

# UNIVERSITY OF HOUSTON

## Radiation Safety Manual

### **Radiation Safety Requirements for Analytical X-ray Machines and Other Industrial Radiation Machines**

These procedures are adapted from the regulations in Title 25 of the Texas Administration code (TAC), Chapter 289, Section 228. All forms can be found in the Radiation Safety Manual located via the Internet at <http://www.uh.edu/plantops/ehrm>.

#### **Definitions**

**Analytical radiation machine** - This includes, but is not limited to x-ray equipment used for x-ray diffraction, fluorescence analysis, spectroscopy, or particle size analysis.

**Fail-safe characteristics** - Design features that cause beam port shutters to close, or otherwise prevent emergence of the primary beam, upon the failure of a safety or warning device.

**Local components** - Parts of an x-ray system that include areas that are struck by x-rays such as radiation source housings, port and shutter assemblies, collimators, sample holders, cameras, goniometers, detectors, and shielding, but do not include power supplies, transformers, amplifiers, readout devices, and control panels.

**Open-beam configuration** - A radiation machine in which an individual could accidentally place some part of his/her body in the primary beam path during normal operation.

**Other industrial radiation machines** - This includes, but is not limited to, x-ray equipment (including cabinet x-ray equipment) used for cathodoluminescence, ion implantation, gauging, or electron beam welding.

**Primary beam** - Ionizing radiation which passes through an aperture of the source housing by a direct path from the x-ray tube located in the radiation source housing.

**Safety device** - A 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.

X-ray system - A group of components utilizing x-rays to determine the elemental composition or to examine the microstructure of materials.

### **Equipment Requirements**

A safety device shall be provided on all open-beam configurations. A registrant may apply for an exemption from the requirement of a safety device in accordance with the TAC. Any such request shall include a description of the various safety devices that have been evaluated; the reason each of these devices cannot be used; and a description of the alternative methods that will be employed to minimize the possibility of an accidental exposure, including procedures to assure that operators and others in the area will be informed of the absence of safety devices.

Open-beam configurations shall be provided with a visible indication of: x-ray tube status (ON-OFF) located near the radiation source housing, if the primary beam is controlled in this manner; and/or shutter status (OPEN-CLOSED) located near each port on the radiation source housing, if the primary beam is controlled in this manner. The x-ray control shall provide indication whenever x-rays are produced.

Warning devices shall be labeled so that their purpose is easily identified and shall have fail-safe characteristics.

Unused ports on radiation machine source housings shall be secured in the closed position in a manner which will prevent inadvertent opening.

Each registrant shall ensure that each radiation machine is labeled in a conspicuous manner to caution individuals that radiation is produced when energized. The label shall be affixed in a clearly visible location on the face of the control unit.

On open-beam configurations, each port on the radiation source housing shall be equipped with a shutter that cannot be opened unless a collimator or a coupling has been connected to the port.

Each x-ray tube 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 x-ray generator shall be supplied with a protective cabinet that limits leakage radiation measured at a distance of 5 centimeters from its surface such that it is not capable of producing a dose in excess of 0.5 millirem in any 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 area surrounding the local component group which could result in a dose to an individual present in the area in excess of the dose limits.

Radiation surveys of all analytical x-ray systems sufficient to show compliance with shall be performed upon installation of the equipment; 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 in the system is disassembled or removed; any time a visual inspection of the local components in the system reveals an abnormal condition; or whenever personnel monitoring devices show a significant increase over the previous monitoring period or the readings are approaching the radiation dose limits.

Each area or room containing radiation machines shall be conspicuously posted with a sign or signs bearing the radiation symbol and the words "CAUTION - X-RAY EQUIPMENT," or words having a similar intent.

## **Operating Requirements**

Operating and safety procedures shall be written and available to all radiation machine operators. No person shall be permitted to operate radiation machines in any manner other than that specified in the procedures, unless that person has obtained written approval of the Radiation Safety Officer.

No person shall bypass a safety device unless such person has obtained the approval of the Radiation Safety Officer. When a safety device has been bypassed, a readily discernible sign bearing the words "SAFETY DEVICE NOT WORKING," or words having a similar intent, shall be placed on the radiation source housing.

## **Personnel Requirements**

No person shall be permitted to operate or maintain radiation machines unless such person has received instruction in and demonstrated competence in the identification of radiation hazards associated with the use of the radiation machine; radiation warning and safety devices incorporated into the radiation machine; operating and safety procedures for the radiation machine; symptoms of an acute localized exposure; and proper procedures for reporting an actual or suspected exposure in excess of the limits. All Authorized Users including the Principal Investigator must attend and pass the UH X-ray Safety Short Course. The Principal Investigator must provide specific training for the use of the x-ray machine and associated radiation hazards. Authorized Users must know how to use a survey meter. A copy of the current operating and the safety procedures shall be maintained near the x-ray machine.

In addition to any assigned radiation dosimeters, finger badges shall be provided to and shall be used by personnel maintaining analytical radiation machines if the maintenance procedures require the presence of a primary x-ray beam when any local component in the x-ray system is disassembled or removed.

### **Security**

Radiation Machines shall be secured from unauthorized removal. Devices and/or administrative procedures shall be used to prevent unauthorized use of radiation machines.