

# X-ray Safety User Refresher Training

University of Rhode Island

Radiation Safety

401-874-2600

[www.uri.edu/radiation](http://www.uri.edu/radiation)

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- This is the refresher training that only covers basic necessary items you need to know when you work with X-ray machines.
- This training is an annual refresher training that required every year as long as you work with X-ray machines

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# Exposure

- Defined only for photons, not for other types of radiation
- Traditional unit - Röntgen or Roentgen (R)
- SI unit - C/kg
- Comparison
- $1 \text{ R} = 2.54 \times 10^{-4} \text{ C/kg}$
- $1 \text{ C/kg} = 3876 \text{ R}$

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# Absorbed Dose and Dose Equivalent

- Results from all types of radiation
- Absorbed Dose
  - Traditional unit - rad
  - SI unit - Gray (Gy)
  - Comparison
    - 1 Gy = 100 rad
    - 1 rad = 0.01 Gy
- Dose Equivalent
  - Traditional unit - rem
  - SI unit - Sievert (Sv)
  - Comparison
    - 1 Sv = 100 rem
    - 1 rem = 0.01 Sv

Absorbed dose x Radiation Weighting Factor = Dose Equivalent

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# Sources of Background Radiation

Natural ~ 310 mrem

- Radon ~ 200 mrem
- Cosmic ray ~ 35 mrem
- Rocks and Soil ~ 40 mrem
- Food and drink ~ 35 mrem

Man-made ~ 315 mrem

- Medical ~ 300 mrem
- Consumer products ~ 13 mrem
- Research ~ 2 mrem

Total  
Background  
Radiation  
625 mrem/year

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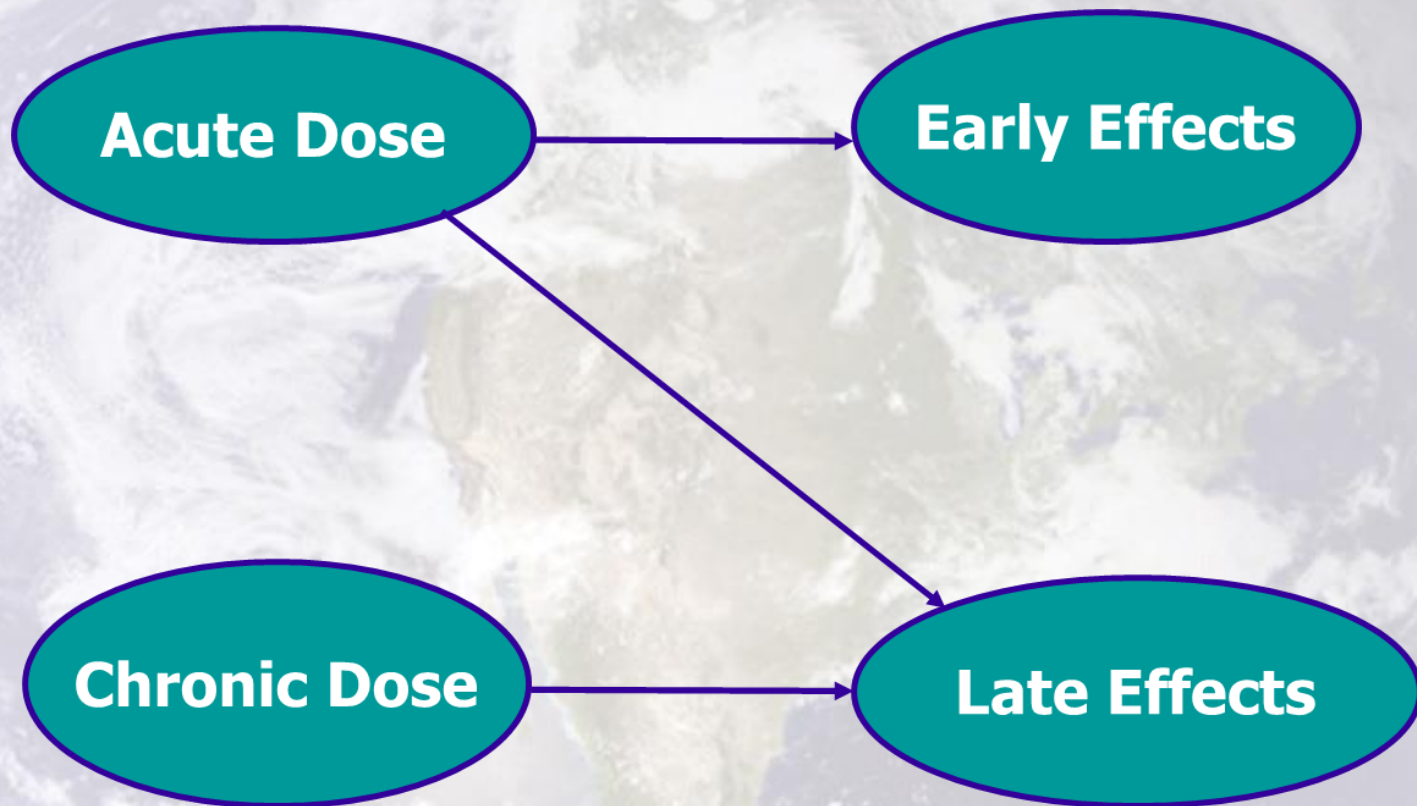
# Biological Effects

- Radiation causes damage in tissue
- No known effects have been found in humans from low level exposure
- Effects depend on many factors
  - The dose
  - The portion of body exposed
  - The rate at which exposure was accumulated
  - The health of the person

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# Biological Effects of Radiation



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# Biological Effects of Radiation

- Acute Dose – Primarily Concern is Early deterministic Effects
- Stochastic Effects Later in Life
- An individual receives a large, short-term, dose. Early deterministic effects may be observed within a few minutes to days
- In research set up, Whole body acute doses are almost impossible unless intentional or in major accident
- Most common injuries are to skin or eyes
- Same long term hazard as chronic dose

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# Acute dose (continued)

- Acute Radiation Syndrome - Deterministic Effect
- symptoms : nausea, vomiting, diarrhea, general malaise, loss of appetite, infections, fever, hemorrhage, and sometimes death
- These early effects only occur for massive doses, which are usually a result of industrial accidents, cancer treatment exposure, or war-related exposures

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# Biological Effects of Radiation

- Chronic Dose – Primary Concern is Later Stochastic Effects
- An individual receives a dose over an extended period
- Chronic dose may cause cancer or genetic defects
- Cataracts (a deterministic effect) resulting from doses to the lenses of the eyes threshold is around 50 rem and typically show the signs around 100 rem

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# ALARA

- The guiding principle behind radiation protection is that radiation exposures should be kept “As Low As Reasonably Achievable (ALARA)”
- Economic and social factors are taken into account
- Radiation doses for both workers and the public are typically kept lower than their regulatory limits. URI action level is 500 mrem (10 percent of the regulatory limit)

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# Protection From External Sources

- Achieving ALARA
- Time
- Distance
- Shielding

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# Time

**Less time means less dose.**

**Time x Dose Rate = Dose**

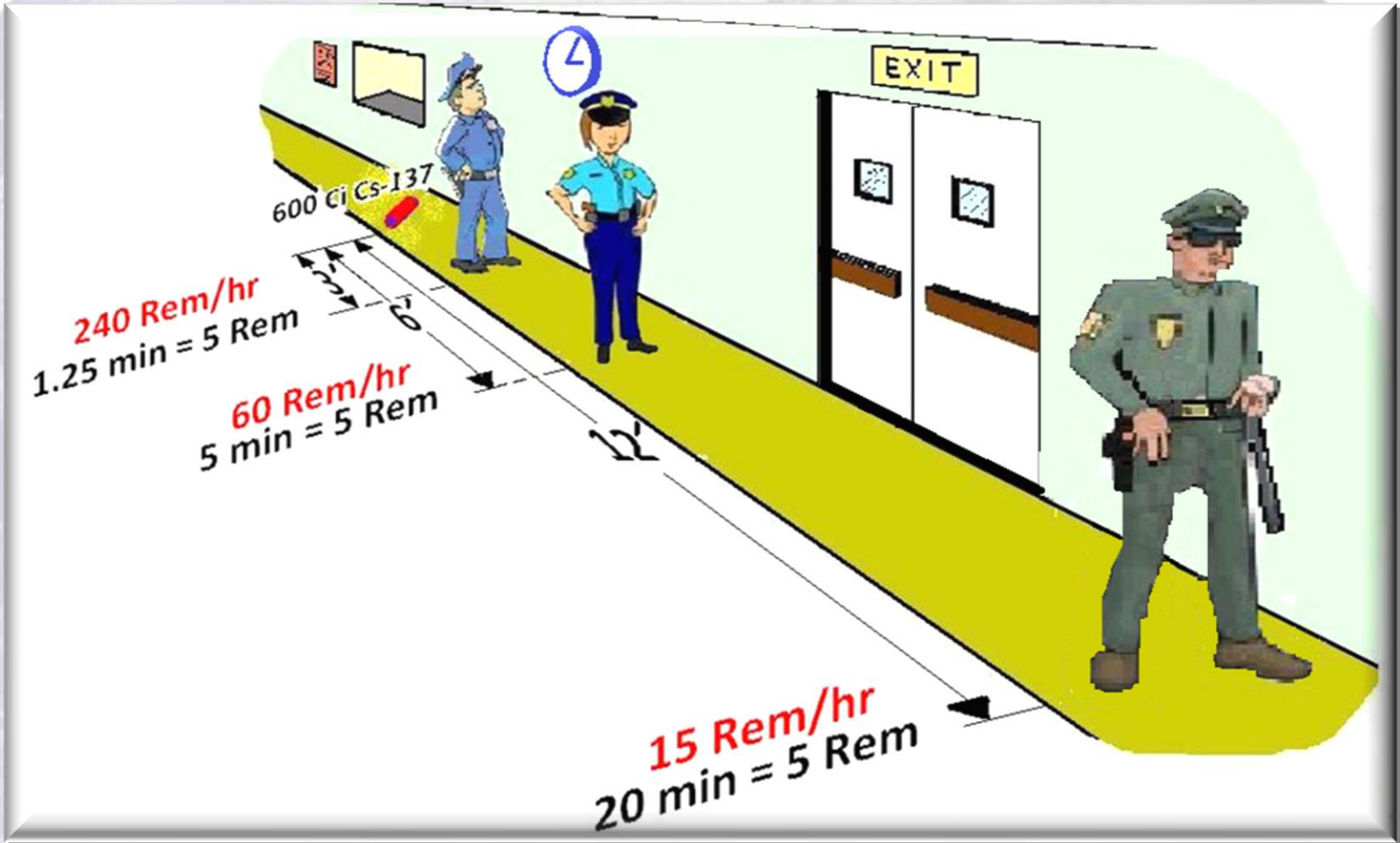
Example:

If you spend 2 hours in a  
5 rem/h radiation area,  
your dose is 10 rem.

**(2 hours) X (5 rem/h) = 10 rem**



# Distance



# Shielding



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# Personnel Monitoring Procedures and Guidelines

- The Radiation Dosimetry Program is administered by Radiation Safety
- Radiation badges are only required to be issued to radiation workers likely to receive 1/10 the maximum permissible exposure limits (500 mrem), which is generally unlikely at URI
- Radiation Safety badges were worn by primary users of X-ray machines
- Area badges can be positioned in or around potentially higher exposure labs for Public Dose monitoring.

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# Personnel Monitoring Procedures and Guidelines

- **If issued, the radiation badge should always be worn when working with X-rays**
- The radiation badges should be kept in a location free from radiation exposure when not in use
- If a badge is lost or damaged, notify the Radiation Safety Officer immediately for a replacement badge
- Notify the Radiation Safety Officer if you terminate and turn in your badges
- The previous radiation badge must be turned in promptly when a new badge is issued

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# Personnel Monitoring Procedures and Guidelines

- The radiation badge in no way provides protection from radiation
- Its sole purpose is to measure the amount of radiation to which it is exposed
- Do not experiment with a radiation badge by exposing it deliberately to radiation or in a X-ray unit
- The radiation badge is only for occupational exposure measurement
- DO not take badges out of the building/campus

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# Personnel Monitoring Devices

- If issued, dosimeters must be worn **when working with sources of radiation**
- The radiation badge should only be worn by the individual whose name is on the badge
- Dosimeters are exchanged monthly or quarterly
- Dosimetry records are kept by the Radiation Safety Officer for inspection
- A dose assessment is required for lost or damaged badges
- Radiation workers receiving radiation badges must fill out a Radiation Badge Request Form and send it to the Radiation Safety office

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# Maximum Permissible Exposure Limits

- Whole Body 5 rem/year
- Any individual organ or tissue 50 rem/year
- Eye 15 rem/year
- Skin or extremity 50 rem/year
- Minor (Under 18 years old) 0.5 rem/year
- Individual member of public 0.1 rem/year
- Embryo/Fetus (During pregnancy) 0.5 rem

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# Survey Meters

## G-M Portable Survey Meter

- Respond to the emissions from a radioactive source or machine source
- Responds with an audible tone
- Two types of probe:
  - pancake-style probe measures surface contamination (in cpm)
  - pancake-style probe with exposure rate filter measures exposure rate (in mR/hr)



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# Calibration

- Instruments must be calibrated at least once every calendar year
- Do not use if past calibration date
- Contact the RSO if your instrument is not functioning properly or out of calibration

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# Preventing Unnecessary Exposure

- Know location and/or presence of primary and diffracted beams AT ALL TIMES
- Do not perform maintenance without confirming that the tube is not energized
- Do not attempt to modify devices
- Follow written instructions
- Perform a safety device check at least monthly
- Survey unit whenever relocated or reconfigured
- Don't put your body parts in the beam

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# X-rays and Injuries

- Close beam x-ray units have almost no potential injuries.
- Analytical x-ray diffraction equipment has the potential to generate high intensity ionizing radiation
- Most frequently reported injuries, in cases of accidental exposure, are severe injury to the upper extremities (hands and fingers)

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# Main Causes of Accidents

- Poor equipment configuration
  - unused beam ports not covered
- Manipulation of equipment when energized
  - adjustments or realignments when x-ray beam is on
- Equipment failure
  - shutter failure, warning light failure
- Inadequate training or failure to follow procedures
  - incorrect use of equipment, overriding interlocks

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# Basic X-ray Safety Guidelines

- Designated Responsible Operator
- X-ray User Training
- Operational Procedures
- Records
- Engineering Protection Systems
- Surveillance Program
- Signage

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# Emergency Procedures

- In the event of an emergency, if possible:
  - Turn the unit off.
  - Remove the key.
- Report the emergency to your AU.
- If the unit cannot be turned off, warn others in the area to leave, evacuate the area, and notify, public safety, and RSO in accordance with your emergency plan.

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# Incident Notification

- Individuals working with radiation must assume the responsibility for their own safety and must ensure that their actions do not result in a hazard to others.
- In the event of a suspected or known exposure, immediately stop work and notify your Authorized User and the Radiation Safety Officer.
- If it is determined that there is an acute localized exposure, seek medical attention as soon as possible.

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# Posting Requirements

Notice to Employee

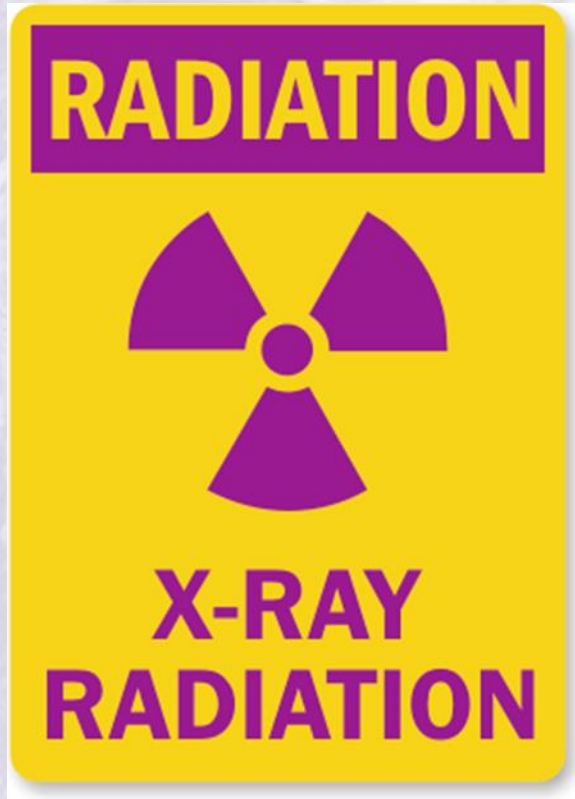
Emergency Contact

Caution X-ray Sign

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# Signs and Postings



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# Signs and Postings

## **RADIATION EMERGENCY PROCEDURES**

**IN CASE OF RADIATION EXPOSURE:**

- 1. STOP WORK IMMEDIATELY**
- 2. NOTIFY PERSONNEL IN AREA**
- 3. CALL RADIATION SAFETY**

**DAY: 789-9391**

**NIGHT : 874-2121**

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# NOTICE TO EMPLOYEES

## STANDARDS FOR PROTECTION AGAINST RADIATION; NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS; INSPECTIONS

**IN THE RHODE ISLAND RULES AND REGULATIONS FOR THE CONTROL OF RADIATION, THE RHODE ISLAND RADIATION CONTROL AGENCY HAS ESTABLISHED STANDARDS FOR YOUR PROTECTION AGAINST RADIATION HAZARDS. IN THE RHODE ISLAND RULES AND REGULATIONS FOR THE CONTROL OF RADIATION, THE RHODE ISLAND RADIATION CONTROL AGENCY HAS ESTABLISHED CERTAIN PROVISIONS FOR THE OPTIONS OF WORKERS ENGAGED IN WORK UNDER AN AGENCY LICENSE OR REGISTRATION.**

### YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to--

1. Apply these Regulations to work involving sources of radiation.
2. Post or otherwise make available to you a copy of the Rhode Island Radiation Control Agency regulations, the license and documents incorporated into the license by reference and amendments thereto, and the operating procedures which apply to work you are engaged in, and explain their provisions to you.
3. Post any Notice of Violation involving radiological working conditions, proposed imposition of civil penalties, or orders issued, and any response from the licensee or registrant.

### WHAT IS COVERED BY THESE REGULATIONS

1. Limits on exposure to radiation and radioactive material in restricted and unrestricted areas;
2. Measures to be taken after accidental exposure;
3. Personnel monitoring, surveys, and equipment;
4. Caution signs, labels, and safety interlock equipment;
5. Exposure records and reports;
6. Options for workers regarding Agency inspections; and
7. Related matters.

### INSPECTIONS

All licensed or registered activities are subject to inspection by representatives of the Rhode Island Radiation Control Agency. In addition, any worker or representative of workers who believes that there is a violation of the Radiation Control Act, the regulations issued thereunder, or the terms of the employer's license or registration with regard to radiological working conditions in which the worker is engaged, may request an inspection by sending a notice of the alleged violation to the Rhode Island Radiation Control Agency. The request must set forth the specific grounds for the notice, and must be signed by the worker or the representative of the workers. During inspections, Agency inspectors may confer privately with workers, and any worker may bring to the attention of the inspectors any past or present condition which he believes contributed to or caused any violation as described above.

### POSTING REQUIREMENT

COPIES OF THIS NOTICE MUST BE POSTED IN A SUFFICIENT NUMBER OF PLACES IN EVERY ESTABLISHMENT WHERE EMPLOYEES ARE EMPLOYED IN ACTIVITIES LICENSED OR REGISTERED, PURSUANT TO PART B OR PART C OF THE RHODE ISLAND RULES AND REGULATIONS FOR THE CONTROL OF RADIATION, BY THE RHODE ISLAND RADIATION CONTROL AGENCY, TO PERMIT EMPLOYEES WORKING IN OR FREQUENTING ANY PORTION OF A RESTRICTED AREA TO OBSERVE A COPY ON THE WAY TO OR FROM THEIR PLACE OF EMPLOYMENT.

### YOUR RESPONSIBILITY AS A WORKER

You should familiarize yourself with those provisions of the Rhode Island Radiation Control Agency regulations, and the operating procedures which apply to the work you are engaged in. You should observe their provisions for your own protection and protection of your co-workers.

### REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The Rhode Island Radiation Control Agency regulations require that your employer give you a written report if you receive an exposure in excess of any applicable limit as set forth in the regulations or in the license. The basic limits for exposure to employees are set forth in Sections A.2.3 and A.2.9 of these Regulations. These sections specify limits on exposure to radiation and exposure to concentrations of radioactive material in air.
2. If you work where personnel monitoring is required:
  - (a) Your employer must give you a written report, upon termination of your employment, of your radiation exposures; and
  - (b) Your employer must advise you annually of your exposure to radiation.

FORM RCA-1 (1/94) - PREVIOUS EDITIONS OBSOLETE

License information and regulations can be obtained at the radiation safety office, URI Bay campus, 16 reactor road, Narragansett, RI or call 789-9391



# Security

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

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# URI Procedures and Policies RI Radiation Safety Regulations

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# X-ray Safety Manual

- Purpose - The purpose of the X-ray Safety Manual is to assist personnel, students, and management in complying with the State Radiation Regulations and the Radiation Safety Program.
- Intent - This Radiation Safety Manual is not intended to be an exhaustive or fully comprehensive reference, but rather a guide for Authorized Users and X-ray Users.
- Authority - The X-ray Safety Manual is an enforceable component of the Radioactive Material Broad Scope License and Radiation Producing Devices Registrations under which the URI is authorized.

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# Radiation Safety Responsibilities

- **Radiation and Laser Safety Committee** - Technical Expertise, Approve Facilities and Usage, Review Radiation Safety Program, Support RSO
- **Radiation Safety Officer and Staff** - Radiation Safety Manuals, Audits and Lab Reviews, Incident Investigations, Health Physics Services and operations, AU Consultations and Technical Support
- **Authorized Users** – Compliance, X-ray Users Safety and Instruction
- **X-ray Users** - Work Safely, Follow the Rules

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# 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.
- 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.
- Rooms containing x-ray machines should be RESTRICTED AREAS.

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# Area Requirements

- Radiation surveys of all analytical x-ray systems sufficient to show compliance shall be performed upon;
  - installation of the equipment;
  - following any change in the initial arrangement;
  - 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.

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# Personnel Requirements

- No person shall be permitted to operate or maintain radiation machines unless such person has received instruction in general x-ray safety
- All X-ray Users including the Authorized User must attend and pass the URI X-ray Safety Training including annual refresher training
- The Authorized User must provide specific training for the use of the x-ray machine and associated radiation hazards to all of his or her X-ray users

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# Emergency Information

- The Radiation Safety Office hours: Monday through Friday, 8:30 a.m. – 4:30 p.m.
- For assistance with a radiation emergency or incident during normal office hours call the radiation Safety Office.
- In the event of an after hours radiation emergency, contact the URI Public Safety.
- emergency information is available in the X-ray Safety Manual at <http://www.uri.edu/radiation>
- If you call after normal office hours about a non-emergency incident, you may leave pertinent information on the radiation safety office's telephone voicemail.

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# Emergency Telephone Numbers

- Environmental Health and Safety (401) 874-7993
- Environmental Health and Safety (Emergency) (401) 874-2121
- **Radiation Safety Office (401) 874-2600**
- **Radiation Safety Officer (401) 874-9439**
- **Health Physicist (401) 874-9451**
- URI Health Service (401) 874-2246
- URI Public Safety (Emergency) (401) 874-2121
- URI Public Safety (Non-Emergency) (401) 874-4553
- Medical Emergencies (401) 874-2121

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