.1 TLD dosimeters shall be prescribed for the following individuals:
- all authorized X-ray workers .
  - Security and Physical Plant personnel whose routine duties require them to enter X-ray areas.
  - Any University person who does not otherwise qualify who requests a dosimeter in writing.
- 6.7.2 Extremity dosimeters shall be provided to Authorized X-ray Users who may conduct live alignments or work with open beams of X-rays.
- 6.7.3 Electronic Personal Dosimeters shall be used by any person who may be exposed to radiation fields in excess of 100 micro-Gy per hour during X-ray work.
- 6.7.4 Dose monitoring results shall be provided to Authorized X-Ray Users through posting of dosimetry reports at designated locations in each building with an X-ray device. Individual annual summaries of dosimetry results shall be provided by Health Physics upon request.
- 6.7.5 **Facility Requirements and Posting**
- 6.7.6 The use of an X-ray device shall not commence in any area, room or enclosure until it is approved by Health Physics.
- 6.7.7 Approved installations of X-ray devices shall not be altered except with the approval of Health Physics.
- 6.7.8 Health Physics shall maintain a listing of all areas, room and enclosures where an active X-ray device is used or stored.
- 6.7.9 Every area, room or enclosure approved for the use of an X-ray device shall be posted at every point of access with: a durable sign(s) approved by Health Physics containing:
- the X-ray warning sign;
  - the words "Caution – X-rays" or an equivalent warning;
- 6.7.10 There will be posted conspicuously in each approved area, room or enclosure:
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- a poster of the McMaster X-ray Safety Rules (included as Appendix B<sup>1</sup>)

## 6.8 **Conduct of Work**

- 6.8.1 Each X-ray device shall have a designated X-ray Supervisor who is responsible for the safety of the device and for work conducted with the device, as specified in Section 5.
- 6.8.2 Day to day safety and control of the X-ray device shall be maintained by the Competent Person, as outlined in Section 5. The X-ray Supervisor may carry out these duties or another person may be designated as the Competent Person. Designations of the Competent Person shall be in writing with a copy to Health Physics.
- 6.8.3 All X-ray work shall be carefully planned and executed and shall incorporate steps to control exposure to the primary X-ray beam and any leakage and scatter. The work shall be conducted according to procedures that address the X-ray safety aspects of the work.
- 6.8.4 Each lab shall maintain ready access to suitable, calibrated radiation survey meters required to assess conditions specified by Health Physics.
- 6.8.5 Work shall comply with detailed X-ray Safety Procedures where they exist or, subject to approval by the HPAC, with alternate documented procedures that provide an equivalent level of safety and assurance of regulatory compliance.

## 6.9 **Decommissioning**

- 6.9.1 Health Physics is to be notified by the X-ray Supervisor when an X-ray facility or X-ray device is no longer to be used. The option of storage or decommissioning may be determined at a later date.
- 6.9.2 Decommissioning shall include:
- securing the x-device against unauthorized use
  - removing the X-ray facility or X-ray device from the active list
  - removal of all signs and postings
- 6.9.3 Once an X-ray device has been placed on the inactive list it shall not be returned to use until written notification is given to Health Physics by the X-ray Supervisor, and a successful commissioning survey has been conducted .
- 6.9.4 A record of the decommissioning shall be maintained by Health Physics

## 6.10 **Security Requirements**

X-ray devices shall be maintained secure at all times such that access is restricted to Authorized X-ray Users. This may generally be achieved by:

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<sup>1</sup> The current version of the poster at time of approval is shown. This poster may be modified by Health Physics from time to time as required.





- a) Keeping the lab locked when an Authorized X-ray User is not in attendance;
- b) Maintaining key control over the operation of the power supply for the X-ray device.
- c) Ensuring that only Authorized X-ray Users who have received operational training for the X-ray device have access to its key.

## 6.11 **Emergency Procedures**

### 6.11.1 **General**

All emergencies shall be responded to promptly under the guidance of Health Physics.

### 6.11.2 **Unusual Exposures and Exposures Exceeding Regulatory Limits**

- (a) Health Physics shall review dosimetry results. Health Physics shall make a written notification to a Ministry of Labour Inspector regarding any dose determined to have been received during X-ray work that does not appear to be reasonable and appropriate. The individual(s) involved, the X-Ray Supervisor, the Chair of the Health Physics Advisory Committee, the Vice President (Administration) and the Co-Chairs of the Joint Occupational Health and Safety Committee for the area shall be copied on the notification.
- (b) Where an X-Ray Worker has received a dose in excess of the ‘Regulatory Investigation Levels’ shown in Table 1, an investigation shall be carried out forthwith under the leadership of Health Physics. A written report of the findings of the investigation and of the corrective actions taken shall be provided to the Ministry of Labour. Copies of the report and associated correspondence shall be provided to the individual(s) involved, the X-Ray Supervisor, the Chair of the Health Physics Advisory Committee, the Vice President (Administration) and the Co-Chairs of the Joint Occupational Health and Safety Committee for the area.
- (c) Where an accident, failure of any equipment or other incident occurs that may have resulted in a worker receiving a dose equivalent in excess of the applicable “Regulatory Dose Limits” in Table 1, 2 or 3, the Senior Health Physicist or designated shall be notified immediately. The Senior Health Physicist shall immediately notify the Ministry of Labour and the Co-Chairs of the Joint Health and Safety Committee for the area. In addition, the following shall be notified: individual(s) involved, the X-Ray Supervisor, the Chair of the Health Physics Advisory Committee, and the Vice President (Administration).

### 6.11.3 **Exposures Exceeding Administrative Control Levels**

Where a person has received a dose in excess of the applicable “Administrative Control Levels” shown in Table 1, 2 or 3, an investigation shall be carried out under the leadership of Health Physics. A written report of the findings of the





investigation and of the corrective actions taken shall be provided to the individual(s) involved, the X-Ray Supervisor, the Chair of the Health Physics Advisory Committee, the Vice President (Administration) and the Co-Chairs of the Joint Occupational Health and Safety Committee for the area.

#### 6.11.4 Exposures with Physical Injuries

In addition to the investigation and reporting requirements above, any suspected physical injury caused by X-ray device use shall be examined by the Medical Consultant to the HPAC.

#### 6.11.5 On Call Resources

The Senior Health Physicist or another Health Physics staff member competent to respond to any of the emergencies listed shall be maintained on call at all times. A contact procedure shall be maintained with the Security Services Dispatcher.

#### 6.11.6 Fire

Health Physics shall respond to any fire involving an X-ray facility to provide radiological safety supervision as required.

### 6.12 Inspections, Audits and Enforcement

6.12.1 Authorization to use X-ray devices at McMaster University shall be considered a privilege as opposed to a right. The privilege, within the restrictions of the OHSA, is granted at the sole discretion of the HPAC.


6.12.2 The Senior Health Physicist and designated Health Physics Staff may impose any restriction on an X-ray facility or device or Authorized X-ray User up to and including suspending authorization and confiscating equipment if, in their opinion, violations of the X-ray Safety Program have occurred which may lead to safety hazards or non-compliance with the OHSA and its regulations.

6.12.3 All persons shall comply with orders given by Health Physics pending review by the HPAC at its next scheduled meeting.

6.12.4 The HPAC may take any action it deems appropriate, up to and including permanent cancellation of approvals for an X-ray facility or device or permanent revocation of an X-ray user's authorization.

6.12.5 Health Physics shall conduct inspections of X-ray facilities and devices to assess general safety, compliance, security and radiological conditions in facilities. Facilities and devices shall be inspected at least annually, and a summary of inspection findings shall be provided to the HPAC.

6.12.6 X-Ray Supervisors shall establish a regular inspection protocol for X-Ray facilities. The results of the inspection shall be documented in a record maintained by the X-ray Supervisor. A sample inspection protocol is included in Appendix C. X-ray Supervisors may use this protocol or an alternate protocol

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approved by Health Physics which achieves an equivalent standard of safety and compliance.

### 6.13 **X-ray Safety Procedures**

6.13.1 Health Physics shall prepare supporting, detailed X-ray Safety Procedures, consistent with the requirements of this program as deemed to be required by the HPAC. The procedures shall be approved by the Senior Health Physicist and authorized by the HPAC.

6.13.2 Compliance with the X-ray Safety Manual is a requirement of the X-ray Safety Program.

### 6.14 **Reporting**

6.14.1 Health Physics shall perform an annual detailed audit of safety and compliance in all approved areas, rooms and enclosures and shall report findings to the HPAC

6.14.2 The Senior Health Physicist shall prepare an annual summary of X-ray safety and compliance in the University and shall present the report to the HPAC, Senior Management, the Central Joint Occupational Safety Committee and the McMaster University Board of Governors.

## 7 **RECORDS**

7.1 All records required by the X-ray Safety Program shall be retained for a period of at least five (5) years.

7.2 X-ray Supervisors shall maintain records as required by the X-ray Safety Program.

## 8 **EXCEPTIONS**

8.1 All exceptions to this program must be applied for in writing and require the written approval of the Health Physics Advisory Committee.

8.2 The Senior Health Physicist may temporarily approve exceptions, pending the next scheduled meeting of the HPAC. In such case, the members of the HPAC shall be notified of the temporary exception within three days of it being granted.

8.3 Exceptions that are contrary to the OHSA and its Regulations shall not be granted without the written approval of the Ontario Ministry of Labour.

Appendices:

A. Dose Limits

B. X-Ray Safety Poster



C. Inspection Protocol

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## Appendix A: Dose Limits

Table 1 : Dose Limits for X-ray Workers

Dose	Period of Time	Regulatory Dose Limit (mSv)	Regulatory Investigation Level (mSv)	Administrative Control Level (mSv)
Effective Dose	one-year dosimetry period	50		5
	quarterly dosimetry period	N/A	5	2
Equivalent Dose to the Skin (1cm <sup>2</sup> or more)	one-year dosimetry period	500		100
	quarterly dosimetry period	NA	50	50
Individual organs or tissues other than the lens of the eye or skin	one-year dosimetry period	500		100
	quarterly dosimetry period	NA	50	50
Lens of an eye <sup>1</sup>	one-year dosimetry period	150		NA
	quarterly dosimetry period	NA	50	50

<sup>1</sup> Doses are not normally measured separately for the lens of the eye. The limits for Equivalent Dose to the skin will ensure sufficient management of these exposures.

<sup>2</sup> Annual doses due to internal exposure are included in the calculation of effective dose.

Table 2 : Effective Dose Limits for Pregnant X-ray Workers

Dose	Period of Time	Regulatory Dose Limit (mSv)	Administrative Control Level (mSv)
Effective Dose to the abdomen	balance of pregnancy	5	2



Table 3 : Limits for Authorized X-ray Users Not Designated as X-ray Workers and for Any Other Person

Dose	Period of Time	Regulatory Dose Limit (mSv)	Administrative Control Level (mSv)
Effective Dose	One-year	5	2.5
	quarterly Dosimetry Period	NA	1
Equivalent Dose to the Skin	one-year dosimetry period	50	15
	quarterly dosimetry period	NA	10
Equivalent Dose to the Hands and Feet	one-year dosimetry period	50	25
	quarterly dosimetry period	NA	10
Lens of an eye <sup>1</sup>	one-year dosimetry period	15	NA

<sup>1</sup> Doses are not normally measured separately for the lens of the eye. The limits for Equivalent Dose to the skin will ensure sufficient management of these exposures.

<sup>2</sup> Annual doses due to internal exposure are included in the calculation of effective dose.

Table 4: X-ray Field Limits

Area	X-ray Field Limit
Open configuration X-ray devices	5 $\mu$ Sv/h (0.5 mrem/h) at the edge of the experimental table top or most accessible point
Cabinet type X-ray devices	5 $\mu$ Sv /h at 5 cm from any surface of the cabinet
Area occupied by an X-ray worker during operation of an X-ray machine for industrial radiography or industrial fluoroscopy (non-cabinet type machine)	1 mSv per week
Area occupied by any other person during operation of an X-ray machine for industrial radiography or industrial fluoroscopy (non-cabinet type machine)	100 $\mu$ Sv per week.



## Appendix B: X-Ray Safety Poster

### M C M A S T E R   U N I V E R S I T Y X - R A Y   S A F E T Y   R U L E S

In addition to those responsibilities stated in RMM 701, the X-ray Safety Program, each operator of an x-ray device shall ensure that the operation of his or her x-ray device is in accordance with the following safety rules:

1. Only authorized persons having received operational instructions from an x-ray supervisor or competent person, x-ray safety instruction from Health Physics, and wearing a current dosimeter shall operate any x-ray device under the jurisdiction of the HPAC.
2. Each operator user shall ensure by use of warning lights mounted on the equipment, that the operating status of the x-ray device is plainly and visibly displayed.
3. No mechanical or electrical safety device shall be bypassed or caused to be ineffective without inspection and approval by the Health Physics Department.
4. No shielding device or safety enclosure provided or approved by Health Physics shall be removed or moved in such a way as to cause it to be ineffective during the operation of an x-ray device.
5. Any major changes to experimental apparatus shall be approved by the Health Physics Department. Approval may be obtained upon successful completion of a radiation survey.
6. Determination of primary x-ray beam location during live alignments shall be made using a fluorescent screen mounted on the apparatus, or on the end of a long-handled tool to prevent interception of the primary beam by any part of the body. Samples are not to be aligned by hand when the beam is present.
7. An approved beam stop is to be positioned as close to the experimental apparatus as possible, at any x-ray port where the equipment in use does not include a built-in beam stop as an integral part of the apparatus.
8. Stray radiation levels at any x-ray device must be kept within the limits set out in Appendix D of the X-ray Safety Program.
9. Any defective or faulty equipment shall be identified as such, taken out of service, and reported as soon as possible to the owner, supervisor, advisor, or Health Physics.
10. Undergraduate experiments involving the use of x-ray devices may only be conducted when a functioning survey meter is present and used by the lab demonstrator or instructor, to monitor the device for stray radiation.
11. The x-ray operator changing samples or making adjustments to the x-ray equipment is the only person who shall operate the shutters controlling the x-ray beam in use.

Health Physics





## Appendix C: Inspection Protocol

MCMASTER UNIVERSITY, GENERAL X-RAY SAFETY CHECKS

### PROCEDURES FOR ROUTINE SAFETY CHECKS ON X-RAY MACHINES.

#### 1.0 Purpose

This document provides instructions on the minimum maintenance and x-ray safety checks that are required by x-ray supervisors and competent persons who are responsible for the operation of x-ray devices at McMaster University. These requirements are additional to any set out in: OML Regulation 861 Respecting X-ray Safety, RMM 701 the McMaster X-Ray Safety Program, and the McMaster X-Ray Safety Rules Poster.

#### 2.0 Scope

These instructions are provided where applicable on x-ray equipment or x-ray machines which are "in service" on the campus of McMaster University.

#### 3.0 Authorized X-ray Operators

Only those individuals who have received x-ray safety training from McMaster's Health Physics Department, have a good working knowledge of the x-ray machine, have received authorization from the owner of the x-ray machine, and are wearing x-ray dosimeters are permitted to operate and test x-ray machines as required by this document.

#### 4.0 Related Documents

- Ontario Ministry of Labour Regulations 861, Respecting X-ray Safety, 1990.
- X-Ray Safety Rules Poster
- RMM 701, X-ray Safety Program

#### 5.0 Responsibility

The x-ray supervisor of each x-ray device is responsible for ensuring that the machine is maintained and tested as described in this document. Health Physics is responsible for providing instruction and information on x-ray safety checks, and will monitor x-ray machines periodically, or on demand, to support compliance with the requirements of this document.

#### 6.0 Frequency of Checks

Each owner shall ensure that the x-ray machines in his/her possession are checked according to this procedure at least once per quarter on any x-ray machine considered to be in service.

#### 7.0 Safety Items To Be Checked

The following sets of safety related items should be checked where applicable, at least quarterly. Owners or operators of x-ray machines may increase the items or frequency of checks as desired.



MCMASTER UNIVERSITY, GENERAL X-RAY SAFETY CHECKS

### 7.1 CHECK 1 - Warning Lights.

Warning lights should be “failsafe”, ie: operation of the item should be inhibited when the corresponding light is not working. The light should come on as soon as the item is activated, and the light should go off when the item is deactivated.

1. “X-RAYS ON”. With the X-ray machine shutdown, loosen or remove each warning light in turn, and attempt to power up the X-ray tube or open a shutter.
2. “SHUTTER OPEN” - Remove or loosen the bulb and attempt to operate shutter. Lights should respond immediately when any of the shutters is opened or closed.

### 7.2 CHECK 2 - Safety Interlocks

1. X-ray towers - Check operation of microswitches and their corresponding shutters to ensure that shutter action is inhibited when the microswitch is not activated. Remove any experimental apparatus from X-ray tower, and attempt to open shutters.
2. Cabinet/enclosure doors - Open cabinet or enclosure door and attempt to open shutters. Check operation of interlock switches, ie: microswitches, magnetic switches, etc...to ensure that they prevent operation of the X-ray power or shutters when the doors are in the open position.

**NOTE:** Cabinet and enclosure doors should not be used as “On” or “Off” switches, ie: to operate the shutters or energize the X-ray tube. Shutters and the X-ray tube should only be operated from the control panel.

### 7.3 CHECK 3 - Primary Controllers

1. Internal Shutters - Activate each internal shutter in service and observe response time. The shutter should respond immediately, smoothly, and close quickly.
2. External Shutters - Activate each external shutter mechanism to ensure smooth and fast operation.

### 7.4 CHECK 4 - Secondary Controllers

1. Beam stops - check alignment of beam stops to ensure that they are properly positioned to intercept the entire x-ray beam when there is no sample in place.
2. Shielding boxes, tunnels, enclosures - check that these items are properly positioned to provide the shielding protection required, and that they have not been altered or disassembled rendering them ineffective. Check cover caps over slit access ports to ensure that they close completely when released.

### 7.5 Observed Failures

An x-ray machine which fails any of the above tests shall be removed from service, and not returned to service until the fault is corrected. The failure shall be reported to Health Physics as soon as possible.