

X-RAY MACHINES

1. INTRODUCTION

Management of x-ray machines is the responsibility of the Principal Investigator (PI) under whose license the machine is being used. For information concerning set up of an x-ray laboratory, see the Laboratory Licensing chapter. It is the responsibility of each member of the laboratory to maintain safe use of the x-ray machine(s) in their area.

X-ray machines are certified periodically by a State Qualified Expert. Additionally, radiation surveys and surveys following repairs or changes are coordinated through Health Physics. See Area Requirements in this chapter. Any new x-ray equipment should be registered with Health Physics to ensure compliance with these inspection requirements.

2. PURCHASING

Laboratories wishing to order an x-ray machine should first obtain a license for the device from the Radiation Safety Officer (RSO) and Radiation Safety Committee (RSC). Please refer to the Laboratory Licensing chapter for licensing information. Radiation safety training for x-ray users should be completed by all personnel planning to use the device prior to beginning work with the machine. Please refer to the Training chapter. Whole body dosimeters as well as extremity rings may be issued to personnel using x-ray machines, as determined by Health Physics. Please refer to the Exposure Control Chapter.

X-ray machines should only be ordered using a Purchase Request (PR)/Standing Purchase Order (SPO) through the Procurement Service Center. The PRs and SPOs must be approved in advance by Health Physics. **The University's Procurement Card, other credit/debit cards, and other purchasing methods may NOT be used to order radiation-producing machines unless PRIOR approval is granted by the RSO or the Alternate RSO. Exceptions may be granted on a case-by-case basis.**

X-ray machines may be delivered to the area of use as long as prior notification has been made to Health Physics.

3. ANALYTICAL X-RAY DEVICES

Analytical x-ray systems and equipment are groups of components utilizing x-ray or gamma radiation to determine the elemental composition or examine the microstructure of materials using diffraction or fluorescence analysis. Analytical x-ray devices are regulated under Part 8 of the *Rules and Regulations Pertaining to Radiation Control* issued by the State of Colorado. A summary of Part 8 requirements is included in this chapter.

Analytical x-ray devices have the potential for significant radiation exposure to personnel. Therefore, the restrictions outlined in the regulations and by the RSC must be followed. Contact

Health Physics at (303) 492-6523 to review these regulations. Analytical x-ray devices are certified once every two years by a State Qualified Inspector.

Summary of Part 8 Requirements

Equipment Requirements

Each x-ray unit must have a safety device which prevents the entry of any portion of an individual's body into the primary x-ray beam path, or which causes the beam to be shut off upon entry into its path. This may also be known as an interlock. The x-ray unit must also have a readily discernible indication of x-ray tube "on-off" status; shutter "open-closed" status; and an easily visible warning light labeled with the words *X-RAY ON*, or similar words. Any equipment installed after October 1, 1978 shall have fail-safe characteristics in the warning devices.

Any unused ports shall be secured in the closed position, in a manner which will prevent casual opening. All analytical x-ray equipment shall be labeled with a readily discernible sign or signs bearing the radiation symbol and the words: *Caution High Intensity X-ray Beam* on the source housing; *Caution Radiation - This equipment produces Radiation When Energized* near any switch that energizes an x-ray tube; or *Caution Radioactive Material* if the radiation source is a radionuclide. If the source is a radionuclide, refer to the Laboratory Licensing chapter for licensing of sealed sources.

Any x-ray unit installed after October 1, 1978 shall be equipped with a shutter for each port on the radiation source housing that cannot be opened unless a collimator or a coupling has been connected to the port. Each source housing shall be equipped with an interlock that shuts off the tube if it is removed from the radiation source housing, or if the housing is disassembled. Each radioactive source housing, or port cover or each x-ray tube housing shall be constructed so that, with all shutters closed, the radiation measured at a distance of 5 cm from its surface is not capable of producing a dose in excess of 0.025 mSv (2.5 mrem) in one hour. For systems utilizing x-ray tubes, this limit shall be met at any specified tube rating. These requirements should be met by the manufacturer. Contact Health Physics for assistance.

Each x-ray generator shall be supplied with a protective generator cabinet which limits leakage radiation measured at a distance of 5 cm from its surface such that it is not capable of producing a dose in excess of 2.5 μ Sv (0.25 mrem) in one hour.

Area Requirements

The local components of an analytical x-ray system shall be located and arranged and shall include sufficient shielding, or access control such that no radiation levels exist in any surrounding local area which could result in a dose to an individual present in excess of the public dose limits. Public dose limits are 1 mSv (100 mrem) per year and 0.02 mSv (2 mrem) in any one hour.

Radiation surveys shall be performed upon installation of the equipment, and at least once every 12 months thereafter; following any change in the initial arrangement, number or type of local components in the system; following any maintenance requiring the disassembly, or removal of a local component in the system; during the performance of maintenance and alignment procedures if the procedures require the presence of a primary x-ray beam when any local component of the system is disassembled, or removed; any time a visual inspection of the local components in the system reveals an abnormal condition; and whenever personnel monitoring devices show a significant increase over the previous monitoring period, or the readings are approaching

occupational (radiation worker) dose limits. Occupational dose limits include 0.05 Sv (5 rem) per year whole body dose, 0.15 Sv (15 rem) per year eye dose, and 0.5 Sv (50 rem) per year shallow dose to the skin or to any extremity.

Each area or room containing analytical x-ray equipment shall be conspicuously posted with a sign, or signs bearing the radiation symbol and the words *Caution X-Ray Equipment*. Each area should also have *Emergency Notification* signs which include telephone numbers for the PI and/or other emergency contact designee. These signs may be obtained free of charge from Health Physics.

Operating Requirements

Normal operation procedures shall be written and available to all analytical x-ray equipment workers. No individual shall be permitted to operate analytical x-ray equipment in any manner other than that specified in the procedures unless such individual has obtained the written approval of the RSO.

No individual shall bypass a safety device or interlock, unless such individual has obtained the written approval of the RSO. Such approval shall be for a specified period of time. When a safety device or interlock has been bypassed, a readily discernible sign bearing the words *Safety Device Not Working*, or similar words, shall be placed on the radiation source housing.

Except as described in the previous paragraph, no operation involving removal of covers, shielding materials, or tube housings, or modifications to shutters, collimators, or beam stops shall be performed without ascertaining that the tube is off and will remain off until safe conditions have been restored. The main switch, rather than interlocks, shall be used for routine shutdown in preparation for repairs.

If the x-ray device contains a radioactive source, replacement, leak testing, or other maintenance or repair procedures shall be conducted only by individuals specifically authorized under the University's Radioactive Materials License. For information concerning these tasks, contact Health Physics at (303) 492-6523.

Personnel Requirements

Individuals must complete x-ray training through Health Physics and on-the-job training in the laboratory prior to operating or maintaining analytical x-ray equipment. This training will include identification of radiation hazards associated with the use of the equipment; significance of various radiation warning, safety devices and interlocks incorporated into the equipment; proper operating procedures for the equipment; recognition of symptoms of an acute localized exposure; and proper procedures for reporting an actual or suspected exposure. Please refer to the Training chapter.

Personnel dosimeters issued by Health Physics shall be used by analytical x-ray equipment workers using systems having an open-beam configuration and not equipped with a safety device; and personnel maintaining analytical x-ray equipment if the maintenance procedures require the presence of a primary x-ray beam when any local component in the analytical x-ray system is disassembled or removed.

4. MEDICAL (HUMAN USE) X-RAY DEVICES

Medical x-ray devices (healing arts or veterinary medicine) are regulated under Part 6 of the *Rules and Regulations Pertaining To Radiation Control* issued by the State of Colorado. PIs using a medical x-ray device for human use must be licensed by the Medical Licensing Board of the State of Colorado. These devices are inspected every year by a State Qualified Inspector. Contact Health Physics at (303) 492-6523 for assistance with licensing a medical x-ray device.

5. SECURITY AND STORAGE

Each laboratory must ensure security of x-ray machines. This may require locking of laboratory doors and/or locking the device. All laboratory areas in which x-ray machines are used should have a sign displayed on all entrances as indicated under Area Requirements described above. Health Physics may supply appropriate signs and stickers. Operating keys should not be kept in the machine when the machine is not in active use.

6. TRANSFERS

X-ray machines may be transferred to another licensed laboratory with **prior approval** from Health Physics. Transfers between buildings should be arranged through Health Physics to ensure safe handling and transport. The machine will be transferred to the laboratory license of the recipient through a license amendment. Please refer to the Laboratory Licensing chapter.