



Title: <b>X-Ray Diffraction Guidelines</b>			
EH&S – 6-6	Revision: 7/05	Date 1/94	Pages 5

**PURPOSE:** This section provides guidelines specific to the radiation safety aspects of design and operation of analytical x-ray equipment such as Diffractometers and Spectrographic equipment.

**SCOPE:** Hospital wide.

## INTRODUCTION:

The radiation safety problems associated with analytical x-ray equipment are unique. Most analytical x-ray equipment has very narrow, extremely intense, low energy beams. Therefore, the radiation monitoring problems are various and difficult.

## DEFINITIONS:

**Enclosed Beam X-ray System:** An enclosed beam x-ray system is one in which all possible x-ray paths are fully enclosed according to the requirements of Section 2 of Operation Safeguards.

**Fail Safe Design:** One in which any failure of indicator or safety components, that can reasonably be anticipated, cause the equipment to fail in a mode such that personnel are safe from exposure to radiation. For example:

- a. If a light indicating "x-ray on" fails, the production of x-rays will be prevented.
- b. If a shutter status indicator fails, the shutter will close.

**Open Beam X-ray System:** An x-ray system that does not comply with all the requirements of Section 2 will be classified as an open beam x-ray system.

## PROCEDURES:

### I. Responsibilities

1. Department Chairmen are responsible for ensuring compliance with this section. At their discretion, alternate means of assuring an equivalent level of safety may be required for programmatic reasons. Such variations will be documented and referred to the Department of Environmental Health & Safety.

2. Principal Investigators are responsible for direct implementation of this section. Specifically, investigators and/or facility managers will:
  - a. Ensure that operational procedures pertaining to radiation safety are established and executed.
  - b. Provide adequate instruction in safety practices for all personnel who work with or near analytical x-ray equipment.
  - c. Approve all individuals who are to operate any analytical x-ray equipment. Such approval will be based on the individual's competence as an operator, and the extent of radiation safety training he/she has received.
  - d. Review and approve (after consultation with the Environmental Health & Safety representative) all modifications to x-ray apparatus that may significantly alter the safety status of the facility.
  - e. Provide tests of all radiation safety devices at regular intervals; at least quarterly. Records of such tests should be maintained.
3. Users are responsible for complying with the provisions of this section.
4. Department of Environmental Health & Safety is responsible for assisting in the implementation of this policy. Specifically, the Division of Radiation Protection Services will:
  - a. Assist the Principal Investigator in establishing operational procedures pertaining to radiation safety.
  - b. Assist the Principal Investigator in providing adequate instruction in radiation safety procedures to personnel who work with or near analytical x-ray equipment. These instructions may be devised as orientations, formal written procedures, or formal training sessions.
  - c. Assist the Principal Investigator in reviewing and approving modifications pertaining to the radiation safety program.
  - d. Perform radiation surveys of all analytical x-ray equipment at least every six months and maintain records of such surveys.
  - e. Audit for compliance with this guide and report to the Department Chairman.

## **II. Operational Safeguards**

1. The following recommendations are applicable to analytical x-ray units that use either closed or open beam Diffractometers and Spectrographic equipment:

- a. Each facility or laboratory containing analytical x-ray equipment should have a listing of responsible persons posted conspicuously at the entrance to the facility or laboratory.
- b. A warning light of fail-safe design labeled with the words "x-ray on" will be conspicuously located near the x-ray tube to indicate when the x-ray tube is activated.
- c. A sign or label indicating "caution - x-ray produced when energized" should be placed near any switch which energizes an x-ray tube.
- d. The dose of unwanted radiation from components such as high voltage rectifiers will not exceed 10 mrem per week in any accessible region 5 cm from the outside surface of the generator cabinet. Assuming that an individual may be in the vicinity of the equipment while it is operating for as long as 40 hours per week, the dose rate should not exceed 0.25 mrem/hr.
- e. Normal operation procedures and alignment procedures will be documented by the manufacturer of the x-ray system, or by the Principal Investigator if the source housing and x-ray accessory apparatus are not compatible components supplied by the same manufacturer.
- f. Normal operation will be that a qualified operator following instructions will not receive in any one hour a dose equivalent in excess of 37.5 mrem to the hands and forearms; or 2.5 mrem to the whole body, gonads, bloodforming organs, or lenses of the eyes.
- g. Alignment procedures should be such that a qualified worker aware of the radiation hazards will not receive in any one hour a dose equivalent in excess of 37.5 mrem to the hands and forearms; or 2.5 mrem to the whole body, gonads, bloodforming organs, or lenses of the eyes while following these instructions. If either of these dose rates is likely to be exceeded, a definite warning will be included in the alignment instructions.
- h. All safety devices (shutters, warning lights) should be tested quarterly to insure their proper operation. Records of these tests should be maintained.
- i. Any attempt to alter safety devices either temporarily or on a permanent basis will be approved by the Principal Investigator, and a warning of the alteration conspicuously posted. Radiation protection surveys should be made after each alteration of safety devices.
- j. Radiation protection surveys should be conducted in the immediate vicinity of the x-ray apparatus by qualified personnel on a routine basis. These surveys may be performed by the operator with the guidance of the Radiation

Protection Services representative.

- k. Operators of analytical x-ray equipment will be required to use finger dosimeters or other personnel monitoring devices provided by the Radiation Protection Services representative.

## 2. Closed Beam Diffractometers and Spectrographic Equipment

- a. The radiation source, sample, detector and analyzing crystal (if used) entered by any party to the body during normal operation.
- b. The inherent shielding of the chamber walls will be sufficient to limit the dose rate in all regions 5 cm from its outer surface to 0.25 mrem/hr during normal operation.
- c. The sample chamber closure will be interlocked by a fail-safe method. The x-ray tube high voltage supply, or a shutter in the primary beam, will operate so that no x-ray beam can be consciously and deliberately defeated and conspicuously posted.
- d. If there is more than one port in the radiation source housing or more than one radiation source, all requirements above must be satisfied for each port in every source housing associated with the system.

## 3. Open Beam X-ray Equipment

- a. Any x-ray system that does not comply with the above section will be classified as an open beam x-ray system.
- b. All shutters will be provided with a "shutter open" indication of fail-safe design.
- c. Radiation levels external to the x-ray tube housing with all shutters closed will not exceed 2.5 mrem/hr as measured 5 cm from the surface of the housing, within which an x-ray tube is operating at full rated power and at maximum rated accelerating potential.
- d. Each port of the x-ray system will be provided with a beam shutter interlocked with the x-ray accessory apparatus coupling or collimator, so that the port will be open only when the coupling or collimator, is in place. Shutters at unused ports will be secured to prevent casual opening.
- e. A guard or interlock which prevents entry of any part of the body into the primary beam path should be used.
- f. A system barrier will be provided so that the dose equivalent received by

individuals in the controlled area is **As Low as Reasonably Achievable [ALARA]**, but does not exceed 5 mrem in any one hour or 100 mrem in any five consecutive days.

**INQUIRIES/REQUESTS:** Environmental Health and Safety  
L1-059 HSC  
Zip 8017  
Main Office: 444-6783  
FAX: 444-6845

**RELATED FORMS:**

**RELATED DOCUMENTS:**