

***ANALYTICAL X-RAY
EQUIPMENT USE
POLICIES & PROCEDURES***



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References

1. www.hsc.wvu.edu/rsafety/
2. www.wvdhhr.org/rtia/radiological_health.asp
3. www.nrc.gov/

Attachments

Table 64-23 P – Determination of Competency

RULES FOR USING ANALYTICAL X-RAY EQUIPMENT

1.0 General Provisions

- 1.1 All ionizing radiation producing devices such as X-ray equipment are required to be registered with the WVU Radiation Safety Department located at the Health Sciences Center.
- 1.2 The following rules govern the use of such analytical X-ray equipment and other ionizing radiation producing devices at West Virginia University. Concurrently, those rules meet all the terms of radiation safety standards recommended by the State of West Virginia [**Radiological Health Rules –64-CSR-23, 7.3.a. “Radiation Safety Requirements--The registrant shall be responsible for directing the operation of the X-ray systems under his administrative control. The registrant or the registrant's agent shall assure that the requirements of this rule are met in the operation of the X-ray systems.”**]

2.0 Purpose

- 2.1 Analytical X-ray equipment (industrial X-ray systems, cabinet X-ray systems, analytical machines) are used for X-ray diffraction analysis, fluorescence analysis, or direct X-ray transmission analysis of materials. These analytical X-ray systems are comprised of components that utilize X-rays to determine elemental composition, or to examine the structure of materials. These analytical X-ray devices are used for non-medical purposes. The primary objective of this program is to keep occupational exposures to radiation as low as reasonably achievable (ALARA) while utilizing this classification of equipment.

3.0 Scope and Authority

- 3.1 All X-ray equipment registered with Radiation Safety must include the name of the individual designated as the Primary Authorized User (PAU) who is directly responsible for the unit and available to train other users/operators.
- 3.2 If the registered Primary Authorized User (PAU) ceases to have possession of an X-ray unit, the (PAU) shall immediately notify Radiation Safety advising them of the circumstances. Radiation Safety should also be notified by a department representative when the registered (PAU) changes.
- 3.3 Radiation Safety will maintain a current database of all registered X-ray equipment and the Primary Authorized User (PAU).

The database will include:

- 3.3.1 The name, location and telephone number of the Primary Authorized User (PAU);

- 3.3.2 The name, location and telephone number of additional users/operators of the X-ray equipment;
- 3.3.3 The precise location of the X-ray equipment (room and building);
- 3.3.4 The main purpose for use of the X-ray equipment;
- 3.3.5 The make, model and serial number of the X-ray equipment; and,
- 3.3.6 The date, vendor and description of service performed during normal maintenance and repair on the X-ray equipment;

4.0 Equipment Requirements

- 4.1 **Safety Devices** -- Prohibits the entry of any portion of the human body into the **primary X-ray** beam path; or triggers the beam to automatically shut off upon entry into the beams path.
 - 4.1.1 A safety device must be present on all open-beam configurations.
 - 4.1.2. Some of the safety devices currently available include interlocks, warning lights, shielding and beam enclosures.
- 4.2 **Warning Devices** -- Open-beam configurations must be provided with a readily discernible indication of:
 - 4.3.1 X-ray tube status (ON-OFF) located near the radiation source housing, if primary beam is controlled in this manner; and/or,
 - 4.3.2 Shutter status (OPEN-CLOSED) located near each port on the radiation source housing, if the primary beam is controlled in this manner.

NOTE: Warning devices must be labeled so that their purpose is easily identified.

- 4.4 **Labeling** -- All analytical X-ray equipment must be labeled with a readily discernible sign or signs bearing the radiation symbol and the words:
 - 4.4.1 "CAUTION - HIGH INTENSITY X-RAY BEAM," or words having a similar intent, on the X-ray source housing; and,
 - 4.4.2 "CAUTION RADIATION - THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED," or words having a similar intent, near any switch that energizes an X-ray tube if the radiation source is an X-ray tube; or

- 4.4.3 "CAUTION - RADIOACTIVE MATERIAL," or words having a similar intent, on the source housing in accordance with CFR20 if the radiation source is a radionuclide.
- 4.5 **Warning Lights** -- An easily visible warning light labeled with the words "X- RAY ON," must be located:
- 4.5.1 Near any switch that energizes an X-ray tube and must be illuminated only when the tube is energized; or
- 4.5.2 In the case of a radioactive source, near any switch that opens a housing shutter, and must be illuminated only when the shutter is open.
- 4.6 **Posting** -- Each area or room containing analytical X-ray equipment must be noticeably posted with one or more signs bearing the radiation symbol and the words "CAUTION X-RAY EQUIPMENT."
- 4.7 **Beam trap** -- A beam trap or other primary beam shield must be provided to intercept the primary beam.
- 4.7.1 **Chamber** -- The X-ray tube housing, sample detector, and analyzing crystal must be enclosed in a chamber (or coupled chambers) that will prevent entry of any part of the body.
- 4.7.2 **Ports** -- Access ports to the sample chamber must be of a fail-safe design that will prevent X-ray generation or entry of the X-ray beam into the chamber when any port is opened.

5.0 Area Requirements

- 5.1 The local components of an analytical X-ray system must be positioned in a location to assure adequate shielding and limited access such that radiation doses to individuals maintain as far below the limits as is reasonably achievable and within established limits [64CSR23 6.5].
- 5.2 Each area or room containing analytical X-ray equipment must be posted with one or more signs bearing the radiation symbol and the words "**CAUTION X-RAY EQUIPMENT**". In addition, written operating instructions must be available to all analytical X-ray equipment workers.
- 5.3 New X-ray equipment must not be installed and/or used, whether permanent or mobile, until a floor plan, shielding specification and equipment arrangement have been reviewed and approved by the Radiation Safety Officer. [64-CSR-23, Section 7.4.a] *The required information is denoted in Appendix C and D.*
- 5.4 Any future modifications to the X-ray equipment or registration data will require the prior written approval of the Radiation Safety Officer.

Data required in approval request:

- 5.4.1 Current use;
 - 5.4.2 Location;
 - 5.4.3 Deviation; and
 - 5.4.4 Shielding design/structure
- 5.5 Floor plan drawings shall show the proposed location of the X-ray source and, where applicable; shall indicate the use of rooms or areas that are adjacent, both horizontally and vertically, to the proposed location; and shall indicate the type and thickness of the shielding installed or to be installed on the boundaries of the proposed location; and shall indicate the type and location of the safety devices such as warning lights, interlocks and cut-off switches. [64-CSR-23, Sec 7.4.d.2, 7.4.d.2A & B]

6.0 Operating Procedures

- 6.1 **Manuals** -- Analytical X-ray equipment must be operated as specified in the instruction manual unless written permission is obtained from the Radiation Safety Officer.
- 6.2 **Bypassing Safety Device** -- A safety device must not be bypassed unless written approval is obtained from the Radiation Safety Officer that will include a specified length of time. When a safety device has been bypassed, a noticeable sign must be placed on the X-ray housing bearing the words "**SAFETY DEVICE NOT WORKING.**"
- 6.3 **No** individual will be permitted to operate and/or maintain any analytical X-ray equipment unless the individual has received proper *instruction* from the registered (PAU) and demonstrate *competence* to operate the device. [64-CSR-23, Sec. 7.3.a.2]
- 6.3.1 User/Operator must be trained by the PAU and meet all training or skill requirements as specified (*Table 64-23P*).
 - 6.3.2 Training will include
 - 6.3.1.1 The radiation hazards associated with the equipment in use;
 - 6.3.1.2 The significance of the various radiation warning devices, safety devices, and interlocks;
 - 6.3.1.3 Equipment operations manual;
 - 6.3.1.4 Symptoms of severe exposure;
 - 6.3.1.5 Protocol for reporting accidental exposure;

- 6.3.1.6 Modifications to X-ray apparatus that affects radiation protection such as shielding [**64-CSR-23 Sec 7.4.b**), X-ray tube housing, cameras, and safety interlocks; (**See Appendix C**)
- 6.3.1.7 The importance of wearing personal radiation monitoring devices (dosimeters) and the use of area radiation monitors; and,
- 6.3.1.8 Investigating unusual radiation exposure to occupational workers and, if necessary, taking remedial action.

7.0 Repair and Alignment Procedures

- 7.1 The following safety precautions must be taken to reduce radiation exposure risks during repair and alignment procedures:
 - 7.1.1 The main switch, rather than the safety interlocks, must be used to shut down the equipment.
 - 7.1.2 No X-ray tube shall be used without a suitable housing to restrict the radiation to a well-defined beam.
 - 7.1.3 A sign stating "**Interlocks Not Working**" must be posted on the equipment while the interlocks have been defeated for alignment purposes.
 - 7.1.4 If the dose limits, in an unrestricted area, is exceeded during the repair or alignment procedure, temporary barriers must be set up and the area must be properly posted. The area must be kept under surveillance until normal operations have been restored.

8.0 Primary Authorized User (PAU)

- 8.1 Primary Authorized User responsibilities include...
 - 8.1.1 Completion of the ionizing producing equipment registration form and returning it to Radiation Safety.
 - 8.1.2 This registration form will include
 - 8.1.1.1 proposed use of the equipment;
 - 8.1.1.2 type of the equipment;
 - 8.1.1.3 name of the users/operators;
 - 8.1.1.4 shielding design;
 - 8.1.1.5 floor plan;

- 8.1.1.6 current use of rooms and/or adjacent areas, horizontally and vertically, to the X-ray source.
- 8.1.2 Ensure that all personnel under their supervision...
 - 8.1.2.1 are registered with Radiation Safety and receive training as outlined above and/or specific hands-on training in the safe use of the equipment; and,
 - 8.1.2.2 wear the required personal radiation monitoring device (dosimeter).
- 8.1.3 Ensure that only authorized personnel enter the restricted areas when the X-ray equipment is in use.
- 8.1.4 Monitor X-ray device is set-up properly for daily operation.
- 8.1.5 Notify Radiation Safety:
 - 8.1.5.1 When known or suspected occurrence of radiation exposure to an occupational worker or member of the public;
 - 8.1.5.2 A registered X-ray unit is to be relocated and/or the data on file requires updating or modification;
 - 8.1.5.3 Proposed changes are to occur with the approved shielding design;
or
 - 8.1.5.4 Major maintenance or repairs are required on the X-ray unit.

9.0. Radiation Surveys

- 9.1 The X-ray equipment Primary Authorized User (PAU) is required to conduct and document radiation contamination surveys using a G.M. survey meter.
- 9.2 A GM survey is required when the equipment
 - 9.1.1 is modified in any manner;
 - 9.1.2 contains an obvious defective component; or
 - 9.1.3 receives maintenance service and/or any part is removed.

NOTE: - If you do not have access to a G.M. survey meter, and you need one for the purpose discussed above, contact Radiation Safety for assistance.

10.0 Personnel Radiation Monitoring

- 10.1 The X-ray equipment users indicated below are required to wear a ring and/or whole body radiation monitoring devices that is provided by Radiation Safety upon request (applications area available on RSD web site).
 - 10.1.1 Analytical X-ray equipment workers using systems having an open-beam configuration and not equipped with a safety device; or
 - 10.1.2 Personnel maintaining analytical X-ray equipment if the maintenance procedure requires the presence of a primary X-ray beam and/or when any local component in the analytical X-ray system is disassembled or removed.

11.0 SECURITY AND STORAGE

- 11.1 Each research laboratory must assure 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. And transfers between buildings should be arranged (or get RSO's approval) through RSD to ensure safe handling and transport.

12.0 General Precautions and Guidelines

- 12.1 Obtain the proper training/instruction from the PAU before operating the analytic X-ray machine.
- 12.2 Wear the assigned whole body dosimeter between the collar and waist on the side facing the radiation source.
- 12.3 Call Radiation Safety to survey and monitor newly installed X-ray equipment and prior to using previously registered equipment that was modified.
- 12.4 DO NOT assume the X-ray equipment was left in safe working condition by the previous user, check the shielding and settings prior to turning on the unit.
- 12.5 Regularly check that the warning lights and interlocks are working properly by setting the X-ray unit to the lowest kV and mA setting and then reset.
- 12.6 Check the safety device and shielding at least once per month. View the location and/or presence of primary and diffracted beams at all times. Cap off any unused ports.
- 12.7 Do not perform maintenance without first checking to make sure the tube is not energized.
- 12.8 It is recommended that you do not work near an open unshielded beam. However, if necessary, reduce the beam current mA and the beam energy (kV) to the lowest possible setting. This will keep the X-ray beam exposure rate minimal.
- 12.9 Keep hands and body at a safe distance from the beam
- 12.10 Adequate shielding is required. However, additional exposure reduction techniques are important.
 - 12.10.1 Increase the distance between you and X-ray source; and,
 - 12.10.2 Decrease the time spent near an X-ray source.