

TEMPLE UNIVERSITY

RADIATION SAFETY USERS GUIDE

IRRADIATORS

**Environmental Health &
Radiation Safety Department**
June 2023

Table of Contents

	Page
RADIATION BASICS	3
Radiation Quantities	4
Half-life	4
Background Radiation	4
Radiation Detection Instruments	4
Biological Effects of Radiation	4
PRINCIPLES OF RADIATION SAFETY	6
Occupational Dose Limits	6
Public Dose	6
Dose to Embryo and Fetus	6
Registration of Radiation Workers	7
Personal Monitoring	7
Types of Dosimeters	7
Dosimeter Placement	7
Exposure Reports	8
ALARA	8
Posting	8
RADIATION SAFETY PROGRAM	9
Individuals Responsible for Radiation Safety Program	9
Radiation Safety Officer	10
Authorized User	11
Radiation Workers	12
RADIATION SAFETY PROCEDURE	13
Training Program	13
Audit Program	14
Survey Program Radiation Exposure Survey	14
Location of Use, Storage, Transfer, and Disposal of Irradiator	15
Radioactive Materials Control and Accountability	15
Security	15
Proper Recordkeeping	15
Visitors and Minors	15
Notification	16
Employee Protection	16
Deliberate Misconduct	17
General Operating Procedures	17
OPERATING INSTRUCTION AND EMERGENCY PROCEDURES FOR BLOOD BANK IRRADIATOR	17
Periodic Inspection and Maintenance	19
APPENDIX A: Radiation Worker Registration Form	20

RADIATION BASICS

Radiation Quantities

- **Exposure** is a measure of the ionization produced in air by x or γ radiation. The conventional unit of exposure is roentgen (R)
- **Radiation effect** on any material is determined by the radiation “dose” that is received by the material.
- **Radiation dose** is the quantity of radiation energy deposited in a material.
- **Absorbed dose** is the amount of energy deposited in any material by the ionizing radiation. Absorbed dose is measured in rads. A rad, is a measure of energy absorbed per gram of material.
- **Dose Equivalent** is a measure of the effectiveness of the absorbed dose. It expresses the effect of all radiation on a common scale for calculating the effective absorbed dose. The unit of Dose Equivalent is rem, which is defined as the product of absorbed dose and the quality factor of radiation. The quality factor for x-rays, gamma rays, and electrons is 1.

It is customary to refer to the quantity of radioactive materials based on its activity. The activity is simply the number of nuclear disintegration or transformations the quantity of material undergoes per second. The activity is measured in curies (Ci). The SI unit for activity is Becquerel (Bq).

The conversion between conventional unit and SI unit is listed below:

Quantity	Conventional unit	(SI) unit	Conversion
Exposure	roentgen (R)	Coulomb/Kg of air (C/kg)	1 C/kg = 3876 R 1R = 2.58×10^{-4} C/kg 1R = 1000 mR
Dose	rad (100 ergs/g)	gray (Gy)	1 Gy = 100 rad 1cGy = 10^{-2} Gy = 1 rad 1 rad = 1000 mrad
Dose equivalent	rem (rad X quality factor(Q))	sievert (Sv) (Gy X Q)	1 Sv = 100 rem 1 rem = 1000 mrem
Activity	Curie,	Bacquerel (Bq)	1 Ci = 3.7×10^{10} Bq 1 Ci = 1000 mCi

Half-life

Radioactive atoms decay randomly but at a characteristic rate. The decay times, the number of steps in the decay, and the kind of radiation released at each step are well known.

The time required for half of the material to decay is called its Half-life and is designated by $T_{1/2}$. Each radioactive isotope has its own characteristic half-life. Half-lives can range from less than a millionth of a second to millions of years depending upon the isotope. The number of atoms of a radioactive material remaining after a time (t) is calculated by the following relationship:

$$A=A_0 e^{(-0.693 \cdot t)/T_{1/2}},$$

where A_0 is the original number of atoms.

Example: ^{137}Cs has a half-life of 30 years. If the initial amount of ^{137}Cs is 10,000 Ci, after 30 years 5,000 Ci of ^{137}Cs will be remaining.

Background Radiation

Radiation is occurring naturally in the environment. The sources of this radiation include radon in the air, naturally occurring radioisotopes, and cosmic rays from outer space. We are constantly exposed to this radiation. This is commonly called naturally occurring background radiation.

The average background radiation exposure to an individual in the United States is about 600 mrem (6 mSv) per year. Background radiation varies from area to area. For instance, Colorado has higher radiation levels because its high altitude receives higher dose of cosmic radiation, and its uranium rich soil produces more radiation. Brick homes have higher natural radiation levels than homes made of other materials such as wood; domestic water supplies contain radon; and certain foods such as bananas and Brazil nuts contain higher levels of radioisotope than other foods.

Radiation Detection Instruments

Detection of contamination and monitoring of exposure must be performed using an appropriate survey instrument. No single instrument can measure all types of radiation. The survey instruments most frequently used for irradiators are Geiger-Muller (GM) detector and ion chamber.

Biological Effects of Radiation

Biological effects of radiation on living cells may result in three outcomes:

- cells repair themselves, resulting in no damage.
- cells die, much like millions of body cells do every day, being replaced through normal biological processes; or
- cells change their reproductive structure.

The effects of radiation, like those of most chemical substances, can be seen clearly only at doses much higher than are allowed by Federal and State regulations.

Biological effects of radiation may be classified as deterministic or stochastic effects.

Deterministic effects can appear in a matter of minutes to as long as a few weeks after exposure to very high doses of radiation. The higher the dose, the sooner the effects will appear, and the higher the probability of death. For example, in 1986, firefighters battling the fire at the Chernobyl nuclear power plant in the Ukraine died from very large doses of approximately 1,100,000 milli-rads (11 Gy) of radiation.

It is not always possible to determine the amount of fatal dose because radiation affects different people in different ways. However, it is believed that 50% of a population would die within thirty days after receiving a dose of between 250,000 mrem (2.5 Sv) to 450,000 mrem (4.5 Sv) over a period of a few minutes to few hours. This would vary depending upon the health of the individuals before the exposure and the medical care received after the exposure. These are acute whole-body doses, meaning that the whole body is exposed to the radiation in a very short period (minutes to hours). Exposure of only parts of the body will likely lead to more localized effects, such as skin burns or tissue damage in the exposed area.

Stochastic effects of radiation are effects that appear many years (usually between 5-20 years) after exposure. The period before cancer appears is known as the latent period. Genetic effects and the development of cancer are the primary health concerns. The cancers that may develop because of radiation exposure are indistinguishable from those that develop spontaneously or because of exposure to other carcinogens. Radiation exposure may be only the initiating step that may or may not eventually lead to cancer. Genetic effects may appear in the exposed person's direct offspring, or may appear several generations later, depending on whether the altered genes are dominant or recessive.

Although radiation is known to cause cancers at high doses and high dose rates, currently there are no data to unequivocally establish the occurrence of cancer following exposure to low doses and dose rates below about 20,000 mrem. (0.2 Sv) Studies of a population exposed to chronic low levels of radiation above normal background have shown no biological effects. This population includes occupationally exposed radiation workers and people living in areas having high levels of background radiation above 1,000 mrem (0.01 Sv) per year.

PRINCIPLES OF RADIATION SAFETY

Exposure of members of the public and workers can be minimized using good safety practices, adequate training of users of radiation or radioactive material, and appropriate equipment. The following practices are a must in efforts to minimize exposure: **Time, Distance, and Shielding**.

- **Minimize the time** spent near the source of radiation or in the radiation field. The longer the time, the higher is the dose received.
- Minimize the external radiation exposure by **increasing the distance** of the individual from the source of radiation. Keep in mind that the intensity of any radiation field is reduced by a factor of four when the distance from the radiation source is doubled.
- Do not manipulate or remove any of the **protective shielding** of the irradiator. The shielding is strategically in place to provide the lowest exposure rate to users.

Occupational Dose Limits

The annual dose limit for occupational radiation workers is 5,000 mrem (0.05Sv) for whole body, 15,000 mrem (0.15 Sv) for the lens of the eye and 50,000 mrem (0.5 Sv) for organs (e.g., breast, lung), skin and extremities. These limits include exposure from all sources.

Public Dose

The radiation dose received by individual members of the public can not exceed 100 mrem (0.001Sv) in one calendar year. In addition, the radiation dose in unrestricted areas can not exceed 2 mrem (0.00002 Sv) in any one hour.

Dose to an Embryo/Fetus

The National Council on Radiation Protection and Measurements (NCRP) has recommended limits for radiation exposure to an embryo/fetus. The Nuclear Regulatory Commission (NRC) and the Department of Environmental Protection of the State of Pennsylvania (PA) have set limits for radiation exposure to the embryo/fetus of a declared pregnant woman. The NRC and PA require that the dose to an embryo/fetus during the entire pregnancy, from occupational exposure of a **declared** pregnant worker, must not exceed 500 mrem (0.005 Sv). Efforts must be made to assure that this dose is distributed uniformly over the entire period of pregnancy.

A pregnant employee is highly encouraged to voluntarily inform their employer, in writing, of their pregnancy and the estimated date of conception. Further, such an employee is encouraged to visit the Radiation Safety Department and receive information regarding concerns they may have about radiation exposure during pregnancy. Such an employee may discuss their concerns with the Health Physicist.

Upon submission of a completed “Declaration of Pregnancy” form (available at the Radiation Safety Department, 3307 N. Broad Street, # B 49), the Radiation Safety Department will:

- Evaluate the exposure history of the individual and their coworkers.
- Provide information concerning risk and precautions.
- Evaluate the working environment with respect to radiation exposure.
- Make recommendations for reducing radiation exposure.
- Monitor monthly radiation exposure with respect to the NRC and PA limits.

Registration of Radiation Workers

The Nuclear Regulatory Commission (NRC) and Department of Environmental Protection of the State of Pennsylvania (DEP) regulations require that individuals should receive training prior to working with irradiator. Workers who have the potential of receiving doses more than 10% of regulatory limits are required to be monitored for exposure to radiation. In addition, Temple University policy requires that all radiation workers register with The Environmental Health and Radiation Safety Department (EHRS). A Radiation Worker Registry is maintained by EHRS to ensure that these regulatory requirements are met. Authorized users are required to register workers who are using irradiator under their supervision. (Appendix A)

Personal Monitoring

EHRS provides personal monitoring devices to monitor exposure of workers to radiation. Dosimeters are provided to adult radiation workers who are likely to receive an annual total effective dose equivalent (TEDE) of 500 mrem (0.005 Sv) and to minors or to declared pregnant workers who are likely to receive an annual TEDE of 50 mrem (0.0005).

Exposure of a personnel monitoring device to deceptively indicate a dose delivered to an individual is prohibited and is a violation of Pennsylvania Department of Environmental Protection regulation. (PA 215.28). NRC regulations also prohibit such deliberate misconduct.

Types of Dosimeters

Workers are provided appropriate monitoring devices (dosimeters). Dosimeters are exchanged quarterly or as determined by the RSO. A NVLAP-accredited commercial vendor processes the monitoring devices.

Dosimeter Placement

Interpretation of the measured dose depends on the placement of the dosimeter. All personnel must wear their dosimeters correctly. Dosimeters must be worn at collar level. Dosimeters must

be returned to EHRS promptly at the end of each quarter or as determined by the RSO. The Individuals who are late in returning their dosimeters will be fined and repeated non-compliance will be referred to the **RADIATION SAFETY COMMITTEE (RSC)** for further disciplinary action.

Exposure Reports

Exposure report is available at EHRS for individuals who wish to review their exposure. EHRS reviews exposure reports and all high or unusual exposures are investigated, and a report is provided to the RSC along with the result(s) of the investigation.

ALARA (As Low As Reasonably Achievable)

This policy provides specific guidance and data on Temple University’s approach to the implementation of the ALARA principle. EHRS reviews personnel exposures on a regular basis. A written report is provided to the RSC that includes any abnormal exposures or those exceeding ALARA Levels I and II, and the results of the subsequent investigation by the EHRS of such exposures. ALARA Level I and II are stated below:

ALARA	Level I		Level II	
	mrem/y	mrem/Q	mrem/y	mrem/Q
Whole body	480	120	1440	480
Lens of Eye	1500	375	4500	1125
Extremities, Skin, any organ/tissue	4800	1200	14400	3600

EHRS evaluates the cause of radiation exposure above ALARA limits and present it to the RSC, with the request to provide guidance to EHRS for possible corrective actions. EHRS in turn implements the recommendations of the RSC. In every case, the investigator will be asked to take steps to reduce the radiation exposure unless the investigator can demonstrate that all reasonable measures were utilized to keep the radiation exposure ALARA.

Posting

To alert personnel of the presence of radioactive materials and potential radiation hazards, caution signs and labels should be posted for the following:

- The irradiator materials must be posted with a **“CAUTION, RADIOACTIVE MATERIAL”** sign.
- The PA "Notice to Employees," must be posted. Please see radiation safety for the most up to date version.

RADIATION SAFETY PROGRAM

Individuals Responsible for Radiation Safety Program

The Temple University/Temple University Health System Management Designee is responsible for oversight of Temple University's Radiation Safety Program and along with the Radiation Safety Officer, has the ultimate responsibility for the license and the activities associated with the NRC and PA licenses. The licensee has also established a Radiation Safety Committee (RSC) to oversee the activities authorized by the licenses. The membership of RSC is appointed by the management designee and includes senior managers (Directors, Chairpersons, Heads) of those departments/divisions that are involved in the use of radioactive material or radiation producing equipment to assure active participation of members of senior management in the implementation of the Radiation Safety Program. Management is responsible for:

- Radiation safety, security and control of radioactive materials, and compliance with regulations
- Completeness and accuracy of the radiation safety records, and all information provided to the PA DEP
- Knowledge about the contents of the license and application
- Meticulous compliance with current PA DEP and Department of Transportation (DOT) regulations and the licensee's operating and emergency procedures
- Commitment to provide adequate resources (including space, equipment, personnel, time, and, if needed, contractors) to the radiation protection program to ensure that public and workers are protected from radiation hazards and meticulous compliance with regulations is maintained
- Selection and assignment of a qualified individual to serve as the Radiation Safety Officer (RSO) for licensed activities
- Prohibition against discrimination of employees engaged in protected activities (10 CFR 30.7)
- Commitment to provide information to employees regarding the employee protection and deliberate misconduct provisions in 10 CFR 30.7 and 10 CFR 30.10, respectively
- Obtaining PA DEP's prior written consent before transferring control of the license
- Notifying appropriate PA DEP regional office in writing, immediately following filing of petition for voluntary or involuntary bankruptcy

Radiation Safety Officer (RSO)

The management has assigned the RSO the responsibility to ensure that all licensed activities are conducted in accordance with the current regulatory requirements. The RSO is given the authority to stop an operation immediately if, in their judgment, the operation is unsafe or is in violation of Temple University policies. Furthermore, the RSO may require specific actions by the users to assure compliance with Temple University policies, and Federal and State regulations.

Responsibilities of the RSO:

- General surveillance of all radiation safety activities, including investigation of over-exposures, accidents, losses, thefts, unauthorized receipts, uses, transfers, disposals, and other deviations from approved radiation safety procedures, and implementation of corrective actions.
- General surveillance of all radiation safety activities, including investigation of over-exposures, accidents, losses, thefts, unauthorized receipts, uses, transfers, disposals, and other deviations from approved radiation safety procedures, and implementation of corrective actions.
- Developing and implementing radiation safety training program for workers
- Developing and implementing a personnel monitoring program for workers, reviewing of personnel exposure records, and developing corrective actions for those exposures approaching the regulatory limits
- Controlling the procurement of radioactive material, including the authorization of purchase of radioactive material
- Performing an initial review of requests for new authorizations/procedures and making appropriate recommendations to the management for final approval or disapproval
- Performing leak tests and inventories of sealed sources
- Evaluating relevant equipment, physical facilities, operational techniques, and procedures
- Managing the radioactive waste program including collection, storage, and disposal of radioactive waste
- Development, distribution, implementation, and maintenance of up-to-date operating and emergency procedures
- Possession, installation, relocation, use, storage, repair, and maintenance of self-shielded irradiators are consistent with the limitations in the license and the manufacturer's written recommendations and instructions.
- Safety consequences are analyzed before conducting any activities involving repair, use, maintenance, installation, or relocation, which were never previously analyzed.

- Individuals installing, relocating, using, maintaining, or repairing self-shielded irradiators are trained and authorized as described in the license application.
- Prospective evaluations are performed demonstrating that individuals are not likely to receive, in one year, a radiation dose more than 10% of the allowable limits or personnel monitoring devices are provided.
- When necessary, personnel monitoring devices are used and exchanged at the proper intervals, and records of the results of such monitoring are maintained.
- Self-shielded irradiators are properly secured.
- Proper authorities are notified of incidents such as damage to or malfunction of self-shielded irradiators, fire, or theft.
- Unusual occurrences involving the self-shielded irradiators (e.g., malfunctions or damage) are investigated, cause(s) and appropriate corrective action(s) are identified, and timely corrective action(s) are taken.
- Radiation safety program audits are performed and documented.
- Maintaining records required by the regulations.

Authorized Users (AU)

Authorized Users are faculty members to use irradiator, have required irradiator training and adequate experience.

Responsibilities of AU

The Authorized User is responsible for:

- Developing, implementing, and maintaining specific operating and emergency procedures for the following:
 - a) An analysis of each type of material to be placed in the irradiator to ensure that it is compatible with the irradiator's design or to determine if any special safety procedures are needed.
 - b) Instructions for using the self-shielded irradiator and performing routine maintenance, according to the manufacturer's (or distributor's) written recommendations and instructions.
 - c) Instructions for maintaining security to prevent unauthorized use, access, or removal of self-shielded irradiators and the associated sealed sources.
 - d) Steps to take to keep radiation exposures ALARA.
 - e) Steps to maintain accountability.
 - f) Steps to control access to a malfunctioning or damaged irradiator.

- g) Steps to take, and to contact RSO, and local emergency responder (fire department, etc), when an irradiator malfunctions or has been damaged or caught fire.
- Ensuring safe use of irradiator under their respective use
 - The health and safety of anyone using or affected using irradiator under his or her direction or supervision.
 - Ensuring that personnel working under their supervision receive required radiation safety training for irradiator prior to use including work-specific training.
 - Providing necessary equipment and supplies for safe use of irradiator.
 - Security of irradiator and any security problem are immediately reported to RSO and security.
 - Ensuring that his/her employees, staff, and visitors comply with relevant regulations, policies, and procedures.
 - Ensuring that personnel working under their supervision are appropriately monitored.
 - Ensuring that manufacturer's written procedures followed for routine cleaning and lubrication and mechanical/electrical maintenance.
 - Notifying RSO when there is a need for any repair and non-routine maintenance.
 - Ensuring that all non-routine maintenance is performed by the manufacturer or authorized distributor who are or other specifically licensed by the NRC.
 - Ensuring that a calibrated radiation survey instrument is available to protect health and minimize danger to life or property.
 - To immediately notify the RSO for any occurrence of high radiation level and overexposure.
 - To immediately notify the RSO for loss or stolen radioactive materials or any incident involving irradiator; and
 - To notify RSO prior to planning for transfer, sale, or relocation of irradiator.

Radiation Workers

Individuals who use irradiator under the supervision of one or more authorized user(s) are radiation workers.

Responsibilities of Radiation Workers

The Radiation Worker is responsible to:

- Attend irradiator radiation safety training.

- Be able to operate and use the irradiators; know the types of hazards presented, and the specific precautions and handling requirements.
- Be familiar with all the relevant procedures of the radiation safety program.
- Know the proper use of radiation survey instruments.
- Know how to wear, handle, and store the radiation monitoring badges and return the badges promptly at the end wear period as specified by EHRS.
- Maintain appropriate survey records.
- Secure irradiator by making sure that area is locked when it is unattended.
- Inform coworkers and visitors to the work area about any precautions they should take; and
- Know who to call in any incident involving radiation, security or other incidents related to irradiator.

RADIATION SAFETY PROCEDURE

Training Program

Authorized users and radiation workers must complete the irradiator radiation safety training.

The EHRS evaluates the competency of the workers prior to approving the individual to work with irradiator.

Training may be in the form of lecture, videotape, hands-on, or self-study and may include the following:

- Radiation Safety
 - a) Radiation vs. contamination
 - b) Internal vs. external exposure
 - c) Biological effects of radiation
 - d) Types and relative hazards of radioactive material possessed
 - e) ALARA concept
 - f) Use of time, distance, and shielding to minimize exposure
 - g) Use of radiation detection instruments.
- Regulatory Requirements
 - a) Locations of use and storage of radioactive materials
 - b) Material control and accountability
 - c) Annual audit of radiation safety program
 - d) License conditions, amendments, renewals

- e) Transfer and disposal
 - f) Recordkeeping
 - g) Handling incidents
 - h) Licensing and inspection by regulatory agency
 - i) Need for complete and accurate information
 - j) Employee protection
 - k) Deliberate misconduct.
- Additional practical training is provided by the authorized user that may include the following:
 - a) Proper use of survey instruments
 - b) Explanation of the Theory and Operation of Irradiator
 - a. Routine vs. non-routine maintenance
 - b. Operating and emergency procedures

Radiation Safety Training for Ancillary Staff

This annual training is for individuals who frequently enter irradiator areas.

Audit Program

EHRM performs periodic audits of irradiator. The audit assesses if the authorized activities are being conducted in a safe manner and in accordance with regulatory requirements and Temple University Policies. The audit reviews the adequacy of training of workers, supervision by authorized user(s), availability of survey instruments, security of radioactive material, minimization of personnel exposure to radiation, and the required record keeping. Any deficiencies are corrected and noted. The RSO issues a notice of violation to the authorized user if a violation of regulatory requirement or license conditions is identified and the RSO determines that the violation has safety significance. The authorized user is required to respond to the notice. The results of the audit are presented to the RSC. Details of significant violations are discussed by the RSC. The RSO has the authority to limit authorized user's use of radioactive material or in extreme cases suspend the use of radioactive material if the violations persist or are not addressed adequately.

Survey Program Radiation Exposure Survey

A proper type of survey instrument (GM or ion chamber) must be used to survey points where exposure may occur. If the radiation exposure at the surface of the irradiator exceeds 2 mR/hr at contact EHRM.

Locations of Use, Storage, Transfer and Disposal of Irradiator

Authorized location for use and storage of irradiators are specified and approved by the PA DEP and stated in the license. Any relocation, transfer or disposal of irradiator required advance PA DEP notification, approval, and amendment to the PA DEP license.

Radioactive Material Control and Accountability

Any radioactive material encased in a capsule designed to prevent leakage or escape of the radioactive material is defined as a sealed source. It is imperative that all radioactive sealed sources are properly accounted for, and the periodic inventories are performed. The physical inventory is performed semiannually by EHRS. In addition, EHRS performs tests every six months for leakage and contamination.

Security

Irradiators sealed sources must be secured at all the time. AUs and radiation workers are responsible for maintaining the security of irradiators and to preventing the unauthorized individuals to have access to irradiators.

Proper Recordkeeping

Authorized users are required to maintain accurate and up-to-date records of use, and manufacturer required testing. The records must be readily available and be kept in auditable form. EHRS audit these records during its periodic survey.

The AU is responsible for completeness and accuracy of these records.

Visitors and Minors

Any individual who has not received radiation safety training commensurate with the potential radiological hazard present and is not under the direct and constant supervision of the Authorized User is **prohibited** from entering irradiator facilities.

Minors (persons under the age of 18 years old) are also **prohibited** from entering these facilities unless special arrangements including training provided by the Radiation Safety Department are made with the Radiation Safety Officer and/or the Radiation Safety Committee prior to entry.

Notification

Report any issues concerning radiation, unsafe practices, or any violations of regulatory requirements to the attention of the Radiation Safety Officer. Radiation safety officer must be notified immediately in the event of:

- Unintentional or intentional injuries,
- Incidents related to presence of unauthorized personnel in irradiator areas,
- Loss or sealed sources,
- Unusual or threatening phone calls,
- Breaches in any security measures that are in place,
- Any acquisition, transfer or disposal of irradiator that was not processed through the EHRS,
- Any accident resulting in unusual radiation exposure,
- Any misuse of irradiator, and
- Any condition which may lead to or cause a violation.

The RSO or designee must notify PA DEP immediately if sealed sources are discovered to be missing, caused unusual exposure, or misused.

Employee Protection

The University and Health System expects that everyone who works with radioactive materials will raise concerns of unsafe practices, violations of regulatory requirements, or policies associated with the use of radioactive materials. Specifically, employees cannot be fired or discriminated against with respect to pay, benefits, working conditions or other items or conditions of employment for participating in protected activities, including:

- Asking the PA DEP to enforce its rules against an employer.
- Refusing to engage in activities that violate PA DEP requirements.
- Raising safety concerns internally to supervisor or management.

Such concerns may be reported to the Environmental Health and Radiation Safety Department, the Radiation Safety Committee, Temple University, Temple University Health System Management, or the PA DEP.

Deliberate Misconduct

It is a criminal violation for an individual to engage in deliberate misconduct that causes or would have caused, if not detected, to be in violation of regulations, condition of license or Temple University Policies, or deliberately providing incomplete or inaccurate information.

General Operating Procedures

- Dosimeters are worn when using the irradiator.
- Daily checks are performed before using the irradiator.
- Ensure that the canister is not damaged and can rotate freely.
- Do not irradiate explosive, flammables and corrosive materials
- Maintain a logbook to record irradiator use and to ensure that only authorized persons will use or have access to the irradiator.
- Control access to the irradiator's keys or control access to the area where the irradiator is located.
- Insure monthly & quarterly test are performed.
- Please see your departments policies & procedures for further details.

OPERATING INSTRUCTIONS AND EMERGENCY PROCEDURES FOR BLOODBANK IRRADIATOR

See manufacturer's user manual for detailed operating instructions. Emergency procedures are summarized below.

Emergency procedures:

- **Electrical Defects**

An EMERGENCY STOP switch is located on the front face of the unit, in case of emergency, such as electrical shock or other insulation defects push in the EMERGENCY STOP Button.

- **Canister Fails to Rotate**

In case the canister fails to rotate or ceases to rotate push the EMERGENCY STOP Button on the front face of the unit. The canister **may** return to its original position. If the canister does not return to original position, Notify radiation safety and the manufacturer.

- **Drum Remains in the IRRADIATION Position**

If the drum does not return to the loading/unloading position at the end of the irradiation cycle or fails to return during a power failure or other emergency, **call radiation safety and the manufacturer.** Never force the canister to rotate on your own.

In the unlikely event the source becomes unshielded, do the following:

- Leave the irradiator area to reduce radiation exposure.
- Control access to the area by locking the door
- Immediately contact:
 - Radiation Safety Officer (Kurt Bodison): 2-7646, Cell Phone: 215-852-3955
 - Environmental Health and Radiation Safety Office: 2-2520
 - Temple University Emergency Response AFTER HOURS: 215-783-1899

Safety features:

- **Radiation Safety**

Maximum exposure rate in air next to the irradiator is less than 20 micro Sv per hour (2.0 mR per hour).

In this type of irradiator, the sources are fixed. The beginning of irradiation or the positioning for introducing the blood samples is made possible by the rotation of a revolving drum containing the irradiation chamber. The size of the drum is such that protection is guaranteed wherever the drum is positioned.

It is impossible to remove the radioactive sources from the machine the source holder is screwed on to the body of the irradiator.

- **Contamination Risks**

The sealed sources are approved as “Material under a special form. The outer contamination of the sources, checked in the laboratory is below 0.005 microcuries (185 Bq).

- **Safety During Operation**

The safety devices built in the unit include the following safety interlocks:

- The operator may interrupt the irradiation cycle at any time by pressing the CYCLE BREAK switch.
- The starting of an irradiation, which corresponds to the rotation of the drum, is only possible if the canister holding the samples is in position.

- The rotation of the drum can only occur if the door is mechanically locked with a latch. At the end of the cycle, the door mechanical safety device is unlocked, it is then possible to open the door by pulling the latch.
- A flashing indicator light allows to control the rotation of the canister and to always check that the irradiation mechanism operates properly.
- In case of failure of the power supply, an emergency battery brings the canister automatically back to the loading/unloading position and stops the programmed irradiation cycle. The timer indicates the irradiation time remaining at the cut-off time.
- An EMERGENCY STOP switch electrically disconnects the device (including the battery) in case of electrical shock or other insulation defect.

Periodic Inspection and Maintenance

General:

- The unit must be installed in an approved location which can be secured by locking and must be free of excessive dust, well lighted and maintained at normal ambient temperature.

Check and Maintenance Schedules:

- | | |
|--------------------|--------------------------|
| • Daily | check bulbs |
| • Quarterly | safety devices check |
| • Every six months | Leak test |
| • Annual | Preventative Maintenance |


Electrical Controls:

- Check the following:
 - Emergency stop switch
 - Door lock safety device
 - Battery indicator lamp
 - All indicator lamps

Mechanical Controls

- Check the following:
 - Door
 - Canister rotation: appearance of chamber and walls, floor free from debris
 - Canister: check for the absence of dents and deformation

APPENDIX A: Worker Registration Form



TEMPLE UNIVERSITY
Environmental Health and
Radiation Safety

Radiation Worker Registration

Registrant:

<input style="width: 100%; height: 20px;" type="text"/>	<input style="width: 100%; height: 20px;" type="text"/>	<input type="checkbox"/>
(Last Name)	(First Name)	(M)

Social Security Number: (Required)

TU ID: (Required)

Sex: Male
 Female

Title/Position(s) _____ Department: _____ Supervisor: _____

Office Phone: _____ University Temple Hospital Jeanes Episcopal/Northeastern Other _____

Exposure: Indicate your anticipated use of source of radiation at Temple University.

<input type="checkbox"/> Directly with unsealed radioactive materials (e.g. liquids) Radionuclide(s) _____ Activity (mCi) _____ <input type="checkbox"/> Directly with radioactive material in a device (e.g. irradiator teletherapy unit, HDR) Device: _____ Building: _____ Room: _____ Other (describe): _____	<input type="checkbox"/> Directly with sealed radioactive materials (e.g. brachytherapy sources) <input type="checkbox"/> Directly with X-ray producing machine(s) <input type="checkbox"/> Incidentally exposed to source of radiation (e.g. nurses for radiation therapy patients, anesthesiologist) Describe source of exposure: _____
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Total Radiation Exposure:

Institution/Company/RSO	Phone number	Address	City	State	Zip Code

Calendar year to date: _____ mrem Have you been assigned a planned special exposure as defined by the NRC? No Yes

Training: List any radiation safety training courses that you have attended. Please include the following:

Institution/Company	Course Name/Topic	Hours	Date

Have you worn a dosimeter (Radiation Badge) or other monitor previously? Yes No If no, continue to signature.

Experience: List previous employment with exposure to radiation. If no previous experience indicate None. Please include the following:

Institution/Company	Address	City	State	Zip Code	Dates

By signing below, I certify that the above information is correct and true to the best of my knowledge. If at any time I begin working with or around radiation at another institution I will notify EHRS to ensure a complete radiation exposure record is maintained.

Signature: _____
Date: _____

This section to be completed by authorized user/x-ray machine supervisor ONLY. I certify that I have given the above mentioned individual sufficient training in radiation safety so that they can work safely under my close supervision until they can take the next safety training class.

PI/Supervisor Signature: _____
Date: _____

Fax completed form to 215-707-1600 (2-1600)

rev. 4/2018



Environmental Health and Radiation Safety

Authorization to Release Radiation Exposure History

Name: _____
Please Print

Social Security Number: _____ - _____ - _____

Alternate name for records (e.g., maiden name): _____

Authorization to release my radiation exposure records to Temple University is hereby granted. Photocopies of this release authorization are acceptable.

Signature: _____ Date: _____

RSD Use Only

Institution	Request Date	Follow-up 1	Follow-up 2	Follow-up 3	Received

Fax completed form to 215-707-1600 (2-1600)

rev. 4/2018