

NON-HEALING ARTS RADIATION GENERATING DEVICES

This Safe Operating Procedure (SOP) summarizes regulatory and UNL policy requirements to possess and operate radiation generating devices and other common non-healing arts radiation generating equipment. The non-healing arts x-ray equipment discussed in this SOP include:

- Open and closed x-ray devices
- Hand-held x-ray devices
- Electron microscopes
- X-ray photoelectron spectrometers
- Cabinet x-ray systems
- Educational x-ray equipment

NOTE: there may be other types of radiation generating devices that are not directly addressed by this SOP such as particle accelerators or other novel research approaches and devices. At a minimum, the purchase, installation, and application of ANY radiation generating device(s) must be approved by the Radiation Safety Office.

Definitions

Useful regulatory definitions from Nebraska Title 180, Control of Radiation that apply to the use of non-healing arts radiation generating devices are provided below.

Cabinet x-ray system means 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 x radiation. An x-ray tube used within a shielded part of a building, or x-ray equipment which may temporarily or occasionally incorporate portable shielding is not considered a cabinet x-ray system.

Closed-beam means a system where the beam path cannot be entered by any part of the body during normal operation.

Educational equipment means a device used for educational purposes only. No research is performed using this equipment.

Hand-held means a portable instrument that is designed to operate when held in the hand.

Interlock means a device or engineered system that prohibits access to an area of radiation hazard either by preventing entry or by automatically removing the hazard.



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Open-beam means an x-ray system where an individual could place some part of their body through a beam port into the volume defined by the collimation system.

Particle accelerator means any machine capable of accelerating electrons, protons, deuterons, or other charged particles in a vacuum and of discharging the resultant particulate or other radiation into a medium at energies usually in excess of 1 megaelectron volt (MeV).

Primary beam means ionizing radiation coming directly from the radiation source through a beam port into the volume defined by the collimation system.

Radiation generating device means any system, device, subsystem, or component of, which may generate x-rays or particle radiation between 5 kiloelectron volt (keV) and 1 megaelectronvolt (MeV), and is not intended for healing arts use for humans or animals. The devices may be closed-beam, open-beam, or hand-held.

Safety device means a device, interlock, or system that prevents the entry of any portion of an individual's body into the primary x-ray beam path or that causes the beam to be shut off upon entry into its path.

Authorization to Possess or Operate Radiation Generating Devices

Operation of non-healing arts radiation generating devices must be performed under the supervision of an individual that has been approved by the UNL Radiation Safety Committee (RSC). The approved individual or Authorized User (AU) must be a faculty or staff member knowledgeable in the operation of radiation generating devices.

To become an AU:

1. Complete initial EHS radiation safety training.
2. Complete vendor-provided equipment training, if applicable.
3. Complete an Authorization Application by contacting the Radiation Safety Office. Authorization applications require Department Head concurrence.
4. Complete and submit normal operation procedures. For open-beam and hand-held devices, a safety device or alternative method evaluation will be conducted to ensure appropriate radiation protection during operation will also need to be submitted.
5. Commission the x-ray equipment and operating location through inspection by the Radiation Safety Office.
6. Obtain approval from the UNL RSC.

State Registration for Radiation Generating Devices

All radiation generating devices must be registered with the Nebraska Department of Health and Human Services, Office of Radiological Health within 30 days of receipt, change in location, or disposal. The Radiation Safety Office maintains this registration. The AU shall promptly notify the Radiation Safety Office of any such changes. Receipt of new equipment will require a commissioning inspection by the Radiation Safety Office.



Training Requirement for Radiation Generating Devices

AUs must complete applicable EHS radiation safety training initially and annual thereafter. Radiation Workers (RWs) are individuals that are approved to use radiation generating devices under the supervision of the AU. RWs includes student laboratory instructors.

RWs operating a radiation-generating device must complete the following training:

- Initial EHS radiation safety training.
- Device specific training on normal and emergency operating procedures by the AU or approved instructor.
- Annual radiation safety refresher training.
- Additional vendor-provided equipment training, if required.

Students participating in a laboratory class which uses educational radiation generating devices require the following training:

- EHS radiation safety training lecture.
- Device specific training on normal and emergency operating procedures by the AU or approved instructor.

Dosimetry is not issued until the initial EHS and device specific training is completed and provided to the Radiation Safety Office. Training documentation is not necessary for students participating in a laboratory class which uses educational radiation equipment.

Radiation Surveys and Inspections for Radiation Generating Devices

The Radiation Safety Office will inspect radiation generating devices on an annual basis to evaluate compliance with regulatory requirements. These routine inspections will be scheduled with the AU. X-ray operation by the AU or RWs will be required during the inspection.

Additional radiation surveys are required by regulation under certain circumstances. If any of the circumstances listed occur, it is the responsibility of the AU to promptly notify the Radiation Safety Office to schedule a radiation survey:

- Following any change in the initial arrangement, number or type of local components in the system; OR
- Following any maintenance requiring disassembly or removal of a local component in the system; OR
- Any time a visual inspection of local components in the system reveals an abnormal condition.

Normal Operating Procedures for Radiation Generating Devices

Normal operating procedures are step-by step instructions necessary to accomplish the analysis. These procedures must include sample insertion and manipulation, equipment alignment, routine maintenance by the registrant, and data recording procedures, which are related to radiation safety. These instructions are required for each x-ray device and must be available to all RWs and students, as applicable. The AU is responsible to ensure no individual operates the radiation generating devices in any manner other than that prescribed in the



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normal operating procedures. Any procedure, maintenance or alignment that requires access to the primary x-ray beam with any local component of the system disassembled or removed, requires prior approval by the UNL Radiation Safety Office.

Dosimetry for Radiation Generating Devices

All approved operators of radiation generating devices will be issued dosimetry as discussed in the EHS SOP, **Dosimetry Program**. Students participating in laboratory courses involving infrequent use of educational radiation generating devices will not be issued dosimetry.

Electron Microscopes (EM)

Upon installation, an initial radiation survey must be conducted by the Radiation Safety Office to determine the regulatory status of the EM. If the incidental radiation dose equivalent rate averaged over an area of 10 cm² does not exceed 0.5 mrem/hour at 5 cm from any accessible surface, then the following procedure applies:

- Contact EHS to initiate registration with the Radiation Safety Office.
- State registration, radiation safety training, dosimetry, and RSC approval is not required.
- Operators are to follow manufacturer's normal operating procedures.
- The Radiation Safety Office will perform an annual physical inventory of the EM.
- Promptly notify the Radiation Safety Office if the EM is modified (e.g., addition of an integrated radiation generating device such as an XRD or XRF) or relocated.

If the incidental radiation dose equivalent rate exceeds 0.5 mrem/hour at 5 cm, is operated above 5 keV, or includes an integrated radiation generating device, then the EM is considered a radiation generating device and subject to the full requirements of this SOP.

X-Ray Photoelectron Spectroscopy (XPS)

Upon installation, an initial radiation survey must be conducted by the Radiation Safety Office to determine the regulatory status of the XPS. If the incidental radiation dose equivalent rate averaged over an area of 10 cm² does not exceed 0.5 mrem/hour at 5 cm from any accessible surface and operates below 5 keV, then the following procedure applies:

- Contact EHS to initiate registration of the XPS with the Radiation Safety Office
- State registration is required.
- EHS radiation safety training, dosimetry, and RSC approval is not required.
- Operators are to follow manufacturer's normal operating procedures.
- The Radiation Safety Office will perform an annual physical inventory of the XPS.
- Promptly notify the Radiation Safety Office if the XPS is modified or relocated.

If the incidental radiation dose equivalent rate exceeds 0.5 mrem/hour at 5 cm, is operated above 5 keV, or includes an integrated radiation generating device, then the XPS is considered a radiation generating device and is subject to the full requirements of this SOP.



Cabinet X-Ray Systems

The following procedure must be followed when using a cabinet x-ray system:

- Authorized users of cabinet x-ray systems must be approved by the RSC.
- State registration is required.
- EHS radiation safety training is not required. However, operators shall receive device specific training by the AU, designated RWs, or the cabinet manufacturer. Completion of training must be provided to the Radiation Safety Office.
- Annual radiation safety refresher training is required.
- Dosimetry is not required to operate cabinet x-ray systems.
- An annual radiation survey and interlock testing (at the manufacturer's recommendation or not less than annually) is conducted by the Radiation Safety Office.
- Promptly notify the Radiation Safety Office if the cabinet x-ray system is modified or relocated.

Reporting of Suspected Beam Exposure

Exposure to the primary x-ray beam is unlikely. If you suspect that a part of your body has been exposed to the primary x-ray beam, report the suspected exposure immediately to the Authorized User and the Radiation Safety Office at 402.472.4925 to initiate an exposure investigation.