

X-Ray Safety For Non-Medical Uses

Registration and Approval

Registration of Machines

Radiation producing machines at USC must be registered with Radiation Protection and the State of California Department of Health Services (DHS), in accordance with California Radiation Control Regulations (CRCR) Title 17, Sections 30110 through 30146.

The acquisition, installation and use of machines that emit ionizing radiation requires the authorization of the Radiation Safety Committee (RSC) and Radiation Protection.

Radiation Safety Committee Approval

Faculty members wishing to use such machines shall submit a Permit Application for Radiation Producing Machines to the Radiation Safety Committee for approval. Upon approval by the Radiation Safety Committee, a Permit will be issued to the faculty member for the specific uses indicated on the application. The Permit is valid for three years.

The Faculty member must provide the Radiation Safety Committee with the following information:

- ❖ Manufacturer
- ❖ Machine type and model
- ❖ Serial number
- ❖ Number of x-ray tubes
- ❖ Proposed location of the machine
- ❖ Facility description
- ❖ Use protocol
- ❖ Date of receipt
- ❖ Emergency procedures

Upon approval by the Committee, Radiation Protection will register the machine with the DHS.

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Registered machines must be reregistered with Radiation Protection and the DHS every two years or when changes are made to the machine.

Units which are removed from service or transferred to users outside the jurisdiction of USC must be reported to Radiation Protection and to the DHS.

Training

Training and Qualifications of Personnel

The Permit Holder is responsible for the safe use of radiation producing machines under his/her Permit.

The Permit Holder shall ensure that personnel authorized to operate radiation producing machines are trained and qualified in their safe use and are cognizant of accepted radiation protection practices in controlling radiation exposures to themselves and others in the vicinity.

New personnel are required to receive training from the Permit Holder prior to using radiation producing machines and satisfy all other appropriate training requirements which include:

- ❖ Introduction to Laboratory Safety
- ❖ Dosimetry

Training Documentation

All radiation safety related training or education that employees receive shall be properly documented and maintained on file for review by Radiation Protection.

- ❖ Introduction to Laboratory Safety.
- ❖ Proper use of interlocks, safety features and operating controls.
- ❖ Security requirements for operating controls/unoccupied rooms.
- ❖ Radiation levels in the primary beam and scattered from objects.
- ❖ Knowledge of and supervised experience with experimental protocols.

Protective Equipment

Personnel Monitoring

In accordance with the Personnel Dosimetry Program, each user of radiation producing machines will be issued personnel monitoring devices. The assigned dosimeter is to be worn whenever the radiation producing machine is being used.

Whenever protective lead aprons are worn, the whole body dosimeter should be worn on the outside of the apron at the neckline. Ring or wrist dosimeters are to be worn if the unprotected hands and forearms must come in close proximity to the beam.

Lead Aprons

Lead aprons and thyroid collars should be worn by operators and other personnel working around radiation producing machines.

All protective aprons or gloves should be inspected for radiation leakage at least every six months, or whenever the integrity of the equipment is suspect.

Eye Protection

Leaded glass or leaded acrylic eye wear is recommended for eye protection.

Note: Plastic lenses provide only a minimum of protection, whereas safety glasses and corrective glass eye-wear can reduce the dose to the eye considerably.

The calculated linear absorption coefficient for 15 keV x-rays is approximately 12.85 cm^{-1} for optical glass and 1.27 cm^{-1} for plastic lenses. As inferred, 1 mm thick glass lenses will attenuate these x-rays by nearly one order of magnitude more than plastic lenses of the same thickness.

Use of Fluorescent Screens

A fluorescent screen should be viewed only through highly absorbing glass, preferably through 0.25 inch thick lead glass.

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Facilities

All areas where x-ray units are located must be posted as follows:

- ❖ Entrances to all rooms containing radiation producing machines must be posted with a sign bearing the words, *Caution X-Rays* or *Caution Radiation*.
- ❖ The name and telephone number of a person to be contacted in case of emergency must be posted at each entrance.
- ❖ A label bearing the words, *Caution X-Ray, This Equipment Produces Radiation When Energized* must be placed near the energizing switch.
- ❖ Emergency procedures must be posted near the equipment controls.
- ❖ A label bearing the words, *Caution, High Intensity X-Ray Beam* should be placed in the area immediately adjacent to each tube head not provided with an interlock. The sign should be clearly visible to any person operating, aligning or adjusting the unit and/or handling or changing a sample.

Machines must be provided with a visual indicator located on or near the tube head which indicates when x-rays are being produced.

It is recommended that the indicator be an assembly consisting of two lights, wired in parallel, indicating *X-Rays On*. If one of the lights burns out, the operator must replace it before leaving the room or leave a note on the light assembly indicating that the bulb is burned out.

A single bulb assembly may be used only if it is wired so that failure of the bulb will cause x-ray production to stop.

Note: An unlighted warning bulb does not necessarily mean that x-rays are not being produced. The light only indicates when x-rays are being produced.

Shielding and Access Control

The utilization of shielding and access control will depend on the unit type.

Shielding of non-medical x-ray units shall be such that no radiation levels in excess of 0.6 millirem per hour (mr/hr) are present in any work area adjacent to the unit.

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Interlocking devices and shutter mechanisms should not be tampered with and shall be inspected at frequent intervals to insure proper operation.

Safety Procedures

Operating Procedures

The Permit Holder has the responsibility for:

- ❖ Providing a safe working environment.
- ❖ Providing equipment that is operationally safe.
- ❖ Ensuring that users understand safety and operating procedures.

When using radiation producing machines, the equipment operator is responsible for ensuring:

- ❖ Their own safety.
- ❖ The safety of others.
- ❖ That all unused x-ray ports are closed.
- ❖ That both the warning lights and the meters on the console are checked, prior to opening a shutter. (**Note:** Never Trust A Warning Light Unless It Is On).
- ❖ That the room must be locked whenever an energized x-ray machine is left unattended.
- ❖ That bare feet are not permitted in the laboratory or around electrical equipment.

Any question or uncertainties about safety should be discussed with the Permit Holder and/or Radiation Protection.

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Emergency Procedures

In the event of an accident or unusual incident involving a radiation producing machine, proceed as follows:

Step	Procedure
1	Turn the machine off.
2	Notify Radiation Protection.
3	Record all important parameters (e.g. mA, kVp, distance from the x-ray source, the nature and duration of the possible exposure.)

Tests and Inspections

Periodic tests and inspections of the machine and the facility must be performed to ensure the continued safe operation of the machine within the established protocol, approved by the RSC.

After the initial set up and after each subsequent major change in experimental set up, the operator must visually inspect each x-ray port and survey the machine for scattered or leakage radiation.

Exposure readings above background external to the primary or secondary shields must be reported to the Permit Holder or his designee.

Routine surveys made by the machine users should be documented and maintained for review by Radiation Protection.

Note: Radiation survey instruments are useful only to indicate the presence of unwanted radiation and to trace the origin of leakage radiation, but are not capable of analytical measurements of the x-rays.

Radiation Protection will ensure that each radiation producing machine is inspected on an annual basis.

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Repairs

A person not knowledgeable about the x-ray equipment should not attempt to make repairs or remedy malfunctions. Always consult the Permit Holder or his designee first.

Repairs to the high voltage section must not be made unless the primary leads are disconnected from the high voltage transformer, and a **signed and dated** notice is posted near the *X-ray On Switch*. Turning off a circuit breaker is not considered a disconnect.

Do not attempt to align x-ray cameras without first consulting an experienced person. Alignment procedures require special training and knowledge to reduce hazards. Special care is required when one power supply is connected to more than one x-ray tube.

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