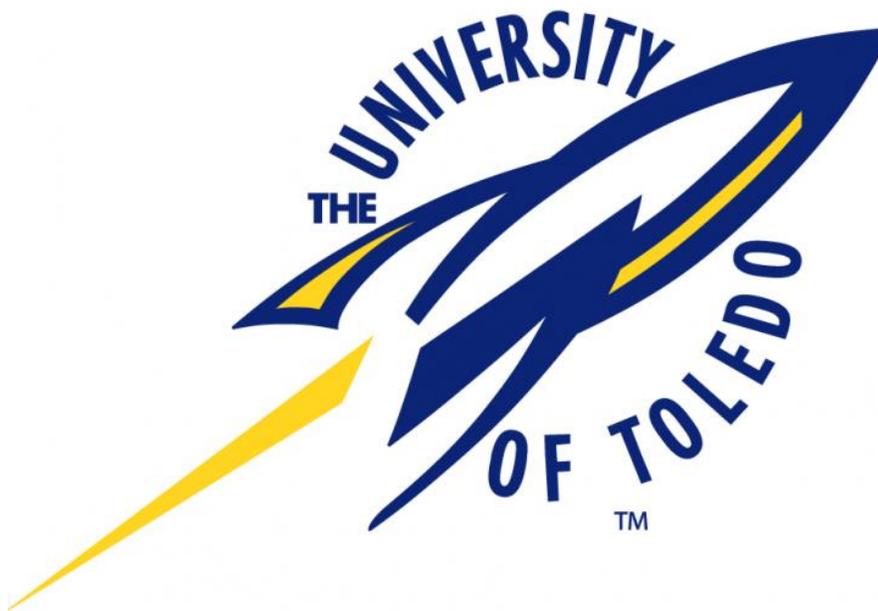


The University of Toledo
Radiation Safety Manual



For Users of Non-Medical
Radiation Generating Equipment (RGE)

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RGE Manual Introduction

This manual is intended to inform RGE and RPD Users of the regulations that are required of them to comply with. Also, included are the ODH regulations for the safe operation of RGE (and other RPD) and specific practices to aid RGE Users in minimizing their exposure to ionizing radiation.

Potential Hazards of Radiation Generating Equipment (RGE)

RGE such as diffractometers use very high intensity, collimated x-ray beams to examine the properties of materials. The x-ray dose rate at the beam port (window) can be several thousand rad per second. Exposure of extremities to the primary x-ray beam can result in severe radiation burns in a matter of seconds. Radiation burns are the principle hazard associated with the use of analytical x-ray equipment or RGE.

Leakage or scatter of the primary beam through apertures in bad fitting of defective equipment can produce very high intensity beams of possibly small and irregular cross section. Dose rates near the machine from scattered radiation can be as high as a few hundred millirem per hour. Although this is not likely to cause radiation burns, doses from scattered radiation can exceed regulatory limits if the beam is not properly enclosed or contained. In fluorescence, the primary beam strikes the sample inside a shielded enclosure, and only the scatter radiation emerges from the machine for analysis. Consequently, external radiation levels are much lower in the fluorescence mode than in the x-ray diffraction mode.

Modern diffraction machines incorporate shielding and safety design features to prevent both acute local accidental exposure and chronic exposure to radiation. Operators should be especially cognizant of protective devices incorporated into their machines and the possibility for failure or malfunction. Decreasing time, increasing distance, and shielding represent the most practical methods a radiation worker can use to minimize their radiation exposure.

Some Definitions

ALARA	As Low As Reasonably Achievable” (pertaining to exposure to radiation).
Individual User	An individual user is a trained and qualified operator using radiation generating equipment under the supervision of a PI principle investigator).
Ionizing Radiation	Any form of radiant energy that can cause an electron to Radiation eave an atom. Such radiation at the University of Toledo can arise from radioactive materials and radiation generating equipment.
Principle Investigator	A Principle Investigator (PI) is the individual responsible for the operation and handling of specific radiation generating equipment.
RGE	“Radiation Generating Equipment” or any object capable of producing X-rays. Such devices may include analytical equipment and instruments that may generate secondary x-rays such as: <ul style="list-style-type: none">• X-ray diffraction• Fluorescence Spectroscopy• Luminoscopes• Electron Microscopes• Gauging Unit• Industrial/Research CT• Industrial Tomography• Accelerators (particle)• Bone Densitometers• Portable radiography• Portable fluoroscopy (c-arm)

No research device at the University may be used to perform diagnosis or therapy of human ailments.

Definitions Continued

Rem	<p>Rem, unit of radiation dosage (such as from X rays) applied to humans. Derived from the phrase <i>Roentgen equivalent man</i>, the rem is now defined as the dosage in rads that will cause the same amount of biological injury as one rad of X rays or gamma rays. Formerly poorly defined, the rem was redefined in 1962 to clarify the usage of the term <i>relative biological effectiveness</i> (RBE) in both radiobiology and radiation protection. A rem is equal to 0.01 Sievert in the International System of Units (SI).</p>
Restricted Area	<p>Any area for which access is controlled for purposes of protection of individual from exposure to radiation. Generally speaking, any area where an individual might receive a dose of 2.0 millirem in an hour should be a restricted area.</p>
Unrestricted Area	<p>Any area for which access is not controlled for purposes of protection of individuals from exposure to radiation.</p>
X-Ray Radiation	<p>Electromagnetic radiation with quantum energy between 0.1 and 100 kilo electron volts (keV) that is not generated by decay of radioactive materials.</p>

Individual Responsible for the Radiation Safety Program (IRRP)

The Radiation Safety Officer/Individual Responsible for Radiation Protection (RSO/IRRP) has the authority to coordinate program activities, as necessary, with the Chief of Campus Police, the University Health Center, the Associate Vice President for Facilities Management and the Director of Environmental Health and Radiation Safety. The (RSO/IRRP) also handles all program matters involving the Ohio Department of Health/Bureau of Radiation Protection (ODH/BRP). Specific on-campus responsibilities of the IRRP pertaining to Radiation Generating Equipment (RGE) include:

- Director of Environmental Health & Radiation Safety
- Serve as the chairman of the X-ray QA Committee
- Provide applications and advice to members of faculty and staff wishing to become approved users of RGE
- Facilitate applications from Faculty/Staff to become approved users of RGE
- Conduct an annual review of the RGE Safety Program by a qualified person
- Enforce regulations and policies as established by the Radiation Safety committee for RGE and the ODH (3701:1-38, 3701:1-68 and 3701:1-66 of the Ohio Administrative Code)
- Suspend use of RGE by anyone who is acting in a way contrary to prudent radiation safety practices or contrary to the regulations of the Ohio Department of Health or the rules and procedures set forth in this manual
- Maintain dosimetry records
- Provide information on matters involving Radiation Generating Equipment to local organizations as requested

Obtaining Permission to Use Radiation Generating Equipment

Planning: The importance of planning the installation and use of machines (RGE) cannot be overemphasized. Adequate lead times must be allowed for review of the facilities that may require new construction or remodeling and registration with the Ohio Department of Ohio (ODH). Preoperational evaluation of shielding needs and operating procedures will also be required before routine use of such machines (RGE) can be authorized. Any question you have regarding this can be directed to the Radiation Safety Officer at 419-383-4301.

Purchasing: In order to purchase or otherwise bring radiation –generating equipment to campus and to supervise their use by students or staff and individual must become an Approved User of Radiation –Generating Equipment (RGE)

To become an Approved User of Radiation Generating Equipment an individual must:

- be a full time faculty or staff member
- have a bachelor's or higher degree in biological, chemical, geological, physical or engineering sciences or the equivalent as specified by the IRRP
- have formal training or supervised laboratory experience with the use of radiation generating equipment
- have formal training or supervised laboratory training of the hazards associated with the use of radiation- generating equipment
- fill out the form entitled "Application for the Use of Radiation Generating Equipment" and submit to the IRRP in the Radiation Safety Office.

Approved Users are responsible for the associated costs of purchase, storage, use and disposal of radiation generating equipment in cooperation with IRRP/ they are responsible, along with the IRRP, for the training and performance of all workers using radiation generating equipment within their laboratories. They are responsible for the safety of all persons entering their laboratories when radiation-generating equipment is in use. Approved Users must adhere to the expectations of the Radiation Safety Program of the University of Toledo.

University of Toledo
Application to become an Approved User of
Radiation Generating Equipment

Name: _____ Today's Date _____

Academic rank or position: _____ Dept.: _____

Highest degree held: _____ Institution granting _____

List formal courses taken in radiation biology or health physics on the handling of RGE:

List supervised lab experience with actual use of radiation-generating equipment:

List any other experience with actual use of radiation-generating equipment:

RGE usage per month:

Type of RGE to be purchased:

Proposed location of RGE _____

I have read the University's Radiation Safety Manual for Radiation –Generating Equipment. I am prepared to follow the policies presented in that manual. I understand that I am responsible for the proper use of RGE in my laboratory. I understand that I am responsible for protecting all individuals present in my lab from the hazards of ionizing radiation present.

Applicant signature

Date

Comments of the Radiation Safety Office:

IRRP Signature

Date

_____ Approved

RGE Project No. _____

_____ Denied

Procedure for Ordering & Receiving RGE

Only APPROVED Users may purchase or receive as gifts any Radiation Generating Equipment (RGE). Each purchase requisition or documentation of acceptance of a gift must be counter-signed by the IRRP. A copy of each requisition or documentation shall be maintained by the Radiation Office.

No x-ray producing instrument may be placed into routine use without having the IRRP survey the instrument in operation for any hazardous conditions and ensure that all policies relating to the use of Radiation-Generating Equipment are being followed.



Student Research

Each student doing research in a laboratory using ionizing radiation must be properly trained by the Approved User in charge of the lab.

Graduate students completing a dissertation or thesis project must complete the form “Assurances of Compliance with Applicable Federal and State Regulations Governing Research”. This form is available from the Graduate School Office. This form is to be completed before the student engages in any research involving ionizing radiation.

In any formal Laboratory Course in which undergraduate students use ionizing radiation, the Approved User in charge of the course or properly trained faculty, staff, or graduate teaching assistant must be present in the laboratory at all times when ionizing radiation is being used.

Undergraduate students doing independent research involving ionizing radiation, must be trained, as are the graduate students and staff members, who work in the laboratory.

Training Required of Personnel Using Radiation-Generating Equipment

Laboratory personnel using Radiation-Generating Equipment (RGE) under the supervision of an Approved User must be trained in the proper use of radiation. This training must include discussion of the portions of this manual entitled, “General Procedures to be Followed by Persons Using Radiation-Generating Equipment” and “Training for People Working in or Frequenting Restricted Areas”. Emphasis must also be placed on ways of monitoring performance areas for the presence of x-ray radiation.

This training must be done by both the Approved User of the Laboratory and the IRRP (RSO). A record of this training must be kept by the Approved User for immediate inspection in the Radiation Safety Notebook located in the Lab. Certificates of documentation must be maintained in this notebook.

The Approved User in charge of a laboratory shall ensure that no person shall be allowed to work unassisted by a trained person with Radiation –Generating Equipment (RGE) in his/her lab, the Approved User shall observe the worker to ensure that the worker thoroughly understands and uses the received training.

Women that become pregnant and use radiation-generating equipment (RGE) have the option to declare the pregnancy to the IRRP (RSO) to receive additional monitoring.

Training for People Working in or Frequenting Restricted Areas

Each person working in or frequenting a restricted area, whether or not actually working with Radiation-Generating Equipment (RGE) must receive training that includes:

- Introduction to nature of ionizing radiation and damage it may cause
- Health problems associated with exposure to sources
- The presence and locations of restricted areas
- Meaning of radiological warning signs within a restricted area
- Occurrence of radiation sources within a restricted area
- What locations within the restricted area should be avoided by persons not directly using the radiation-generating equipment
- Precautions and procedures to minimize exposure
- Reports of radiation exposure which a person may request
- What to do if suspected problems or emergencies arise
- Required presence of “Notice to Employees” within restricted area
- Organization of the University’s Radiation Safety Program
- General contents of the University’s Radiation Safety Manuals
- The existence, scope, and location of the Ohio Administrative Code
- Pertaining to matters of Radiation Safety. These are 3701: 1-38 & 3701: 1-68.

General Procedures for Those Using Radiation Generating Equipment

Note: Only approved users may authorize the use of Radiation Generating Equipment. The equipment must only be operated in the manner in which it was intended. The following are general procedures that must occur with the use of RGE:

- All operators receive training as discussed in the RGE manual
- All analytical systems shall conspicuously display a clearly legible label or labels bearing the radiation symbol and the words "CAUTION - THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED. The label should be located very near to the switch that activates the machine
- All RGE must have appropriate visual indication when the machine turned on and producing x-rays. Discontinue use and contact the IRRP immediately if visual indication is not operating properly
- All machines must have interlocks that turn the equipment off when radiation shielding is opened. Exceptions to this procedure must have prior approval from the ODH and IRRP. If the interlocks are not working properly you may not use the device, discontinue use and contact the IRRP Immediately
- All doors to the space containing Radiation-Generating Equipment have appropriate "Radiation Area" warning signage
- All spaces with Radiation-Generating Equipment must have appropriate "Notice to Employees" signs and all Radiation-Generating Equipment must have appropriate "Safe Operating Procedures" posted and/or in the RGE Notebook specific to that particular unit
- Any equipment malfunction or error must be reported to the IRRP Immediately
- All RGE operators must sign a log indicating the use of the RGE.

Monitoring Compliance for RGE Regulations

Areas where radiation generating equipment (RGE) is housed will be subject to periodic inspections conducted by the Radiation Safety Office. This will be an audit of regulatory requirements and an opportunity to answer any questions between the Instrument lab workers and the Radiation Safety Office. The ultimate goal of the inspections is to ensure safety, as well as, compliance with ODH regulations. The inspections will include but are not limited to:

Equipment security

Lab signage

ODH postings

Dosimetry review (if applicable)

Radiation Safety Notebook

Training Documents

Repair Logs

Interlock Safety Test Logs

Equipment operation audits

Override Logs

The ODH will inspect all RGE on a periodic basis (typically every 3 years). ODH has the authority to issue violations of the regulations. If the PI does not correct these violations within 30 days, the ODH has the authority to issue a "Cease Operations Order". Financial penalties may also be assessed the PI/Institution.

Radiation Dose Limits

In order to detect and evaluate exposure to external radiation, individual monitoring devices will be issued to individuals who are likely to receive in one year (from sources external to the body), a dose in excess of 10% of the applicable or permissible limits.

The Limits are:

Adult Worker	ODH Dose Limit (mrem/yr)
Total Effective Dose Equivalent	5000
Total Organ Dose Equivalent	50,000
Lens of Eye	15,000
Extremities/Skin	50,000
Embryo/Fetus (Declared Pregnant Worker)	Total Effective Dose Equivalent 0.5 rem/9 mos. (total pregnancy)
Minor (<18yrs. of age)	10% of Adult Limits

All suspected occupational radiation overexposures must be reported immediately to Radiation Safety. If any redness or unusual discoloration of the skin occurs, mention this to the Radiation Safety Officer. All dosimetry is reviewed by the Radiation Safety Office.

Any verified radiation overexposures measured by whole body dosimeters and/or finger rings above the Level I or II will require documented review and action taken. Any radiation overexposures, pursuant to Chapter 3701: 1-38 of the Ohio Administrative Code will be reported to the Director of the Ohio Department of Health.

Recognition of an Acute Localized Exposure: Most radiation injuries seldom cause the classical signs and symptoms of the acute radiation syndrome. Symptoms may include a skin lesion, erythema, blistering, dry or wet desquamation, epilation, or ulceration. Local injuries to the skin (typically the hands) evolve very slowly over time and symptoms may not manifest for days to weeks after exposure.

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