# Radiation Producing Equipment Program Document

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## Purpose

Radiation Producing Device (RPD or X-Rays) safety is the responsibility of all individuals at The Pennsylvania State University (the University) including facility, staff, students, and visitors. The use of X-Rays at Penn State also requires compliance to state regulations and university policies.

The requirements and recommendations in this document have been adopted by The Pennsylvania State University to provide for the safe use of X-Rays at the University. They are distributed to help inform the University community on how to safely use radiation producing equipment, and also function to help the University satisfy the requirements of federal and state regulations and University requirements. It is the intent of the University that these program requirements allow as much flexibility as practicable for researchers, experimenters, and device users while still assuring that risks from ionizing radiation are satisfactorily minimized and controlled.

This document contains requirements that cover the purchase, receipt, possession, use, transfer, and disposal of all Radiation Producing Equipment on Penn State controlled property by Penn State personnel or others and by Penn State personnel in the field.

## Introduction

If not used and managed properly, Radiation Producing Devices can cause injury and illness to users who are exposed to chronic or acute radiation. There are many classifications of these devices that create various risks to the individuals using them if proper control measures are not in place.

The requirements and control measures outlined in this document are intended to allow research and other work to take place involving RPDs while still protecting users and members of the public from the potential dangers that RPD can pose and to ensure that University operations are in compliance with national standards and federal and state regulations.

## Scope and Applicability

These Rules and Procedures cover the purchase, receipt, possession, use, transfer, and disposal of all classes of RPD on Penn State controlled property by Penn State personnel or others and by Penn State personnel in the field. This includes the non-University Park campuses, but not the Milton S. Hershey Medical Center located in Hershey, Pennsylvania and any affiliated hospitals, or the College of Medicine.

General RPD are considered those devices that produce radiation between 5keV and 1MeV and are non-healing arts. Devices that produce radiation less than 5keV are exempt from these requirements. Devices that produce radiation greater than 1MeV are defined as Accelerators and are still covered by these rules and requirements (see 8.11). RPD specifically classified as X-Rays used in the Healing-Arts, or used on humans, are a shared responsibility between Penn State and Penn State Hershey Medical Center.

These Rules and Procedures are intended for use by everyone who works with RPDs covered by these Rules. Reviewed in this program description are personnel responsibilities, training requirements, and control measures for various RPD types. An electronic copy is available on the Penn State EHS Website and can be downloaded there for your reference.

Where existing or future federal, state, or local regulations are found to be different from the requirements contained in this manual, those legally accepted regulations shall supersede this document.

## Terms and Definitions

### Definitions

**The definitions listed below are given in a pragmatic as opposed to a detailed manner. They are defined to reflect their use in this document and at Penn State. They are in no way intended to reflect dictionary definitions or their use in any other field or location.**

**Accelerator: A radiation-producing machine capable of accelerating electrons, protons, deuterons, or other charged particles in a vacuum and of discharging the resultant particulate or radiation into a medium at energies in excess of 1MeV.**

**Accessible Surface: The external or outside surface of the enclosure or housing provided by the manufacturer. The term includes the high-voltage generator, doors, access panels, latches, control knobs and other permanently mounted hardware, including the plane across the exterior edge of any opening.**

**Audit: The process by which the RPE Program Manager, or other qualified EHS personnel, ensures that a laboratory containing RPD is following all applicable requirements by physically checking all safety systems and ensuring training and SOPs are up to date.**

**Cabinet X-ray system: An X-ray system with the X-ray tube installed in an enclosure which, independently of existing architectural structures except the floor on which it may be placed, is intended to contain at least that portion of a material being irradiated, provide radiation attenuation and exclude personnel from its interior during generation of radiation. The term does not include an X-ray tube used within a shielded part of a building, or X-ray equipment which may temporarily or occasionally incorporate portable shielding.**

**Certified Cabinet X-Ray: An X-ray system which has been certified under 21 CFR 1010.2 (relating to certification) as being manufactured and assembled under 21 CFR 1020.40 (relating to cabinet x-ray systems).**

**Closed-Beam Radiation-Producing Device: A device in which the beam path cannot be entered by any part of the body during normal operation.**

**Control panel: A device containing means for regulation and activation of a radiation-producing device or for the preselection and indications of operating factors.**

**Controlled Area: The physical area around the X-Ray housing or components where an individual could potentially be exposed to a dose greater than or equal to that defined in 10 CFR 20 as the public dose limit, but less than that defined as a Radiation Area.**

**Dosimeter: A device worn by individuals working with radiation that can track the amount of radiation received in a given period of time. These devices can be used to monitor full body dose or extremity dose.**

**Dose: The amount of energy that ionizing radiation deposits within the material it interacts with. The measurement has multiple units depending on the type of radiation and the material it interacts with. Limits exist for the amount of dose an individual can receive when working with radiation.**

**Electron Microscope: Equipment utilizing the wave characteristics of electrons that have been accelerated by an electric field to visualize the microscopic structure of material.**

**Enclosure: The barrier that separates the controlled area from the uncontrolled area and allows access to the controlled area when opened.**

**Fail-safe design: A design in which all realistically anticipated failures of indicators or safety components result in a condition in which individuals are safe from exposure to radiation.**

**Hand-Held Radiation-Producing Device: A portable device designed to operate when held in the hand, such as a hand-held X-ray fluorescence analytical device.**

**Industrial Radiography: An examination of the structure of materials by nondestructive methods, including fluoroscopy, which utilizes radiation producing machines to make radiographic images. This term only applies to those devices which are used in industry. An Industrial Radiography device used in an academic or research setting will not be considered IR.**

**Interlock: A device or engineered system that precludes access to an area of radiation hazard either by preventing entry or by automatically removing the hazard.**

**kV: Kilovolt.**

**Leakage radiation: Radiation coming from within the source housing, other than the useful beam**

**Local Components: Parts of a Radiation Producing Device system that include parts struck by X-Rays, such as source housings, shielding, shutters, port assemblies, collimators, holders, cameras, and detectors. If any of these parts are removed, it could result in an increase of exposure to any individual, or body part, within the controlled area.**

**Open-Beam Radiation-Producing Device: A device in which any part of the body could enter the beam path during normal operations. Examples include X-ray gauges, tabletop and handheld X-ray devices and electron beam welders. Also describes a device where there is no physical barrier between the controlled and uncontrolled area.**

**Permanent Radiographic Installation: A shielded installation or structure designed or intended for radiography in which radiography is regularly performed.**

**Primary Beam: The ionizing radiation coming directly from the radiation source through a beam port into the volume defined by the collimation system.**

**Radiation Area: An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 5mrem in 1 hour at 30 centimeters from the device.**

**Radiation Producing-Device (RPD): A radiation-producing device where the apparatus, device, electronic product, system, subsystem or component of any of them may generate X-rays or particle radiation between 5 keV and 1 MeV. The device is not intended for healing arts use for humans or animals. The device is fixed or portable, such as mobile devices, portable devices, stationary equipment or transportable equipment.**

**Radiography: The process of creating a radiographic image through X-Ray radiation.**

**Shielded Room Radiography: Radiography that is conducted in an enclosed room, the interior of which is not occupied during radiographic operations, and the interior of which can be classified as a Radiation or High Radiation Area when in operation.**

**Standard Operating Procedures (SOP): Formal written description of the safety and administrative procedures to be followed performing a specific task.**

**Uncontrolled Area: An area in which there is no risk of exposure to an individual over the levels defined in 10 CFR 20 as the public dose limit.**

### Acronyms

**ALARA** – As Low as Reasonably Achievable

**BRP** – Bureau of Radiation Protection

**DEP** – Department of Environmental Protection

**PA** - Pennsylvania

**RAD** – Radiation Absorbed Dose

**REM** – Radiation Equivalent Man

**RPD** – Radiation Producing Device

**RPE** – Radiation Producing Equipment

**RPO** – Radiation Protection Office

**RSO** – Radiation Safety Officer

**SEM** – Scanning Electron Microscope

**XPS** – X-Ray Photoelectric Spectroscopy

## Roles and Responsibilities

### Individual Roles and Responsibilities

#### Radiation Safety Officer

The Radiation Safety Officer (RSO) is a designated staff member who has the knowledge and authority to apply appropriate radiation safety rules, standards, and practices. Their duties for the RPE program include:

• Communication with the DEP and other regulatory bodies

• Review and approve all work of the RPE program manager

• Approving accident/incident investigation results or reports

• Review and provide written approval if operations outside of an SOP are permitted.

• Review and provide approval for a specified period of time if a safety device or interlock is to be bypassed.

• Review and provide approval for a specified period of time if shielding is to be removed.

• Sign any records of safety feature or interlock bypass or shielding removal.

• Review and approve in writing any temporary administrative control measures that may be necessary if a safety device fails during testing.

• Reviewing the radiation protection program at least annually.

• Escalating non-compliance IAW EHS program

#### Radiation Producing Equipment Program Steward

The RPE program manager is responsible for the day-to-day operations of the RPE program and ensuring compliance with the DEP regulations. These duties include:

• Classifying new RPDs appropriately

• Ensuring compliance with any control measures required by the University or DEP

• Conducting specific and routine audits on all RPDs

• Maintaining records of RPD inventory and audits

• Reviewing SOPs for all RPDs

• Participating in accident/incident investigation involving RPDs

• Escalating non-compliance IAW EHS program

• Developing and maintaining the RPE safety program description and policies

• Instructing personnel on safe working practices and ensuring that all personnel are trained in radiation safety commensurate with the hazards of the job.

• Ensuring that safety devices, interlocks, warning signals, labels, postings and signs are functioning and located where required.

• Retaining records required to show compliance with this document.

#### Work Unit Safety Officer

The Work Unit Safety Officer or Departmental Safety Officer need only be aware of the existence of RPE within their department or work unit. Their only responsibility is to ensure that the researchers or individuals that they are monitoring have made the RPO aware of their RPE use and continue to follow the instructions within this document.

#### Radiation Producing Device Owner

The RPD system owner is the individual who has purchased (or approved the purchase of) the RPD or oversees the funding of their specific work unit to all the research to continue. This individual may also be the RPD supervisor if their duties follow those outlined below. If this user is only the RPD owner, and not the supervisor as well, their only requirement within the RPE program is to ensure that the RPO is informed when a RPD is purchased, transferred, or disposed of.

#### Radiation Producing Device Supervisor

The RPD Supervisor is the individual who is the main knowledgeable party for the RPD and oversees the day-to-day of the lab in which the device is used. This individual may also be the device’s owner. This individual will be listed as the main point-of-contact for the RSO and RPE Program Manager. They should be present for any audit activities if available. They will be responsible for:

• Stopping work and immediately notifying the RSO if a safety device or interlock stops functioning.

• Contacting the RSO prior to removing any shielding or the bypass of any interlock.

• Contacting the RPO after the change in any local component.

• Ensuring the RPO is notified of any modifications or movements of the RPD

• Ensuring all their users have completed the appropriate training before using the RPD

• Creating, updating, and following an SOP for all RPDs in their possession (note that any deviations must first be approved by the RSO)

• Informing RPO of any new RPD purchases

• Ensuring all their users use Dosimetry as applicable

• Escalating non-compliance IAW EHS program

#### Radiation Producing Device User

The user of the device shall be an individual who has completed the EHS X-Ray training and been informed of the SOP and its contents. The user shall follow all requirements and consider all recommendations and guidelines outlined in this document for the safe use of RPDs. The user and the supervisor may be the same person.

• Stopping work and immediately notifying the Supervisor if a safety device or interlock is not functioning properly or as expected.

• Completing the appropriate training before using an RPD

• Following applicable SOPs

### Key Interfaces

#### Internal EHS Interfaces

N/A

#### Other Penn State University Interfaces

Interfaces with organizations outside of EHS, which can include but is not limited to:

• University Police and Public Safety: N/A

• Occupational Medicine: N/A

• Office of Research Protection: ORP shall be contacted for Any observed research misconduct.

#### External Interfaces

The Pennsylvania Department of Environmental Protection’s Bureau of Radiation Protection is the state’s governing body for RPDs. All new RPD shall be reported to the DEP BRP by EHS within 30 days of arrival and they shall also be notified in a timely manner if a device has left the possession of the University.

The PA DEP BRP is also the primary regulatory agency that performs inspections of Penn State’s RPE Program. This includes all Commonwealth Campuses. During these inspections, the inspector may ask for any and all information related to the device including manuals, maintenance records, SOPs, training records, usage logs, and audit records. Inspectors may also perform their own audits of the device to ensure the control measures in section 8 are being followed. EHS will assist with regulatory interfaces during these visits.

### Third Party Responsibilities

#### Contractors

N/A

#### Other Third Party (for example, Students, Visitors, Temporary Employees)

Any students of other institutions, visiting scholars, temporary employees, or other individuals not affiliated with Penn State using RPDs are still required to follow all requirements outlined in this document. By using RPDs, an individual will be considered a RPD user and will follow requirements in 5.1.6, 7.2.1, and any applicable items in section 8.0.

### Raising Safety Concerns

All persons working with Radiation Producing Equipment who have concerns about their personal safety, the safety of the general public, or the safety of the environment should promptly report the matter to their supervisor. If the supervisor is unable to answer the person’s concerns to his or her satisfaction, he or she is encouraged to contact EHS (including, but not limited to, EHS Supervisors, EHS senior Director, etc.) to report the situation. If the person raising the concern is not satisfied with the action(s) taken by EHS, the person is free to contact the PA DEP with his or her concerns. In any case, the person raising the concern may not be retaliated against in any way by his or her supervisor, EHS, or the University. Such retaliation is unlawful (10 CFR 30.7) and contrary to maintaining a safety-conscious environment. Any person who feels that he or she has been retaliated against should promptly report the matter to the RSO.

If you have any concerns about safety, workplace issues, compliance, or retaliation you shall call the Penn State Ethics Hotline at 1-800-560-1637 or report the issue online. Please visit this website for more details on reporting misconduct.

## Resources, References, and Source Information

Describes relevant reference information and other listed resources.

### Requirement and Program Inputs

This document contains all necessary guidelines for owners and operators of RPD at Penn State. It shall be considered the standard to follow for all RPD safety needs and guidance. Additional requirements and guidelines exist for EHS personnel to maintain compliance with PA DEP BRP regulations and maintain the University’s X-Ray Registration.

Penn State’s Radiation Producing Equipment Program is based on the requirements outlined in Title 25, Chapters 215, 219, 221, 223, 227a., and 228 of the Pennsylvania Code. In addition, the recommendations from ANSI standards and other university programs were reviewed for best practices in RPD safety while developing this program description.

#### Regulations

##### PA Code Title 25 Ch 215, 219, 221, 223, 227a., and 228

###### Chapter 215: General Provisions for Protection Against Radiation

###### Chapter 219: Standards for Protection Against Radiation

###### Chapter 221: X-Rays in the Healing Arts

###### Chapter 223: Veterinary Medicine

###### Chapter 227a.: Radiation Safey Requirements for Non-healing Arts Radiation Producing Devices

###### Chapter 228: Radiation Safety Requirements for Accelerators

#### Codes and Standards

##### ANSI 43.3-2008 For General Radiation Safety – Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies Up to 10MeV and ANSI 43.2-2021 Radiation Safety for X-Ray Diffraction and Fluorescence Analysis Equipment.

##### ANSI 43.3 describes the best practices for the use of shielded room RPD and larger industrial RPD with energies up to 10MeV.

##### ANSI 43.5 describes the best practices for general RPD usage for devices under 1MeV in energy.

### Contextual and Supporting References

#### Reviews of other university RPD safety programs to gather best practices in addition to the requirements gathered from the above references.

### Other Resources

N/A

## Standard EHS Program Information

### Incident and Emergency Planning and Response Information

**In case of a life-threatening emergency, call 911.** These could include, but are not limited to: Fire, explosions, serious injuries, and any other incident/accident which poses immediate threat to life or the environment.

If the incident/accident involves the suspicion or knowledge of a radiation exposure take the following actions immediately:

* **Call 911 if there is a life-threatening injury.**
* If it is safe to do so, turn off the equipment and secure it to prevent use by other individuals (See 7.1.4, Appendix C, and Appendix E.).
* Do not change the equipment’s configuration. The details from the exact set-up are critical in determining the extent of exposure.
* Contact EHS at the numbers listed above and below, starting with the Radiation Safety Office Emergency number.

Emergency Telephone Numbers and Contact Information

**Radiation Safety Office Emergency 814-777-0215**

**PSU Public Safety (Emergency) 814-863-1111**

**Police, File, and Ambulance Emergencies 911**

Environmental Health and Safety 814-864-6391

Radiation Safety Officer 814-863-3976

Radiation Protection Office 814-865-6391

If an incident/accident that does not pose a life-threatening injury occurs call Environmental Health and Safety (EHS) at (814) 865-6391 during normal business hours (M-F, 8am-5pm) or University Police (814) 863-1111 during all other times or holidays. After hours University Police can direct any call to the appropriate EHS staff member.

#### EHS Incident Reporting and Response

If an accident or incident occurs during operation of a Radiation Producing Device, but no injury or property damage occurs, the user shall still immediately inform the PI and RSO of the event. Instances such as: An interlock or safety feature hasn’t been functioning during normal operation, in initial component fails, or a part of the user’s body passes close to an open beam are all examples of what could be considered a “near miss”. If an actual exposure occurs due to one of these situations, follow the procedures outlined in 7.1.

These near misses shall be reported to the PI and the RSO so a strategy can be formed to avoid these incidents in the future. Attempting to fix these issues without informing the RPO can lead to the dangerous situation repeating and an individual being exposed or severely injured.

If a Radiation Producing Device user reports unsafe working conditions or near misses to the PI or RPO, no retaliatory action can be taken against them. If a user feels that their PI is not taking their safety concerns or warnings seriously, they should covey them to the RPO or EHS. If they then feel that their contact in EHS or the RPO is ignoring their concerns, it should be brought to the Sr. Vice President of Research’s or the Vice President of the Office of Physical Plant’s attention. Always report unsafe work conditions to avoid potential future accidents or incidents. See Section 5.4.

#### Emergency Reporting and Response Procedures

See Appendix C for Emergency Response Procedures.

#### Emergency Rescue Procedures

N/A

#### Facility Evacuation or Lockdown Procedures

N/A

#### Specific Hazard Emergency Procedures

The following list details the specific procedures for handling specific hazards associated with incidents/accidents that can occur when using a Radiation Producing Devices:

* A known, or suspected, exposure to radiation from an RPD occurred in conjunction with a physical injury:
  + Follow the steps outlined in the bullet points in 7.1 exactly as written. Also refer to Appendix C for more detailed information on each bulleted item.
* An injury has occurred, related to the RPE (i.e. shock, fire, crush, etc.), but no one was exposed to radiation:
  + Follow the first 2 bullets listed in 7.1. The injury shall be handled first, but within the steps the device also needs to be secured to prevent more injuries. This can be accomplished by placing the device Out of Service (see below 7.4.2, and Appendix E) immediately following the incident and then applying LOTO procedures once the injury has been handled appropriately.
* A known, or suspected, exposure to radiation from an RPD occurred, but no signs of an injury are present:
  + Skip the first bullet point in section 7.1, but continue to follow the other 3. Refer to Appendix C for more detailed information on each bulleted item. The RSO shall be called at the Radiation Safety Office emergency number listed above.

The equipment should be turned off and secured before the user leaves the area if it is safe to do so. In the event it is not safe to do so, the user (or witness to the incident) should find another individual to secure the area to prevent others from interacting with a potentially hazardous device. If turning off the device is an option, the device can be turned off using the emergency-stop button, by cutting power from a wall outlet or breaker, or by shutting it down according to the SOP. Once this is accomplished, and any injuries or emergencies have been dealt with, secure the device. Securing the device can be accomplished by applying LOTO procedures and adding signage signaling danger or physically blocking usage of the device with items in the room. LOTO procedures for single energy source devices can include keeping visual contact with the cord and wall outlet or adding a “clam-shell” lock to the end of the plug. Do not leave the area unattended without powering down and securing the device. This would expose other users to the same hazardous condition if they approached or powered on the device.

In the process of turning off and securing, ensure the operating parameters and configuration is not changed. Knowing the exact configuration is essential for the RPO to determine possible exposure levels. The user shall also take notes on what exactly they were doing with the device and where they were physically at that time. Information on how far certain body-parts were from certain parts of the device, and how long they were there, is extremely important for dose reconstruction purposes.

Once the device has been turned off, secured, and maintained in it’s operating configuration, call the RPO for assistance with next-steps. If outside of the hours from 8am-5pm, call the Radiation Safety Office Emergency Line.

### Training Requirements

All owners, supervisors, and users of Radiation Producing Devices are required to take training offered by either EHS or other qualified personnel to meet the Penn State and DEP requirements. This training varies depending on the classification of the device and the type of responsibility the individual has over the device.

All training listed under a heading in this section is one-time-only training and refreshers are not required. Users of Veterinary and Healing-Arts Devices are required to take refresher training. It is strongly suggested that all other users and supervisors periodically review their SOP and Emergency Procedures to ensure safe operation of the device.

#### Training Requirements

The types of training that could be required of individuals associated with RPD include: Owner/Supervisor, Electron Microscope, Radiation Producing Equipment – Part 1, Radiation Producing Equipment – Part 2, Open-Beam Radiation Producing Equipment – Part 2, and Instrument-Specific training.

All RPD users shall receive training, and demonstrate competence, in the following areas:

* Types of radiation, identification of radiation hazards associated with the use of the radiation-producing device and associated equipment, and precautions or measures to take to minimize radiation exposure.
* Significance of the various radiation warnings, safety devices and interlocks incorporated into the equipment, or the reasons that warnings, safety devices or interlocks have not been installed on equipment and the extra precautions required in these cases.
* Commensurate with potential hazards of use, biological effects of radiation, radiation risks and recognition of symptoms of an acute localized exposure.
* Normal operating procedures for each type of radiation-producing device and associated equipment, as well as procedures to prevent unauthorized use. Training in normal operating procedures must include hands-on training.
* Emergency procedures for reporting actual or suspected accidental exposure and other radiation safety concerns, such as an unusual occurrence or malfunction that may involve exposure to radiation.
* Radiation survey performance, where applicable.

Users of Open-Beam RPD will also be required to receive more specific instruction in:

* Sources and magnitude of common radiation exposure.
* Units of radiation measurement.
* Radiation protection concepts of time, distance, shielding and ALARA.
* Procedures and rights of a declared pregnancy.
* Regulatory requirements and area postings.
* Worker, embryo/fetus and public dose limits.
* Proper use of survey instruments and dosimetry.

Users of Open-Beam Veterinary or Healing-Arts RPD are not required to take the following trainings so long as their previous schooling or work experience has provided training equivalent to what is listed in the PA Code Title 25 Chapter 223 (Veterinary) and 221 (Heling-Arts).

Appendix A of Pa Code Title 25 Chapter 221 state that the individual shall be trained and competent in the following areas:

(1) Basic properties of radiation.

(2) Units of measurement.

(3) Sources of radiation exposure.

(4) Methods of radiation protection.

(5) Biological effects of radiation exposure.

(6) X-ray equipment.

(7) Image recording and processing.

(8) Patient exposure and positioning.

(9) Procedures.

(10) Quality assurance.

(11) Regulations.

Users who have received training or schooling to cover any or all of these requirements shall communicate their curriculum to the RSO prior to using the devices to determine appropriate equivalencies. The need for any additional training will be determined by the RSO and can be given by the RPO to users who require it. Users who do not have appropriate training to meet these requirements shall complete the trainings required in 7.2.1.3 and 7.2.1.5.

Users of Open-Beam Veterinary or Healing-Arts RPD are also required to take periodic refresher training. This requirement can be fulfilled through continued education, so long as the requirements from PA Code Title 25 Chapter 221, above, are met. This will be determined by the RSO. Otherwise, the RPO has made appropriate refresher trainings available for both types of users. These trainings are PowerPoints to be reviewed on a yearly basis. Users who complete the RPO provided trainings shall communicate to the RPO when the trainings are completed, so that appropriate records can be kept.

All training maintenance and records for users of Open-Beam Veterinary or Healing-Arts RPD shall be sent to the RPO and controlled and maintained by the supervisor of the RPD and EHS. Records of EHS-given training, previous education curriculum, and refresher training shall be available to the RPO or PA DEP BRP inspector upon request.

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 1. Summary of Training Requirements by RPD Type** | | | | | | | |
|  | **Electron Microscope** | **Radiation Producing Devices – Part 1** | **Radiation Producing Devices – Part 2** | **Radiation Producing Devices – Part 2 (Open Beam)** | **Instrument Specific Training** | **Supervisor Training (2)** | **Additional/Supplemental Training** |
| **X-ray or RPD Type** |  |  |  |  |  |  |  |
| Electron Microscope | RQ |  |  |  | RQ | C |  |
| Hand-Held <50 kV |  | RQ |  | RQ | RQ | C |  |
| Hand-Held >50 kV |  | RQ |  | RQ | RQ | C |  |
| Closed Beam RPD |  | RQ | RQ |  | RQ | C |  |
| Open Beam RPD |  | RQ |  | RQ | RQ | C |  |
| Permanent Radiographic Installation |  | RQ | RQ |  | RQ | C |  |
| Shielded Room Radiography |  | RQ |  | RQ | RQ | C |  |
| Veterinary |  | M |  |  | RQ | C |  |
| Accelerator |  | RQ |  | RQ | RQ | C | (3) |
| Healing Arts |  | M |  |  | RQ | C |  |
| Other |  |  |  |  |  | C |  |
| Notes/Comments:   1. RQ indicates required training. “M” indicates recommended training. “C” indicates training required on a case-by-case basis. 2. All RPD Owners or Supervisors are required to take Owner/Supervisor training. 3. Contact RPO as additional, specialized training will be necessary. | | | | | | | |

##### Owner or Supervisor Training

Any individual who fits the description of an Owner or a Supervisor, as defined in 5.1.4 and 5.1.5, shall complete this training. The Owner/Supervisor training details the expectations of an individual designated as one of those positions as well as giving a brief description of the types of RPD and what to expect from the RPO during an audit.

It is a one-time training offered on the LRN and can be accessed through this link: <https://ehs.psu.edu/training?tid=186>.

##### Electron Microscope Training

All users of Electron Microscopes are required to take the Electron Microscope Training offered on the LRN. This training can be taken in lieu of the Radiation Producing Equipment Training (Parts 1 and 2) so long as the user operates no other types of radiation producing equipment other than an Electron Microscope. If a user has taken the Radiation Producing Equipment (Part 1) training already, they are not required to take the Electron Microscope training.

It is a one-time training offered on the LRN and can be accessed through this link: <https://ehs.psu.edu/training?tid=186>.

##### Radiation Producing Equipment – Part 1

All users of RPD, except for Electron Microscopes and the conditions mentioned in 7.2.1, are required to take Radiation Producing Equipment – Part 1 training. This training is offered on the LRN and is followed by a quiz that requires a score of 70% to pass. Once this requirement is completed, the user can move on to Part 2, or Open-Beam Part 2.

It is a one-time training offered on the LRN and can be accessed through this link: <https://ehs.psu.edu/training?tid=186>.

##### Radiation Producing Equipment – Part 2

All users of RPD who have passed Part 1 of the RPE training must then sign-up for part 2 of the training before using the device. Radiation Producing Equipment – Part 2 is a hands-on session given by a member of the RPO staff. The sessions will be 1 hour long and take place in Steam Services Building room 212.

It is a one-time training where session sign-ups are offered on the LRN and can be accessed through this link: <https://ehs.psu.edu/training?tid=186>.

##### Open-Beam Radiation Producing Equipment – Part 2

All users of RPD who have passed Part 1 of the RPE, and will be using an Open-Beam RPD, training must then sign-up for this specific part 2 of the training before using the device. Radiation Producing Equipment – Part 2 is a hands-on session given by a member of the RPO staff. The sessions will be 1.25 hours long and take place in Steam Services Building room 212.

It is a one-time training where session sign-ups are offered on the LRN and can be accessed through this link: <https://ehs.psu.edu/training?tid=186>.

##### Training Proficiency

Only trained personnel are permitted to use Radiation Producing Devices. Each Supervisor is responsible for ensuring that they and all those working under their supervision (including students, visitors, and third parties) have received sufficient training necessary to safety use these devices. A list of all trained personnel and their certificates shall be kept by the laboratory supervisor and updated as new users join or leave the group.

At a minimum, all faculty, staff, students, and visitors operating RPDs are required to complete the following, in addition to the training listed above, before first use of the device:

* Review the Radiation Producing Equipment Program Description (this document)
* Review the SOP for the specific device to be used. Most RPDs are provided with instructions for safe operation by the manufacturer; however, at Penn State, a standalone SOP for each device in use is required.
* Approved SOPs shall be available for review during audits or evaluations of RPD. These SOPs shall be maintained with the device for reference by the operator and maintenance or service personnel. Contact the RPO on guidance for creating this document.
* Receive training from the Supervisor or Manufacturer covering safe operation of the specific device(s) to be used, administrative procedures, and any other applicable SOPs.
* Sign the RPD Specific Training Documentation form found on the [EHS website](https://ehs.psu.edu/laser-safety/laser-safety-resources), and in Appendix B of this document, indicating any faculty, staff, students, or guests who operate RPD have completed the tasks above for the specific device. This document must be signed and dated by the user and updated anytime a new user is authorized to use the device. This document must be available for review during audits and should be maintained with the training certificates.

PIs, Lab Supervisors, Facility Coordinators, Department Safety Officers, or Laboratory Safety Officers may also require additional training beyond what is required above before using RPD at Penn State. These additional requirements shall be followed if they exist within the specific lab, building, or department.

### Documentation & Recordkeeping

All RPD supervisors and users shall keep their RPD documentation in a readily accessible location for audits or general use. This location could either be a physical binder within the lab or a folder on a shared drive or computer. The following documentation shall be available and kept within the binder or folder: SOPs for all devices, training records for all users, and RPD specific training documentation for all units. The following documents shall be available and should be kept within the binder or folder: manuals and service and maintenance records.

#### Documents that Constitute this Program

|  |  |  |
| --- | --- | --- |
| **Table 2. Summary of Program-Specific Implementing Documents** | | |
| **EHS Document ID** |  | **Document Title** |
| EHS-163 | 1 | X-Ray Specific Training Document |
|  |  |  |

#### Customer Record Retention Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| **Table 3. Summary of Customer Record Retention Requirements** | | | |
| **Records Series  (Types of Documents)** | **Record Description** | **Records Series Description** | **Retention Period** |
| Standard Operating Procedure | SOP for RPD | Specific set of operating instructions and safety protocols designed by PI for each RPD in their possession | Life of Equipment |
|  |  |  |  |
|  |  |  |  |

NOTE: Consult the Office Of Records Management, General Records Retention Schedule (EHS Records Retention Schedule), <https://policy.psu.edu/general-retention-schedule#EHS>, for additional detail on Record Retention requirements.

#### Additional Documented Information (SDS, etc.)

N/A

#### Additional Document and Recordkeeping Requirements

In addition to the records mentioned above, the PI or Authorized User of the radiation producing device is also required to maintain records of all maintenance, modification, and service records for the RPD.

### Minimum Program Inspections, Self-Audits, and Evaluations

The inspections, self-audits, and evaluations in this section represent minimum planned frequencies for these activities. Additional, more frequent inspections, audits, or evaluations may occur as needed to address regulatory changes, regulatory requests, observed trends, corrective actions, or other EHS concerns.

#### Minimum Inspections

##### Minimum Periodic Inspections

N/A

##### Minimum Work Unit Inspection

N/A

##### Minimum EHS Inspections

N/A

#### Minimum Audits

Labs with active Radiation Producing Devices shall be audited in person by the RPE Program Manager or other qualified EHS individual on a yearly basis but not to exceed 13 months between audits. The audit will confirm the PI’s RPD inventory, ensure all the proper control measures are in place and functioning as intended, safety features (such as interlocks, shutters, warning lights and required emergency shut-off switches) work as intended, and check all required documentation.

An audit is required for the following situations:

* Initial operation of a new RPD
* Annually
* After replacement of an X-Ray tube
* After any operations or maintenance involving the changing, adjustment, or removal of housing
* After a relocations to a different room/area (note: moves within a room can be waived by the RPO)
* During any maintenance that involves the defeat of interlocks so that the primary beam is exposed
* When a user reports an unusual condition in operation
* When a dosimeter shows greater than 25% of the allowable dose

*NOTE: There will be a forthcoming update to the 4th bullet point that will have effects upon RPD labs. Details, specific notifications, and a change to this section will be communicated shortly.*

Out-of-Service (i.e. inactive, awaiting repair, in storage, etc. see Appendix E) RPD need only be inventoried on a yearly basis. No in-person audit is required in these cases. The yearly inventory can be accomplished in-person or by sending pictures of the device’s information and location to the RPE Program Manager or other qualified EHS individual. If an Out-of-Service RPD is to be placed back into service, EHS must be notified and must perform a survey/audit before the unit can resume operations.

RPD Supervisors shall make a reasonable effort to work with the auditor in scheduling in-person audits or inventory checks. If multiple attempts have been made to schedule an audit with no success, the RPE Program Manager will visit the lab unannounced to complete the inventory within the required timeframe of one year. If a full audit, including the testing of safety devices, could not be completed, the device will be tagged as “Out of Service” in accordance with procedure and is not to be used again until a full audit is performed, and the results of the audit are shown to be satisfactory. If a RPD is used while considered “inactive” by the RPO, the lab and supervisor will be considered to be in non-compliance.

Any issues discovered during the audit will be shared with the Supervisor and kept on record with the RPO. Depending on the severity of issues, they may be corrected at the time of the audit, or an audit follow-up may need to be scheduled. Certain audit findings can warrant a work stop in the lab and the device to be placed OOS until the findings are corrected. Any issues found within the lab are assessed for risk and corresponding corrective actions are taken accordingly. If another qualified EHS individual is conducting the audit and finds an issue, the RPE Program Manager shall be contacted to determine necessary actions.

#### Minimum Program Self-Audits and Evaluations

##### Self-Audits

N/A

##### Customer support visits

A customer support visit may be completed by the RPE Program Steward and can be a more specific visit than an audit. A visit of a lab containing multiple RPDs or specific RPD may be warranted under certain circumstances. For example:

* The user has questions about control measure implementation.
* The new PRD Supervisor is setting up their work area for the first time.
* The existing RPD lab is adding a new device that has a different classification and different control measures and requirements than their previous device(s).
* The RPE Program Manager is following up on concerns from a previous audit to assist with implementation.

This visit may be prompted by questions, comments, observations, or feedback from a user, supervisor, owner, safety officer, or other EHS staff. These visits are not reoccurring and are not required unless specifically requested by the program steward in response to an incident or concern.

A customer service visit may take the place of the yearly audit, and reset the compliance calendar, if all checklist items for the annual audits, as described in section 7.4.2, and all RPD in a lab space are checked at the time of the evaluation. If all checklist items are not completed and all RPDs in the space are not checked, the annual audit will still take place at its scheduled time.

#### Program Metrics

A lab with a RPD will be considered in full compliance if they follow all requirements in this document, the referenced regulations in section 6.1.1, and any instruction from the Program Steward or RSO. This includes all audits listed in section 7.4.2 being completed by the RPE Program Steward or other qualified EHS personnel.

##### Out of Service for working rpd

A functioning device may be designated (see Appendix E) or tagged as Out of Service. This can occur for, but not limited to, the following reasons:

* When an imminent hazard exists or may exist as a result of operation or continued operation of a RPD
* An in-person audit, or inventory confirmation, was not completed within a 13-month period following the previous audit, evaluation, or installation of the device. If scheduling difficulties occurred between lab personnel and EHS staff or the RPE Program Manager, then the device shall be placed OOS until the audit is performed.
  + It is the RPE Program Steward’s or EHS personnel’s responsibility to initiate the process of scheduling an audit and keep track of the audit schedule. It is the user or Supervisor’s responsibility to make all reasonable accommodations for the audit to take place.
* An audit was not performed after a condition in bullets 3-7 in section 7.4.2.
  + It is the responsibility of the supervisor or user to notify the RPO in these cases.
* A RPD is brought back into service after repair and the RPO was not informed.
* The RSO or EHS Program Director determine that an unsafe condition exists in or around the laboratory associated with the continued use or operation of the RPD.
* As needed, or warranted, based upon increasing corrective action in accordance with the EHS escalation program.
  + For example: document up-keep, training lapses, unregistered devices, incorrect dosimetry usage.

The RPE Program Steward may determine that an entire RPD lab with multiple devices will all be placed OOS if significant safety hazards exist or multiple and reoccurring items from the above list persist. When the RPE Program Steward has determined the RPD lab or specific RPD to be placed OOS, they may not use their device(s) until the issue is resolved. An OOS designation on a working device can be attached to only one device and not the entire lab. For example: if the lab has multiple devices, but only one of them has an issue with its control measures, the lab may continue to use the other devices in their lab.

The use, or continued use of an RPD that has been placed OOS may result in additional corrective action IAW the Escalation Program.

#### Management of Change

Significant additions, deletions, or modifications of the requirements in this document will be communicated to all RPD Supervisors and Owners – along with the plans for implementation - before such changes become effective at the University. Supervisors will be given reasonable time (up to 6 months) to complete any changes before being expected to comply with updated regulations, policies, and audits.

## Control Measures and Requirements by RPD Type

### Radiation Producing Device Classification

Classification of RPD will be the responsibility of the RPE Program Manager and the RPO. When a new device arrives, or an existing device is found not to meet exemption requirements, the RPO will consider make, model, location and specific usage of the device when classifying. The device will be placed into one of the following categories:

* Closed-Beam Radiation Producing Device,
* Open-Beam Radiation Producing Device,
* Electron Microscope,
* Hand-Held greater than 50kV,
* Hand-Held less than or equal to 50kV (but greater than 5 kV),
* Shielded Room Radiography,
* Permanent Radiographic Installation,
* Veterinary,
* Accelerator, or
* Other.

For X-Rays used in the healing arts, see section 9.

If a device is created on University property, it is also subject to the requirements of this document and references listed in section 6.0. It shall be classified by the RPE Program Manager IAW the same factors used to classify purchased devices.

Depending on the classification given to the device, different requirements or control measures will be needed. The following sections describe the requirements for the types of classifications listed above.

### General Requirements

The following requirements are for all types of Radiation Producing Devices, regardless of classification. Sections 8.2.1, 8.2.3, 8.2.6.1, 8.6.2.2, 8.2.6.3, and 8.2.10 are normally covered by the manufacturer and need not be a concern of the supervisor during purchase or set-up. However, if the RPD is created within a laboratory (at Penn State or another academic or research organization), the creator of this device shall take into consideration these sections during design, manufacturing, and installation and consult with the RPO to ensure proper compliance with the above-mentioned regulations.

#### Warning Devices

An easily visible warning device light labeled with the words ‘‘X-RAY ON,’’ or words having a similar intent, must be located near every switch that energizes an X-ray tube and must be illuminated only when the tube is energized. In order for a warning device to meet the definition of “easily visible”, the operator of the device shall have a clear line-of-sight to the device during normal operation of the device.

NOTE: The descriptor “near” means visible by an operator when at the control panel or the switch that energizes the device.

This warning light must be of a fail-safe design. If the light is integral to the system and cannot be tested, it will be considered fail-safe if there is reason to believe it performs this function.

This warning light shall be labeled so that its purpose is easily identified.

#### Labeling

A radiation-producing device must be labeled with a readily visible and discernible sign or signs bearing the radiation symbol and the words: ‘‘CAUTION RADIATION—THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED,’’ or words having a similar intent, near every switch that energizes an X-ray tube.

NOTE: The descriptor “near” has been interpreted to mean that it must be visible by an operator when at the control panel or the switch that energizes the device.

For radiation-producing devices with designed openings for object entries, such as baggage units, the following must be posted at or near every opening: ‘‘CAUTION—X-RAY HAZARD: DO NOT INSERT ANY PART OF THE BODY WHEN SYSTEM IS ENERGIZED’’ or words having similar intent.

The RPO will supply both types of labels as needed. It is the responsibility of the user to inform the RPO if the labels they currently have are defaced or missing.

The label should also include language stating that the device is “TO BE OPERATED ONLY BE QUALIFIED PERSONNEL” or words having similar intent. This label can be separate from the one mentioned above.

#### Radiation and High Voltage Source Housing

If the X-Ray tube housing is the primary shield for X-Rays, and can be opened during normal operation, this housing must be equipped with an interlock that terminates high voltage if opened (see 8.2.6.3 for additional requirements for high voltage termination).

The radiation emission from this housing shall be less than 2.5mrem/hr at 5cm from any accessible surface.

High voltage sources must also be equipped with a protective housing that limits leakage radiation to less than 0.5mrem/hr 5cm form any accessible surface.

#### Surveys

Radiation surveys shall be competed at certain frequencies and under certain circumstances to comply with all applicable regulations. The following are instances where surveys shall be performed:

1. Upon Installation
2. At a period of at least every 12 months after the initial installation
3. Following any maintenance or changes to housing (before the device is returned to normal operation)
4. During maintenance if the primary beam is required and an interlock is defeated
5. Following the bypass of any safety device or interlock (or removal of any shielding)
6. An abnormal condition is noticed
7. Personnel Monitoring reveals a dose of more than 25% of the annual limit.
8. After the device is relocated to a new room or space (note: moves within a room can be waived by the RPO)

Surveys relating to items 2 and 7 are initiated by RPO personnel. It is a requirement of the user or supervisor to make reasonable accommodations for RPO personnel to fulfill these survey conditions. For the remaining instances (1, 3, 4, 5, 6, and 8), the duty falls onto the Users and Supervisors to inform the RPO that one has occurred, and a survey is needed.

The annual survey requirement can be postponed if the device is Out of Service. In this case, the annual audit will consist of an inventory confirmation and no survey will be conducted. The impetus then falls onto the User or Supervisor to inform the RPO when the device is brought back into service. The device will remain out of Service and unable to be used for normal operation until a survey is conducted by the RPO and the results are satisfactory.

Upon being notified by EHS of one of the above conditions was not met, or if an attempt was made to place the device back into service without EHS approval, it can be grounds for designating the device OOS as described in 7.4.4.1. The EHS Escalation Policy will be consulted for next steps.

#### Security

Any RPD must be secured from unauthorized use at all times. This can include locking the area the device is when not attended or having password protection on the computer or control panel that controls high voltage.

As a general rule-of-thumb, the device shall be kept in a state that an individual without knowledge of the SOP, or trained in the device’s usage, cannot operate the device accidently or intentionally.

#### Operating Requirements

A Standard Operating Procedure (SOP) shall be written and available to all users of the Radiation-Producing Device. An individual may not operate the device if they have not received training on the SOP. A user may also not operate the device in any manner not listed in the SOP unless they have written approval from the RPO to do so.

An individual may not bypass an interlock or remove shielding unless permission has been obtained from the RSO. If this permission is granted, a sign explaining the bypass or removal shall be posted during the specific work. A record of the bypass of a safety device shall also be created and maintained. This record shall contain the date of bypass, description of the bypass, the length of time the device was altered, the result of the post-bypass survey, and any other relevant information. This record shall be signed by the RSO and kept for 5 years.

##### Interlocks

An interlock may not be used to de-activate the x-ray except during an emergency condition or testing. If an interlock is triggered, it may only be reset from the control panel. All interlocks must be failsafe.

The failsafe nature of interlocks shall be designed into the system so that they are testable by the user/RPO. To be considered testable it shall be possible to isolate and evaluate each component to the extent necessary to detect failures.

Any devices currently owned and operated by Penn State on University property are acceptable in their current state if they do not meet this requirement. Any devices purchased after the release of this document (see section 15.0 for Rev. 0 date) shall be held to this requirement. If the manufacturer does not provide a device that meets this requirement, contact the RPO for assistance with communication to the manufacturer.

If a device fails an interlock test the device shall be immediately placed Out of Service until the issue is resolved.

#### Control Panel

The RPD can only be operated via a control panel. The indications and controls on this panel must be identifiable and discernable.

#### X-Ray Tube Interlock

Any system that contains an X-Ray tube shall be equipped with an interlock that prevents high voltage supply if the tube is removed from the device or if the housing is disassembled.

Any devices currently owned and operated by Penn State on University property are acceptable in their current state if they do not meet this requirement. Any devices purchased after the release of this document (see section 15.0 for Rev. 0 date) shall be held to this requirement. If the manufacturer does not provide a device that meets this requirement, contact the RPO for assistance with communication to the manufacturer.

#### Repair or Modification of RPD

Only trained personnel or registered service providers may install, repair, or make modifications to a RPD. An operation involving the removal of covers, shielding materials, or housings, or an operation involving the modification of shutters, collimators, or beam stops, may only be performed after assessing that the tube is off and will remain off until a safe condition has been restored. The main power switch with a LOTO, as opposed to the interlock, shall be used for routine shut-down.

#### Instruction and Training

General training requirements are outlined in section 7.2.1

In addition to those requirements, users shall be trained on the specifics of their device by a qualified individual. This can include the manufacturer, the supervisor, or another user proficient if the device’s operation. This training should include specifics on the set-up, operation, and emergency procedures for that specific device.

Supervisors shall have a system in place to track all users’ specific training on the device(s) under their purview. This can include a physical or digital course record or sign-up sheet. There shall be a copy of this list, that is easily presentable during a survey or audit, for each device the supervisor oversees.

#### Controlled Areas

Any controlled area that can be credibly accessed shall be identified by an appropriate and recognizable warning sign posted at each entrance. This sign should include language that conveys the following message, or something similar: **Warning: X-Rays in Use Contact [Insert RPD Supervisor] for Access.**

This requirement does not include those controlled areas that are already protected by an interlocked enclosure or room. If a controlled area can be accessed without defeating interlocks, or is too small to be occupied by an individual, it is not considered credibly accessible.

#### Uncontrolled Areas

The dose to an individual within an Uncontrolled Area shall be kept below those levels listed in 10 CFR 20 Subpart D (2 mrem in one hour and 100mrem in one year).

It is recommended that the dose equivalent received by individuals in an Uncontrolled Area should not exceed 0.5mrem in any one hour.

#### Primary Beam Attenuation

The dose rate due to the transmitted primary beam (with or without a beam stop. See 8.5.5) should not exceed 0.25mrem/hr under normal operating conditions. If the dose rate outside of the enclosure, shielding, or permanent fixture near the device is greater than this limit in the direct path of the beam, it is recommended that more shielding be added.

#### Posting

All labs or spaces that contain active RPD shall be posted with *The Commonwealth of Pennsylvania Department of Environmental Protection “Notice to Employees”* and the *Penn State Notice to Employees* forms. The RPO will provide these forms to RPD users upon installation of a new device. It is the responsibility of the Supervisor or User to notify the RPO if the postings are removed or lost for any reason, or if replacement forms are needed.

#### Emergency Stop Testing

If an Emergency-Stop button has the potential to damage part of the Radiation Producing Device, the user may ask for an alternative testing method. An appropriate alternative E-Stop test can include powering down the device fully, depressing the E-Stop button, and then attempting to turn the device back on with the button still depressed. If the machine does not start, it can be assumed hat that the button functions as intended. Any alternative method for E-Stop testing used shall be recorded in detail on the audit form.

### Closed-Beam Radiation-Producing Devices

The following requirements, in addition to those in 8.2, apply to all devices classified by the RPO as Closed-Beam Radiation Producing Devices. Sections 8.3.1, 8.3.2, and 8.3.3 are normally covered by the manufacturer and need not be a concern of the supervisor during purchase or set-up. However, if the RPD is created within a laboratory (at Penn State or another academic or research organization), the creator of this device shall take into consideration these sections during design, manufacturing, and installation. Please consult the RPO if the RPD was not created by an approved vendor of RPDs.

#### System Enclosure

The radiation source, sample or object, detector, and analyzing crystal (if used) of a Closed-Beam RPD shall be enclosed in a chamber that prevents any part of the body from entering during operation.

#### Interlocks

The enclosure mentioned in 8.3.1 shall be interlocked to prevent casual entry into the enclosure. The interlocks must be fail-safe in design and be on every entrance into the enclosure. Interlocks include those features that will automatically close the shutter or terminate high voltage when the enclosure is opened. They can also include mechanisms that physically lock the enclosure when any high voltage is applied to the x-ray tube.

#### Emission Limit

The radiation limit 5 centimeters from any accessible surface on the exterior of the enclosure must not read more than 0.5mrem/hr.

### Electron Microscopes

Electron Microscopes shall follow all of the requirements outlined in 8.2, as well as the Emission Limit requirement in 8.3.3

### Open-Beam Radiation-Producing Devices

The following requirements, in addition to those in 8.2, apply to all devices classified by the RPO as Open-Beam Radiation Producing Devices. Sections 8.5.1, 8.5.2, 8.5.3, and 8.5.4 are normally covered by the manufacturer and need not be a concern of the supervisor during purchase or set-up. However, if the RPD is created within a laboratory (at Penn State or another academic or research organization), the creator of this device shall take into consideration these sections during design, manufacturing, and installation. Please consult the RPO if the RPD was not created by an approved vendor of RPDs.

#### X-Ray Status Lights

Open-Beam devices shall have a conspicuous and active indication that the X-Ray tube is “on” or “off”. This status indicator shall be located near the source housing. The warning light from 8.2.1 fulfills this requirement.

They shall also have a conspicuous and active indicator of the shutter “Open” or “Closed” status if the beam is controlled with a shutter. There shall be a light for each shutter the device has. This indicator can be on the control panel described in 8.2.6.2 so long as the indicator is visible to anyone near the primary beam.

Both of these indicators shall be fail-safe in design.

#### Labeling

In addition to the labeling requirements in 8.2.2, the device shall be labeled with language similar to that in 8.2.2 on each beam port exit.

#### Shutters

Shutters shall be designed so that they cannot be opened if an interchangeable component is not coupled to the beam port.

#### Radiation Emission Limits

Radiation emissions in any area surrounding the local components or housing shall not be in excess of the occupational dose limits outlined in 10 CFR 20 Subpart C (5rem whole body dose and 50rem extremity dose). Any dose to an individual in an area surrounding the device shall be kept below the limits outlined in 10 CFR 20 Subchapter D (100mrem in a year or 2mrem in an hour).

Local components or extra shielding should be arranged to limit radiation to those limits listed above. Consult RPO if extra shielding is required to meet these conditions, or a change to the local components is made.

All radiation limits, excluding the primary beam, shall be met at any tube rating established by the manufacturer.

#### Primary Beam Attenuation

In cases where the primary beam is not intercepted by the detector device under all conditions of operation, protective measures, such as auxiliary shielding or administrative procedures, shall be provided to avoid exposure to any individual from the transmitted primary beam.

In cases where the primary beam is not intercepted by a detector device, but is instead intercepted by a permanent fixture of the device’s location (i.e. fume hood, cabinet, or the wall of the room), the RPO shall determine if extra shielding, or administrative procedures, are required to keep all individuals out of the path of the primary beam and below the limits outlined in 8.5.4.

#### Operator Attendance

The operator shall be present at all times when the equipment is in operation except when the area is locked, or the equipment is secured to protect against unauthorized or accidental entry.

#### Access Control

If the RPD is not in a restricted area (see section 4) the operator shall control access to the area at all times during operation.

If this is the case, all radiation areas and high radiation areas shall be clearly identified and labeled and the operator shall conduct a visual check of the controlled area, immediately prior to operation of the source, to ensure that no individuals are present.

#### Instruction and Training

In addition to the requirements in 7.2.1 and 8.2.7, additional, more detailed, training for users and supervisors of certain unit(s) or space(s) may be required on a case-by-case basis as determined by the RSO and Program Steward, commensurate with the hazards and uses of the unit(s) and space(s). The RPO is responsible for ensuring all users of Open-Beam RPD receive training in the appropriate areas as defined by the DEP regulations. The supervisor is responsible for ensuring all users have followed the requirements outlined in 8.2.7.

### Hand-Held Radiation Producing Devices

The following requirements, in addition to those in 8.2 and 8.5, apply to all devices classified by the RPO as Hand-Held Radiation Producing Devices Greater Than 50kV. If the Hand-Held Radiation Producing Device operates at a tube voltage potential of less than or equal to 50kV, see 8.6.1 for requirements.

Section 8.6.4 is normally covered by the manufacturer and need not be a concern of the supervisor during purchase or set-up.

#### Exemptions

Any Hand-Held RPD operating at less than or equal to 50kV is exempt from 8.5 and 8.6. In addition, these devices are exempt from the requirements in 8.2, except for 8.2.2 (Labeling), 8.2.5 (Security), 8.2.6 (only relating to SOP creation and usage), and 8.2.7 (Instruction and Training).

If the device will be operated in the user’s hand and not in an enclosure, 8.5.5 shall also be followed.

#### Procedures

In addition to the normal operating and emergency procedures contained in the SOP, the SOP shall also contain: instructions to not hold the sample during operation, instructions to not point the device at any personnel, including themselves, and instructions on how to keep the user’s dose ALARA.

#### Training

Users shall be specifically trained in the procedures listed in 8.6.2. Records of this training should be included with the records from the training described in 8.2.7.

#### Emission Limit

Conditions for 8.2.3 shall be considered met if all emissions, excluding the primary beam, are less than 2.5mrem/hr at 5 cm from any accessible surface. This includes any scattered radiation from the primary beam.

#### Security

When not in use the device shall be placed into two locked enclosures, or a single locked enclosure secured to an immovable object, to prevent use or removal from storage location. “Enclosure” in the sense of this requirement can be defined as a room or building if it is secure. However, only one of the enclosures can be a large space. For example: if the device is locked in a case and the case is located in a secure building, the requirement will be considered fulfilled. The requirement would not be fulfilled if the device was in a secure room within a secure facility.

This requirement is not in effect when the device is traveling or being used in the field. In those cases, only one locked enclosure is required.

##### Emission Interlocks

The device shall have the ability to prevent the emission of x-rays, or immediately stop the emission of x-rays, if the opening is not within 1cm of a target material that encompasses the entire beam. Small samples that do not encompass the entire beam shall be analyzed within a sample enclosure.

Any devices currently owned and operated by Penn State on University property are acceptable in their current state if they do not meet this requirement. Any devices purchased after the release of this document (see section 15.0 for Rev. 0 date) shall be held to this requirement. If the manufacturer does not provide a device that meets this requirement, contact the RPO for assistance with communication to the manufacturer.

RSO approval is required for the purchase of a new instrument that does not meet this requirement.

### Bomb Detection RPD

The following requirements, in addition to those in 8.2, apply to all devices classified by the RPO as Bomb Detection Radiation Producing Devices.

#### Control Panel Security

Any bomb detection RPD, or the control panel of the device, shall be locked away when not in use to prevent unauthorized use.

#### Use Log

The user shall maintain a use log for each bomb detection RPD. This log shall contain the date removed from storage, signature of the user, dates and times of use, site where it was used, and date returned to storage.

#### Area Control

The operator of the bomb detection RPD shall restrict entry from unauthorized individuals into the area where the device is in use during operation. Unauthorized individuals are those without dosimetry and without the training described in 8.2.7.

### Permanent Radiographic Installations

The following requirements, in addition to those in 8.2, apply to all devices classified by the RPO as Permanent Radiographic Installations.

#### Entrance Controls

Permanent Radiographic Installations shall follow the requirements from 10 CFR 20.1601 and 10 CFR 20.1902. These requirements are as follows:

* The entrance or access point shall have at least one of the following:
  + A device that, upon entry, causes the level of radiation to be reduced below the point where an individual could receive 100mrem in 1 hour 30cm from the source of radiation.
  + A device that energizes a visible or audible alarm signal so that the individual entering the area and the operator are aware of an entry
* Entryways are locked, except when the area needs to be entered, with positive control over entry. In order to keep positive control over an entry it shall only be accessible to authorized users at any given time of day. This can mean locked when no one is at the controls and visually monitored when someone is.
* The previous requirement can be substituted with a continuous monitoring system
* All controls shall be established so that exit from the area is not prevented.
* The area is posted properly as a radiation, high radiation, or very high radiation, area.

In addition to those requirements listed above, each entrance shall have a visible and audible warning signals to warn of the presence of radiation. The visible warning shall be activated when the tube is energized and the audible warning shall be activated when an attempt is made to enter the area when the tube is energized.

The visible and audible warnings shall be tested at the beginning of each day of use and a record of these tests shall be kept for 5 years.

### Shielded Room Radiation Producing Devices

The following requirements, in addition to those in 8.2 and 8.8, apply to all devices classified by the RPO as Shielded Room Radiation-Producing Devices.

#### Control of Access

A room used for shielded room radiography must be shielded so that any location outside of the room meets the requirements for unrestricted access as listed in 8.5.4. In addition, all openings to the room shall be interlocked so that the device cannot operate unless all openings are secure.

In addition, the Operating Procedure shall include a step for the operator to check for any possible occupancy of the shielded room prior to energizing the tube. This can be accomplished by a visual check or “walk-down” of the area, or a continuous monitoring system that allows the operator to see the high radiation area from the controls of the device.

#### Radiation Monitoring

The supervisor of the device can choose to monitor radiation in one of two ways. The supervisor can permanently install a radiation monitoring system that continuously monitors radiation inside the room and displays radiation levels conspicuously to the operator. They may also acquire a hand-held radiation monitor and create a procedure for the operator to confirm the source has de-energized before entry into the room. Regardless of which method is chosen, the SOP shall be written to include a procedure step for either checking the radiation monitoring device or performing a radiation survey prior to entering the shielded room.

#### Internal Warning Signal

Visible or audible warning signals shall be provided within the enclosure depending on the exposure levels within. The visible/audible signal shall be activated when the dose levels within the enclosure exceed 100mrem/hr and remain activated during the entire exposure. If an audible signal is used, it should be audible to the operator of the radiation source.

Any devices currently owned and operated by Penn State on University property are acceptable in their current state if they do not meet this requirement. Any devices purchased after the release of this document (see section 15.0 for Rev. 0 date) shall be held to this requirement.

#### Exception

The user is exempt from the requirements of 8.9.3 if the enclosure has a minimum of two interlocks. One of these interlocks shall be designed in a way that any physical opening of the enclosure room door results in a disconnection of the energy supply to the high-voltage generator.

#### Signage

In addition to Radiation or High Radiation Area postings, signage with language indicating the need for a radiation detecting instrument is required. The signage shall include language similar to the following: ENTERING A RADIATION EXPOSURE ROOM: RADIAITON DETECTION EQUIPMENT REQUIRED.

The device will be exempt from this requirement if the permanently installed radiation monitoring system method from 8.9.2 is used instead of the hand-held radiation detection device.

#### Internal Emergency Stop

In the event that an individual is within the enclosure during instrument start-up or operation, there shall be an emergency stop button capable of cutting power to the x-ray tube within the enclosure of the Shielded Room.

#### Emission Limits

The dose equivalent and any accessible uncontrolled area shall not exceed 2mrem/hr at 30cm from the outside surface of the enclosure. This requirement shall be met at maximum operating parameters. A simulated target shall also be used to ensure scattered radiation is taken into account when checking for emissions from the shielded room.

#### Testing Records

In addition to the testing requirements and records listed in 8.8.1 for all visible and audible waring controls, users of shielded room RPD shall also record daily checks for the radiation monitoring devices listed in 8.9.2. All of these checks shall be recorded in a log that also includes the user’s name, date and time of operation, purpose of operating, and operating parameters.

### Veterinary Radiation Producing Devices

The following requirements apply to any device used for veterinary medicine that is also not enclosed as described in 8.3.1. If the device is used for veterinary medicine and is enclosed, it can be considered a Closed-Beam RPD and the requirements listed in 8.3 shall be followed.

Sections 8.10.3, 8.10.4, and 8.10.5 are normally covered by the manufacturer and need not be a concern of the supervisor during purchase or set-up.

#### Shielding

A facility used for veterinary procedures shall have sufficient shielding to assure compliance with 10 CFR 20 Subchapter D (100mrem in a year or 2mrem in an hour) for individuals outside of the operating area.

#### Operating Procedures

Any individual whose presence is not required to conduct the X-Ray procedure shall either be 2 meters away from the x-ray source or behind a shield designed as specified in 8.10.1. Any individual whose presence is required and will not be 2 meters away from the source or behind a shield, shall wear appropriate PPE such as lead aprons or gloves that offer at least a 0.25mm lead equivalent protection.

Restraining devices shall be used during X-Ray procedures to hold animals in position when the technique permits. If restraints are not feasible for the technique, and an individual needs to hold the animal, that individual shall wear protective shielding that includes a lead apron, lead thyroid shield, and lead gloves that offer at least a 0.25mm lead equivalent protection.

#### Leakage Radiation

The leakage radiation from the tube’s housing assembly, with a beam limiting device, measured at a distance of 1 meter in and direction may not exceed 87.7 mrem/hr (100mR/hr) when the tube is operating at maximum factors.

The leakage radiation from any other component may not exceed 1.75mrem/hr (2mR/hr) when measured at 5cm from any accessible surface at normal operating parameters.

#### Beam Restriction

The beam shall be restricted to the area of clinical interest and equal to or smaller than the mage receptor. Any collimating devices needed to restrict the beam to the appropriate image receptor to 2% of the source to image distance shall be provided as well as a means to align the center of the x-ray field.

#### Exposure Control Devices

An exposure control device shall be provided to terminate the exposure after a preset time interval, preset product of current and time, a preset number of pulses, or a preset radiation exposure to the image receptor. Termination of an exposure shall cause automatic resetting of the timer to its initial setting or to zero. It may not be possible to initiate an exposure with the exposure control device in the zero or off position, if either position is available, unless equipped for current adjustment. A means shall be provided to initiate the radiation exposure by a deliberate action on the part of the operator such as the depression of a switch. The switch shall be of the dead man type.

Veterinary portable X-ray units shall be supported by a tube stand when the technique permits unless the unit is designed to be hand held during X-ray procedures.

The X-ray control shall provide indication of the production of X-rays that is observable from the operator’s position. The technique factors that are set prior to the exposure shall be indicated on the X-ray control and shall be visible to the operator from the operator’s position.

#### Fluoroscopic Equipment

If the veterinary RPD is of the fluoroscopic type, please contact RPO for further information and guidance.

### Accelerators

Accelerators have their own set of state-regulated requirements outlined in section Chapter 228 of the Pennsylvania Code. Due to the unique nature, and hazard level, of accelerators the RPO shall be involved in the process of acquisition and control measure implementation.

When acquiring an accelerator, more requirements exist than just those listed in section 12.0 of this document. The RPO should be contacted about an accelerator purchase as soon as plans to purchase the device are made and shall be contacted at least 120 days before the actual purchase of the device. This is to ensure ample time is given to the RSO to prepare an accelerator license and to the RPO staff for assistance with shielding design of the facility. Multiple administrative and engineering control measures are required before accelerator installation and operation.

Requirements in the “Rules and Procedures for Use of Radioactive Material at The Pennsylvania State University” document located on the EHS website may also need to be followed if the device can activate materials into a radionuclide.

Contact the RPO for guidance on Accelerators.

Note that some devices may be labeled, sold, or identified as an “accelerator,” but may not require the safety measures that go along with accelerators as defined in this section and this document (as well as the PA state code).

### X-Ray Spectroscopy (XPS)

#### Requirements

X-Ray Spectroscopy devices are not required to be included in the Radiation Producing Equipment program. Requirements from sections 7.0 and 13.0 do not apply. However, the acquisition requirements from paragraph 2 of section 12.0 apply to these devices.

When a new XPS device is acquired, the RPO or RPE Program Manager shall be notified in order to conduct an initial survey of the device. This survey is only required at the acquisition of the device and is not a yearly requirement.

The device shall not have measurable radiation greater than 0.25mrem/hr (0.285mR/hr) at 5cm from any accessible surface. If the device passes this requirement, it is exempt from this program. If the device does not pass this requirement, then the requirements in section 13.0 shall be followed to determine if it belongs in the Radiation Producing Equipment program.

## X-Rays for Healing Arts

If you own, operate, or plan on purchasing a Radiation Producing Device to be used on humans, the RPO must be contacted to provide instruction as early in the process as possible, and significantly before energizing the x-ray or exposing any individuals.

After contacting RPO, follow instructions in Section 12.0 if you intend to acquire, transfer, or dispose of a PRD used in the healing arts.

## Dosimetry

This section describes the requirements, recommendations, and uses for dosimetry for the University’s X-Ray program. The requirements and recommendations in this section do not reflect those of the Radioactive Material Program’s dosimetry usage.

### Overview

The Pennsylvania State University requires personnel monitoring for radiation exposure of certain individuals working with radioactive sources, including Radiation Producing Devices (X-Rays). Personnel dosimetry monitoring of users is dependent on the type of radiation-producing instrument in use and the scope of the work to be performed. Users of veterinary, medical and most Open-Beam Radiation Producing Devices are required to wear whole body and extremity dosimeters. For Closed-Beam Radiation Producing Devices, dosimetry is usually not required. However, individuals responsible for performing beam alignment or maintenance of the system that requires the presence of an open beam configuration are required to wear some form of personnel dosimetry monitoring.

It is the discretion of the Radiation Protection Office to make the final decision on the need for dosimetry monitoring and the types of dosimeters that are used. The RPO will take into account regulations, industry standards, best practices, and potential hazards to determine dosimetry usage.

### Whole Body Dosimeters

As a general rule-of-thumb: All medical units, radiography units, and veterinary units require whole body dosimetry at Penn State. There are, however, a few exceptions to veterinary and radiography units. If the unit is fully enclosed and interlocked, whole body dosimetry is not required.

Whole body dosimetry is also offered for certain Open Beam Radiation Producing Devices. Open-Beam RPD units that have the potential for exposure greater than that of the public dose limits (2mrem [2.3mR] in an hour) or where the designation of a controlled area is required, shall have users with Whole-Body Dosimetry. A controlled area is any area where there is the potential to receive over 100mrem (115mR) in a given year.

A common device that fits this designation is hand-held XRF units that are not operated in their mounted enclosures. These units that are operated without shielding, can result in larger doses if used improperly and often emit exposure rates >2mR/hr within 1 foot (30cm) of the housing.

Note: Stationary enclosures can be used with hand-held XRF instruments. When the instrument is within it’s enclosure, the only area where dose has been recorded is around the area of the trigger. In this case, whole body dosimetry is not required or recommended as there is no measurable exposure >2mR/hr around the instrument.

Whole-Body Dosimetry can also be provided to anyone using Open-Beam RPDs that do not require the designation of a controlled area or have the potential for a dose rate of >2mrem/hr (2.3mR/hr). These dosimeters will be granted on request for any user who would like one for a trial basis. The quarterly dose reports from these dosimeters will be closely watched over multiple quarters and if no dose is detected, the need for these dosimeters will be revisited.

If an enclosure for a Closed-Beam Radiation Producing Device can be defeated during operation, a Whole-Body Dosimeter shall be worn during this process.

### Extremity Dosimeters

Extremity dosimetry is required for Closed and Open Beam Radiation Producing Devices where the user will be preforming alignment or a procedure with an open-beam configuration. Extremity dosimetry is not offered to users of medical or radiographic installations. However, if a user of one of these units opts/asks for extremity dosimetry it will be provided to them. In this case, the dose reports for the extremity dosimetry will be watched over multiple quarters and if no dose is detected, the need for extremity dosimetry will be revisited.

Extremity dosimetry is also not usually offered for veterinary units unless the user will be holding the animal down for the purpose of the x-ray exposure. If this is the case, the user will be required to have extremity dosimetry.

Extremity dosimetry is required for Hand-Held XRF units when the unit is within it's enclosure. Because there is still detectable dose around the trigger area, a ring badge must be worn on the hand operating the instrument.

## Lead Apron Policy

Lead, or lead-equivalent, aprons are required for the use of some medical X-Ray devices and some open-beam veterinary devices.

PPE should be stored in a hanging or flat position. Storage involving folding should be minimized as this can lead to increased wear and probability of defects in the PPE over its useful lifetime.

Usage Requirements

They shall be worn during all operations of the X-Ray device where the user is in the same room as the X-Ray, unless the user is standing behind a protective barrier or at least 2 meters from the primary x-ray beam.

All lead aprons and lead accessories (including thyroid shields and gloves) shall be checked on a regular basis for any damage. The frequency of which can be as often as the user likes, but not to exceed one calendar year. These checks shall be documented. In addition, spot checks are strongly recommended, and should be conducted within one week prior to use.

The check for damages needs to consist of a visual and tactile spot-check of the full apron and accessories. This can be done by placing the apron on a flat surface or holding it up to a light. Ensure there are no obvious visual defects on the surface of the apron or prominent tactile defects within the apron. If a supervisor would like to perform a radiographic inspection of an apron as a mechanism to identify defects, they may do so, but it is not recommended. If such an evaluation is conducted and the apron passes, the results should be summarized and documented. The documented results should be shared with EHS and maintained for the life of the apron and be made available for review upon request. If any major defects are discovered (see below), the lead apron should be disposed of and replaced, or repaired by the manufacturer. If minor defects are detected, the apron can remain in service.

Major defects include, but are not limited to:

* Voids larger than 1.5cm^2 (about half the size of a dime)
* Loss of one of the layers of shielding material (some aprons can have 4+ layers of material inside depending on their lead equivalency). This material can come detached and fall to the bottom of the apron.
* Failure of a fastening device.

This is just a guideline to assist the supervisor in determining if a defect is major or minor. The supervisor wearer may still decide that a minor defect warrants repair or replacement. If during a visit, the inspector deems that a defect is major, the apron will be removed from use and tagged out of service.

Non-visible defects (ones that are not detectible by the human eye) such as pinholes, or scratches will not pose any harm to the wearer. For this reason only a visible and tactile check is required. The aprons do not need to be X-rayed to discover defects smaller than can be detected by the human eye.

Part of the visual inspection should also include an inspection of the fastening, attachment, or support mechanisms (i.e., shoulder straps). Any observable signs of failure in these should be treated as a major defect, as these could lead to the PPE falling out of position during use.

If desired, the RPO can conduct lead apron inspections and recommend further action based on findings.

Disposal

Lead is a hazardous material, and its disposal should handled with care. Dispose of leaded and lead-equivalent garments in accordance with established procedure. Contact EHS for questions or instructions when disposing of such articles.

## Acquisition, Relocation, Transfer, and Disposal of Radiation Producing Devices

### Acquisition

Faculty, supervisors, and users are strongly encouraged to consult with EHS or RPO as early as possible prior to ordering or installing any Radiation Producing Device. EHS can provide useful information concerning appropriate safety features, suitability of installation location and the safe operation of the equipment. EHS performs registration of all radiation-producing instruments, which is required by the PA DEP BRP and must take place within 30 days of the device arriving on-campus, even if the unit is not immediately placed into service. This includes, but is not limited to, any instrument maintained in storage or donated to the University. For this reason, all RPD owners are required to notify EHS upon device arrival, and will be asked for the make, model, and serial number of each new device at or before the time of arrival.

Once installed, the supervisor must contact EHS and arrange to have the device inspected for required labeling, safety devices, radiation levels, and evaluation of the location to assure user and non-user safety. This also applies to relocation of current devices to another University location. The device may not be put into routine service and operation until approved by EHS.

### Relocation

Relocating a radiation producing device requires an additional survey and audit in almost all cases. Supervisors or Owners preparing to relocate a device (even if the device remains in the same room or will see similar use) are required to notify the RPO. Surveys and audits following a relocation help to verify that an unintentional modification or shifting of internal shielding and components has not occurred.. The RPO, at their discretion, may decide that an audit after a relocation is not warranted if the device has not left the room or suite that it was originally located in. An RPD that has been relocated cannot be placed back into service until EHS has provided approval, which typically follows a survey or audit.

### Transfer

Transferring a device to another supervisor within the University may require a safety evaluation of the new supervisor's radiation safety training status.

Instruments being transferred, donated, or sold to another institution, company, or individual, require a written notification to the PA DEP BRP, which will be provided by EHS. To facilitate this notification, Supervisors are responsible for informing EHS prior to the transfer of the equipment.

### Disposal

Supervisors must also inform EHS when a system is permanently removed from service and is to be either disposed of or used for parts. EHS is responsible for notifying the state that these systems are no longer in service and they will be removed from the University's inventory.

Disposal of radiation-producing equipment through University salvage must take into account the proper disposal of all hazardous substances. Lead, oils, and x-ray tubes containing beryllium must be removed and disposed of as hazardous waste. Contact EHS or RPO for guidance on proper disposal.

## Devices That Produce Radiation Incidental to Operation

Due to the effects of Bremsstrahlung Radiation, some electronic devices may produce radiation incidental to their operation. This can occur in any device that accelerates electrons into a target. The main example of one of these devices is an Electron Microscope. Any such device, except electron microscopes (which are covered in Section 8.1) - **if** it is shown to meet certain dose rate requirements - is exempt from requirements listed in this document and PA DEP BRP Rules and Regulations. If you suspect that your device could fall into this category, please contact EHS or the RPO so a confirmation survey can be conducted.

### Survey and Testing

The RPO has the duty and ability to test these devices to determine whether program requirements apply, or if such a device can be exempted from the requirements as described above. Testing may involve an initial survey, or data collection spanning several months (or both of these measurement types). The data collection shall be done by placing a whole-body dosimeter in an accessible area near the device for a period of 6 months. This area shall be the worst-case area for dose that an operator can access. After the 6 month period is up, the dose on the dosimeter will be extrapolated to a full year and a determination for the status of the device will be made by the RPO. The device will be considered exempt for the duration of the 6-month testing period. Upon testing, if results from the device are found to fall under the dose limit, the device is exempt from the requirements described in this program description. However, the RPO may still track the device and conduct follow-up surveys if requested by the PI or others in the community. However, if, upon testing, the dose results from the device are greater than the dose limit for exempt devices, the device will be considered a Radiation Producing Device and all applicable requirements in this document will be followed. For the cases described in this paragraph, the RPO will provide direction as to which sections of this document are applicable to the specific device in question.

## Revision History

|  |  |
| --- | --- |
| Revision Date | Purpose or Description |
| 2/9/2024 | Initial Creation |
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## Guidance for X-ray Control Measures by Type

The following is a list of all RPD classification types and the corresponding sections in the document to be followed. All devices are to follow the requirements in section 12.0 and (if applicable) section 14.

## X-Rays used in the Healing Arts:

* [7.2.1](#_Training_Requirements_1)
* [9.0](#_X-Rays_for_Healing)
* [10.0](#_Dosimetry)
* [11.0](#_Lead_Apron_Policy)

## Veterinary X-Rays:

* [7.2.1](#_Training_Requirements)
* [8.10](#_Veterinary_Radiation_Producing)
* [10.0](#_Dosimetry)
* [11.0](#_Lead_Apron_Policy)

## Accelerators:

Contact EHS for guidance and direction when working with accelerators as requirements include, but may not be limited to:

* [7.2.1.3](#_Radiation_Producing_Equipment)
* [7.2.1.5](#_Open-Beam_Radiation_Producing)
* [8.11](#_Accelerators)
* [10.0](#_Dosimetry)

## Closed-Beam Radiation Producing Devices:

* [7.2.1.3](#_Radiation_Producing_Equipment)
* [7.2.1.4](#_Radiation_Producing_Equipment_1)
* [8.2](#_General_Requirements)
* [8.3](#_Closed-Beam_Radiation-Producing_Dev)

## Open-Beam Radiation Producing Devices:

* [7.2.1.3](#_Radiation_Producing_Equipment)
* [7.2.1.5](#_Open-Beam_Radiation_Producing)
* [8.2](#_General_Requirements)
* [8.5](#_Open-Beam_Radiation-Producing_Devic)
* [10.0](#_Dosimetry)

## Electron Microscopes:

* [7.2.1.2](#_Electron_Microscope_Training)
* [7.4](#_Electron_Microscopes)

## Hand-Held Radiation Producing Devices:

* [7.2.1.3](#_Radiation_Producing_Equipment)
* [7.2.1.5](#_Open-Beam_Radiation_Producing)
* [8.2](#_General_Requirements)
* [8.6](#_Hand-Held_Radiation_Producing)
* [10.0](#_Dosimetry)

## Bomb-Detection Radiation Producing Devices

* [7.2.1.3](#_Radiation_Producing_Equipment)
* [7.2.1.5](#_Open-Beam_Radiation_Producing)
* [8.2](#_General_Requirements)
* [8.7](#_Bomb_Detection_RPD)
* [10.0](#_Dosimetry)

## Permanent Radiographic Installation:

* [7.2.1.3](#_Radiation_Producing_Equipment)
* [7.2.1.4](#_Radiation_Producing_Equipment_1)
* [8.8](#_Permanent_Radiographic_Installation)
* [10.0](#_Dosimetry)

## Shielded Room Radiography:

* [7.1.2.3](#_Radiation_Producing_Equipment)
* [7.1.2.4](#_Radiation_Producing_Equipment_1)
* [8.9](#_Shielded_Room_Radiation)
* [10.0](#_Dosimetry)

## Specific RPD Training Signature Form

|  |  |  |  |
| --- | --- | --- | --- |
| RPD Supervisor: |  | Serial Number: |  |
| Device Location: |  | Device Type: |  |

Your signature below indicates that you have received training on the specific listed above. The training includes the Standard operating procedure, maintenance procedures, and emergency procedures as applicable associated with the listed device.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Date** | **Printed Name of Person Receiving Training** | **Signature of Person Receiving Training** | **Trainee User ID  (i.e., abc123)** | **Name of Person Giving Training** |
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Sign-in Sheet Page #\_\_\_\_\_ of \_\_\_\_\_\_

## Incident & Emergency Response Procedures

**RADIATION PRODUCING EQUIPMENT EMERGENCY PROCEDURES:**

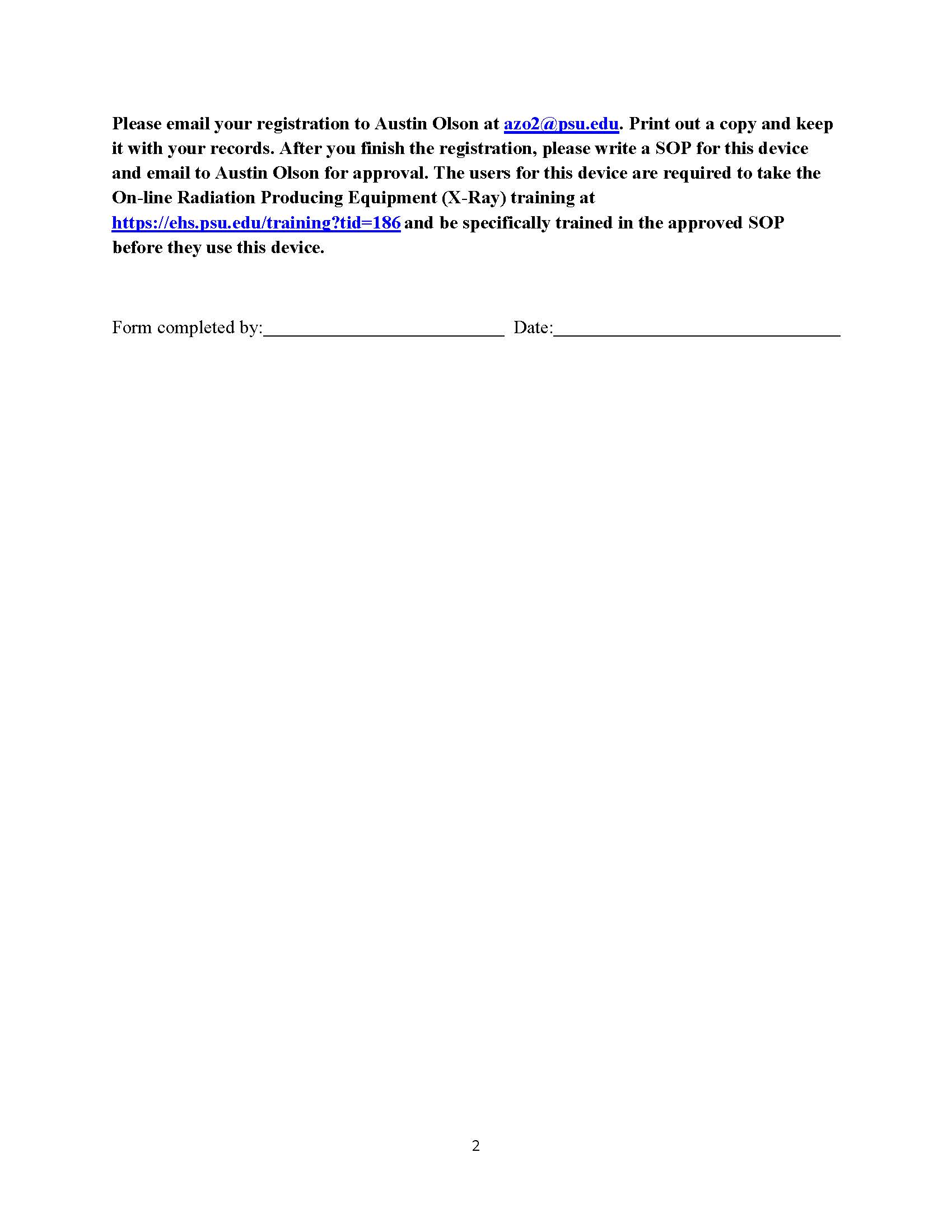
Exposure to the primary beam of an analytical or radiographic x-ray source may result in serious injury. If a situation arises where an individual is accidentally exposed to the primary beam of a radiation-producing instrument, or if you suspect that an individual has been exposed, the following actions are to be taken immediately:

* **If this is a life threatening emergency, such as electrical shock, fire, etc., dial 911 for emergency response.**
* Shut off the x-ray equipment and secure it from use by other individuals.
  + Engage the Emergency-Stop button if applicable. If the device does not have one, unplug the device from the wall or remove the power source.
  + If you are the only individual in the area at the time of the incident, secure the instrument before exiting the area. If another individual is nearby, have them ensure security of the equipment while you continue to follow the emergency procedure.
* Do not change the experimental or equipment configuration.
  + The exposed individual's dose can best be evaluated and reconstructed if the system set-up is not altered in any way following the event.
  + Taking note of the time and distance from the X-ray housing during the potential exposure also greatly helps with dose evaluation.
* Contact the RPO at (814) 777-0215. Inform them that an individual working with an x-ray device may have received an accidental radiation overexposure and that you need to contact the Radiation Safety Officer immediately.
  + The Radiation Safety Officer, or other Radiation Protection Office staff, will inform you on any next steps to be taken.
* Inform the supervisor of the system of the accident.

In conjunction with the individual involved, system supervisor, and respective department safety officer, EHS will begin an investigation as to the circumstances of the event. The system in question will be tagged out of service by EHS pending the results of the investigation and completion of any corrective actions, if needed. EHS is responsible for notifying the PA DEP BRP within 5 days of the occurrence, even if it is later determined that no accidental exposure occurred. The system may only be returned to service following written approval from the Radiation Safety Officer and once the out of service tag has been removed by EHS.

## Registration Form

A close-up of a form

Description automatically generated

## Out of Service

Out of Service RPDs usually fall into one of 3 categories: Devices that do not work and will need manufacturer repair before being operable, devices that can operate but have been disconnected from a power source or in storage for over a year, or devices that were placed Out of Service by EHS personnel.

A Radiation Producing Device can be placed Out-of-Service for several reasons and individuals shall not use the device when it is designated or labeled as such. An Out-of-Service placement can occur from a physical tag, or by designation by the Program Steward or RSO.

A device will be tagged out of service when an EHS personnel places a tag (as shown below) on the device itself. The tag will have an associated number that is linked to a tracking system operated by the RPO. When the user wishes to place the device back into service, they shall contact EHS via the number or email listed. A representative from the RPO will schedule a visit to place the device back into service and remove the tag. Tags shall not be removed by non-EHS personnel for any reason.

A device will be designated out of service via direct communication from the program steward or RSO. When a device is designated out of service, it shall be treated as if it is tagged. It is the responsibility of the supervisor to ensure that no individuals operate the device during this period. This can be done by posting their own tag, form, or the print-out of the notification on the device. The out of service designation ends either when a member of EHS arrives to officially tag the device, or when the device is audited by RPO personnel. A designation of “Out-of-Service” will most likely occur during the period between notification of the RPO for a situation described in 7.4.2 and when an audit can be scheduled, but can also occur for reasons listed in 7.4.4.1.

Any RPD deemed as “Out-of-Service” shall not be used until the RPE Program Steward has completed an audit on the device. It is the responsibility of the user or supervisor to contact the RPO if they wish to place a device back into service. Using a device that is tagged or designated OOS shall trigger an EHS investigation that may result in further corrective actions including temporary suspension from device or the re-training of applicable individuals.

Below is an example of the OOS tag:

**OUT OF SERVICE  
Tag No: \_\_\_\_\_\_\_**

**D**

**This unit has been placed out of service by the Radiation Protection Office of Environmental Health & Safety for failing to meet safety expectations. You are advised not to use this unit without first obtaining approval from EHS:   
814 863-3980 /** [**ehsrad@psu.edu**](mailto:ehsrad@psu.edu)

**Remarks:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

