ANALYTICAL X-RAY MACHINES

PURPOSE

This procedure specifies requirements for analytical x-ray machines, including registration, physical safety features, training and operational requirements for users, and regular safety inspections.

POLICY

All operable x-ray generating machines used in University of Utah facilities shall be authorized by the Radiation Safety Committee and shall be registered with the Utah Division of Radiation Control. All authorizations and registrations (including fees) shall be submitted to the Radiation Safety Officer (RSO) for review and processing. The RSO shall also be notified before moving, transferring or disposing of any x-ray machine.

The responsible user for each analytical x-ray machine shall assure that detailed operating procedures are available and that each operator has received appropriate training and understands and follows the correct procedures.

DEFINITIONS

"Analytical x-ray" refers to equipment used to determine the composition or microstructure of materials by means of diffraction or fluorescence analysis.

"Beam-blocking device" means any part of an analytical x-ray machine or accessory that may be struck by x-rays, such as radiation source housings, ports and shutter assemblies, collimators, sample holders, cameras, goniometers, detectors and shielding.

"Cabinet x-ray" refers to a system having the x-ray tube and the material being irradiated fully enclosed in a cabinet that provides shielding and is equipped with fail-safe interlocks to prevent access to the beam during operation.

"Exposed beam" means the operation of a normally enclosed analytical x-ray machine with any beam-blocking device removed and the x-ray beam on.

"Fail safe" means features that prevent exposure of personnel upon the failure of a safety or warning device.

"Open beam" means any mode of operation in which any portion of the user's body could be placed into the primary beam during normal operation if no further safety devices were incorporated.

A **"normally exposed radiation user"** is an individual who could receive more than one tenth (10%) of the occupational dose limit in any calendar quarter. This category includes individuals who rarely receive radiation exposures, but who work with sources that could produce a significant dose accidentally.

A **"minimally exposed radiation user"** is an individual who is unlikely to receive one tenth (10%) of the occupational radiation dose limit in any calendar quarter.

REFERENCE

"Radiation Safety Requirements for Analytical X-ray Equipment", R313-40, *Utah Radiation Control Rules*, Utah Department of Health. Each responsible user should obtain a copy of R313-40 from the RSO and be familiar with its contents.

EQUIPMENT REQUIREMENTS

The requirements specified in regulation R313-40-30 apply to all of the University's analytical x-ray equipment. The important requirements are itemized in "ANALYTICAL X-RAY MACHINE SAFETY INSPECTION" (RPR 30A). This record is **to be completed by the responsible user** at the time the machine is first registered and submitted to the RSO. The inspection form is also to be used as a safety check list after any maintenance or modification that requires disassembly.

OPERATING REQUIREMENTS

Each person who will operate or maintain analytical x-ray equipment shall **first** receive appropriate instruction and

demonstrate competence on all topics specified in R313-40-60(1).

Written operating procedures covering both normal and abnormal (emergency) conditions shall be available to, and followed by, all users of analytical x-ray equipment. The operating procedures shall include detailed instructions for sample insertion and manipulation, equipment alignment, routine maintenance by the user and recording of data related to radiation safety.

No person shall bypass a safety device without the written authorization of the RSO (R313-40-50). Individuals who expect to perform maintenance that requires the presence of the primary beam when beam-blocking devices are removed shall be authorized in advance by the Radiation Safety Committee and shall notify the RSO that such work is expected.

RADIATION SURVEYS

The RSO will survey the radiation exposure rates in accessible areas near an analytical x-ray machine at least once every 12 months. **The responsible user shall request, or perform and record**, a radiation survey:

1 following any change in the arrangement, number or type of components,

2 following and maintenance requiring disassembly or removal of a component,

3 during any maintenance or alignment procedure that requires the presence of a primary x-ray beam when a component is disassembled or removed, or

4 any time a visual inspection reveals an abnormal condition.

EXPOSURE MONITORING

Users of **open beam** analytical x-ray units, and users of enclosed units who are approved to perform maintenance procedures with an **exposed beam**, are classified as **normally exposed**. Each **normally exposed radiation user** of analytical x-ray equipment shall complete the "RADIATION USER PERSONAL DATA" form (RPR 1A). A finger dosimeter will be issued within approximately one week after the data form is received by the RSO. The dosimeter shall be worn whenever the x-ray machine is operating and shall be kept in an unexposed location at all other times.

All dosimeters shall be returned at the end of the monitoring period. Dosimeters not returned by the 5th of the month after they were worn, but within the next 30 days are considered to be late. Dosimeters returned more than 30 days late, or damaged or misused in any way that invalidates the reading, are considered to be lost. Fines are imposed for late or lost dosimeters (see the *Radiation Safety Policy Manual*).

Users of enclosed x-ray equipment who are not specifically approved to perform maintenance procedures with an exposed beam are classified as **minimally exposed** and are not issued personal dosimeters.

Experience has shown that accidental exposures from enclosed (cabinet) x-ray equipment have usually been to finger tips and were not accurately recorded even when dosimeters were worn. Furthermore, accidental exposures have often been so severe that biological effects appeared before the user dosimeter was processed. Under such circumstances, dosimeters contribute nothing to radiation protection or to long-term exposure records.

Any suspected exposure to the primary beam of an analytical x-ray machine shall be reported promptly to the RSO.

RPR 30A. ANALYTICAL X-RAY MACHINE SAFETY INSPECTION

Responsible user: _____ Group #: _____ Task #._____

Location (Bldg. & Room): _____ Phone: _____

Type and use		Manufacturer	Model	Serial No.
☐ Open beam	Control unit:	_____	_____	_____
☐ Fully enclosed [CX]	X-ray tube(s):	_____	_____	_____
☐ Diffraction enclosed [XD]	Number of ports available:		_____	In use: _____
☐ Fluorescence [XF]	Target material:	_____	kVp: _____	mA: _____

Accessory equipment (powder cameras, goniometers, etc.): _____

_____

Installation date: _____ Inspection date: _____

FACILITY REQUIREMENTS

"CAUTION - X-RAY EQUIPMENT" (or equivalent) sign at entrance?	**Yes**	**No**	
"NOTICE TO WORKERS" (DRC-04) posted conspicuously?	**Yes**	**No**	
Was the last radiation survey performed no more than 12 months ago?	**Yes**	**No**	**N/A**
Since the last radiation survey, have any of the following conditions occurred?			
Removal or disassembly of any component that normally stops the primary beam?	**Yes**	**No**	
Exposure of more than 1,000 mrem per quarter to any finger dosimeter?	**Yes**	**No**	

EQUIPMENT REQUIREMENTS

Safety Devices

Required on open beam units - is there a device that prevents any portion of the body from entering the primary beam, or a device that terminates the beam if obstructed?	**Yes**	**No**	**N/A**
IF "NO", has exemption been filed?	**Yes**	**No**	**N/A**

Signs and Labels

For Open Beam Machines:			
Is “Caution: X-rays Produced When Energized” label affixed or inscribed on cabinet?	**Yes**	**No**	
Is “Caution: Do not Insert Any Part of the Body When System is Energized–X-ray Hazard” label permanently affixed or inscribed at each port?	**Yes**	**No**	
For Closed Beam Machines:			
Is a readily discernable sign bearing a radiation symbol and the words "CAUTION: HIGH INTENSITY X-RAY BEAM" present?	**Yes**	**No**	
Is a readily discernable sign bearing a radiation symbol and the words "CAUTION - RADIATION. THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED" present?	**Yes**	**No**	

Warning Lights or Devices - All Units

Is "X-RAY ON" light - near any switch that energizes and near any x-ray port?	**Yes**	**No**	
If radioactive source - near any switch that opens a housing or shutter?	**Yes**	**No**	**N/A**
Is light fail safe? (required on equipment installed after November 1983)	**Yes**	**No**	**N/A**

Additional Warning Devices Required for Open beam Units

Is X-RAY TUBE STATUS, "ON/OFF" - located near the radiation source housing, and at or near the port, if the primary beam is controlled in this manner?	**Yes**	**No**	**N/A**
Is Shutter Status "OPEN/CLOSED" - located near each port on the radiation source housing, if the primary beam is controlled in this manner?	**Yes**	**No**	**N/A**
Are warning devices fail safe? (required on equipment installed after November 1983)	**Yes**	**No**	**N/A**

EQUIPMENT REQUIREMENTS (Continued)

Ports and Shutters

Are unused ports on radiation source housing secured in the "closed" position in a manner that will prevent casual opening, i.e. without the use of tools? **Yes No N/A**

On equipment installed after November 1983, open beam units shall have ports equipped with a shutter that cannot be opened unless an experimental device has been connected. Does such a device exist? **Yes No N/A**

OPERATING REQUIREMENTS

Are written operating procedures available to all users of x-ray equipment? **Yes No**

Are the Radiation Safety Policy Manual and current RPR's available? **Yes No**

Has written approval been granted by the Radiation Safety Committee or the RSO for operation of the unit in a manner other than specified in the written procedure or for bypassing safety devices? **Yes No**

PERSONNEL REQUIREMENTS

Have all persons operating x-ray equipment received instruction and demonstrated adequate knowledge of:

radiation hazards associated with use of equipment; **Yes No**

significance of radiation warning and safety devices; **Yes No**

operating procedures; **Yes No**

symptoms of acute localized exposure; and **Yes No**

procedure for reporting actual or suspected exposure? **Yes No**

Personnel Monitoring

Have personal monitoring devices (ring badges) been issued? **Yes No**

If "Yes", are they used in compliance with University requirements? **Yes No N/A**

RADIATION SURVEY DATA

Radiation survey meter(s) available at facility:

Make/Model: _____ Ser. No.: _____ Calibration Date: _____

Make/Model: _____ Ser. No.: _____ Calibration Date: _____

Radiation survey meter(s) used for this survey, if different:

Make/Model: _____ Ser. No.: _____ Calibration Date: _____

Make/Model: _____ Ser. No.: _____ Calibration Date: _____

Survey results:

With machine operating at usual kVp and mA:

Maximum exposure rate within 5 cm from tube housing: _____ mR/hr

Is the dose rate less than 2.5 mrem/hr? **Yes No**

Maximum exposure rate within 5 cm from protective cabinet: _____ mR/hr

Is the dose rate less than 0.25 mrem/hr? **Yes No**

Maximum exposure rate at operator's position: _____ mR/hr

Surveyed By: _____

Upon completion, send this inspection report to:
Radiological Health Department, 322 RAB (Campus Address)