



University of Notre Dame
Radiation Safety Manual

Risk Management & Safety
Revision 2
September 2021



Contents

1	Introduction and ALARA Statement.....	5
1.1	Introduction.....	5
1.2	ALARA Statement	5
2	Purpose and Scope.....	5
2.1	Purpose.....	5
2.2	Scope	5
3	Roles and Responsibilities.....	6
3.1	Radiation Control Committee	6
3.2	RCC Chairperson.....	7
3.3	Radiation Safety Officer	7
3.4	Radiation Safety Specialist	9
3.5	Responsible Investigator	9
3.6	Individual Users of Radioactive Material or Radiation Producing Machines.....	9
4	ALARA.....	11
4.1	RSO Dose Review.....	11
4.2	RCC Dose Review.....	11
4.3	RI Dose Review	12
4.4	Dose Investigations	12
4.5	Annual Review of Responsible Investigators	13
4.6	Annual Assessment of the Radiation Protection Program.....	13
5	Dose Limits.....	14
5.1	Occupational Dose Limits.....	14
5.2	Dose Limits for Visitors.....	16
5.3	Dose Limits for Members of the Public.....	16
5.4	Dose Limits for Minors	16
6	Personnel Exposure Monitoring	17
6.1	External Monitoring	17
6.2	Internal Monitoring.....	18



6.3	Exposure Records.....	20
7	Responsible Investigator.....	21
7.1	Initial Application and Approval Process.....	21
7.2	Renewal Applications.....	22
7.3	Amended Application and Approval Process.....	22
8	Radioactive Material Procurement and Tracking.....	22
8.1	Radioactive Material Procurement.....	22
8.2	Receipt of Radioactive Material.....	23
8.3	Unsealed Radionuclide Inventory.....	24
8.4	Sealed Source Inventory and Leak Checks.....	24
8.5	Transfer of Radioactive Material.....	25
9	Radiation Detection Instrumentation.....	26
9.1	Survey Instruments.....	27
9.2	Survey Instrument Operability Check.....	27
9.3	Fixed Radiation Detectors.....	28
10	Safe Use of Radioactive Material.....	28
10.1	Facility Requirements.....	28
10.2	Physical Controls and Postings.....	29
10.3	Individual User Requirements.....	29
10.4	Safe Practices.....	30
10.5	Personal Contamination Surveys.....	31
10.6	Laboratory Contamination Surveys.....	32
10.7	Action Limits and Decontamination.....	33
10.8	Movement of Material or Equipment on Campus.....	33
10.9	Unrestricted Release of Material or Equipment.....	34
10.10	Radioactive Waste.....	34
10.11	Animal Research with Radioactive Materials.....	35
11	Radiation Producing Machine Procurement and Tracking.....	36
11.1	Procurement.....	36
11.2	Receipt.....	36



11.3	Registration.....	36
11.4	Inventory.....	36
11.5	Transfer to another Lab or Facility	37
12	Safe Use of Radiation Producing Machines	37
12.1	Lab or Facility Requirements	37
12.2	Typical facility requirements include the following:	37
12.3	Physical Controls and Postings	38
12.4	Prior to Initial Use.....	38
12.5	Surveys and Testing for Accelerators	38
12.6	Individual User Requirements	38
12.7	Safe Practices.....	39
12.8	Release of Equipment or Material from accelerator facilities	40
12.9	Vendor Radiography Operations	40
13	Radiation Safety Training.....	40
13.1	Individual Users	40
13.2	RIs and Lab Supervision	40
13.3	Lab Personnel who are not Individual Users	41
13.4	Radiation Producing Machine Users	41
14	Enforcement Actions	41
14.1	Major Violations	41
14.2	Enforcement Actions for Major Violations.....	42
14.3	Minor Violations	42
14.4	Enforcement Actions for Minor Violations.....	43
15	Emergency Procedures	43
15.1	Fire or Explosion in Lab.....	43
15.2	Spill of Radiological Material	44
15.3	Accidental exposure from radiation producing machine.....	44
15.4	Missing radioactive material	44
15.5	Decontamination of Labs or Individuals.....	44



1 Introduction and ALARA Statement

1.1 Introduction

The use of radioactive materials at the University of Notre Dame is regulated by the Nuclear Regulatory Commission (NRC) through federal regulations and more specifically by the radioactive materials license issued to the University. The license is a broad scope license that includes radionuclides, radioactivity limits, and specific license conditions. The use of radiation producing machines and devices at Notre Dame are regulated by the Indiana State Department of Health (ISDH) in the Indiana Administrative Code (IAC).

The Notre Dame radiation protection program (RPP) encompasses the use of all ionizing radiation used in research activities at campus facilities and off-campus locations.

1.2 ALARA Statement

Faculty, staff, students, or visitors that work with radioactive material or radiation producing machines and devices at the Notre Dame campus or off-campus locations may be exposed to radiation. The University of Notre Dame is committed to ensuring that any radiation dose received will be kept as low as reasonably achievable (ALARA).

2 Purpose and Scope

2.1 Purpose

The purpose of this Radiation Safety Manual is to provide a comprehensive document that contains or describes the policies, procedures, and requirements of the University's radiation protection program. The radiation protection program is governed by the Radiation Control Committee (RCC) and implemented by the Radiation Safety Officer (RSO). It is designed to ensure compliance with the University's radioactive materials license, federal regulations, and state regulations. The radiation safety guidelines in this manual were developed to ensure a safe research and working environment for the University's faculty, staff, students, and visitors.

2.2 Scope



This manual is applicable to all faculty, staff, students, and visitors at the University's campus and off-campus locations that use radioactive material or radiation producing machines and devices.

Revisions to this manual are approved by the RCC.

The term radiation producing machine, as used in this manual, is defined as a machine such as an x-ray machine or an accelerator that is registered individually with the State of Indiana. The term radiation producing device, as used in this manual, is defined as a device such as an x-ray diffractometer which collectively as a group are registered with the State of Indiana. The term radiation producing equipment is meant to encompass both radiation producing machines and devices.

3 Roles and Responsibilities

3.1 Radiation Control Committee

The RCC is appointed by the President of the University and is responsible for establishing the policies, procedures, and requirements of the University's radiation protection program. The RCC consists of the Chairperson, Radiation Safety Officer, an Officer of the University and representatives from each of the major locations that use radioactive materials or radiation producing machines. The RCC meets regularly throughout the year to make decisions affecting the radiation safety practices at the University.

Responsibilities of the RCC include the following:

- 3.1.1 Establish policies, procedures, and requirements for the University's radiation protection program to ensure the safe use of radioactive materials and radiation producing equipment.
- 3.1.2 Perform reviews of occupational radiation exposures for any abnormalities and take corrective actions if warranted.
- 3.1.3 Review and act on new applications of individuals who wish to become a Responsible Investigator (RI).
- 3.1.4 Review and act on renewal applications from current RIs.
- 3.1.5 Review and act on applications from current RIs to use new radionuclides, additional quantities of radionuclides, additional radiation producing machines, or to use new or additional facilities.



- 3.1.6 Define the conditions and the requirements for safe use of radioactive materials and radiation producing machines and determine the suitability of existing and proposed facilities.
- 3.1.7 Review annual assessments of the radiation protection program.
- 3.1.8 Review reports of activities or practices which do not comply with federal regulations, the University's radioactive materials license or state regulations, and take corrective action if necessary.
- 3.1.9 Review proposals for field uses (off-campus sites) of radioactive material and to decide on the suitability of such proposals.
- 3.1.10 Review and approve revisions to this manual.
- 3.1.11 To maintain written records of all RCC meetings, actions, recommendations, and decisions.

3.2 RCC Chairperson

The RCC Chairperson is the leader the RCC. The Chairperson may call a meeting of the RCC for any reason. The RCC Chairperson has the authority to act on behalf of the RCC if an immediate action is needed and there is insufficient time to call a meeting of the RCC. The RCC Chairperson is listed by name on the University's radioactive materials license. In order to designate another individual as the RCC Chairperson, the University's radioactive materials license must be amended.

3.3 Radiation Safety Officer

The RSO provides oversight of the radiation safety practices at the University's campus and at off-campus locations and is responsible for the implementation of the University's radiation protection program. The Radiation Safety Officer (RSO) is listed by name on the University's radioactive materials license. In order to designate another individual as the RSO, the University's radioactive materials license must be amended. Responsibilities of the RSO include the following:

- 3.3.1 Provide day-to-day oversight of the University's radiation protection program.
- 3.3.2 Advise faculty, staff, students, and visitors in all aspects of radiation protection and the requirements of the University's radiation protection program.



- 3.3.3 Suspend any operations where it is evident that continued operation would result in violation of federal regulations, the University's radioactive materials license, or state regulations.
- 3.3.4 Inform the RCC and the Administration of any instances of non-compliance with federal regulations, the University's radioactive materials license, or state regulations.
- 3.3.5 Ensure personnel working with radioactive material and radiation producing machines are monitored for radiation exposure when required, and maintain dosimetry records.
- 3.3.6 Review dosimetry reports and investigate abnormal dosimetry results. If results are higher than expected, provide recommendations to the RCC regarding methods to reduce personnel dose.
- 3.3.7 Maintain training courses in radiation safety that are required for personnel working with radioactive material and radiation producing equipment.
- 3.3.8 Ensure sealed source leak tests and inventories are conducted according to the conditions of the University's radioactive materials license, and maintain associated records.
- 3.3.9 Maintain an inventory of all radioactive isotopes on campus and at off-campus sites and ensure that the University remains within the possession limits of its radioactive materials license.
- 3.3.10 Prior to approving procurement requests for radioactive material, ensure it will not result in exceeding the authorized limits for a RI or the possession limits of the University's radioactive materials license.
- 3.3.11 Ensure incoming and outgoing packages of radioactive material are received or shipped in accordance with federal regulations.
- 3.3.12 Ensure radwaste removed from labs is stored in designated areas in the RMS building and properly labeled.
- 3.3.13 Review radwaste packaging, shipping papers, and manifests prior to pick-up for disposal. Maintain disposal records.
- 3.3.14 Ensure radiation detection instruments are calibrated annually when in use.
- 3.3.15 Provide oversight of decommissioning, decontamination, and recovery operations.



- 3.3.16 Ensure the University's radiation protection program is assessed at least annually and submit the assessment to the RCC.

3.4 Radiation Safety Specialist

The Radiation Specialist works under the direction of the RSO and performs radiation safety support activities such as radiological surveys, radioactive package receipt surveys, and providing radiological support to labs.

3.5 Responsible Investigator

A Responsible Investigator is a faculty member designated as such after approval by the RCC. The Responsible Investigator may use or supervise the use of licensed radioactive material or radiation producing machines. Responsibilities of a Responsible Investigator include the following:

- 3.5.1 Accept responsibility for the safe use of radioactive materials and radiation producing machines by individuals under his/her supervision.
- 3.5.2 Ensure that users working under their supervision complete the following prior to initiating work activities:
- Radiation Safety Training
 - Lab-specific training
- 3.5.3 Instruct the users of radioactive materials or radiation producing machines working under their supervision in radiological safety as it relates to their lab.
- 3.5.4 Ensure procedures for the safe use of radioactive material or radiation producing machines are available and understood by users under their supervision.
- 3.5.5 Ensure only individuals under their supervision use radioactive materials or radiation producing machines.
- 3.5.6 Ensure dosimetry is issued to those under their supervision who are required to be monitored.
- 3.5.7 Initiate procurement requests for radioactive isotopes.
- 3.5.8 Maintain an inventory of radioisotopes and quantities in their lab.

3.6 Individual Users of Radioactive Material or Radiation Producing Machines



Specific responsibilities of individual users of radioactive material or radiation producing machines include the following:

- 3.6.1 Prior to working with radioactive materials or radiation producing machines ensure the following:
 - Initial Radiation Safety Training is completed, or Refresher Training is current
 - Lab-specific training is current
 - Machine Produced Radiation Training is completed, or Refresher Training is current if using a state licensed radiation producing machine.
- 3.6.2 If issued dosimetry, wear it as directed by RI.
- 3.6.3 Wear PPE when working with radioactive materials (i.e., disposable gloves, safety glasses, lab coat, etc.).
- 3.6.4 Follow the requirements of lab-specific procedures.
- 3.6.5 Do not eat, drink, or apply cosmetics in areas where radioactive materials are used.
- 3.6.6 Perform a personal contamination survey after working with unsealed radioactive material (hands, feet, face, and clothing).
- 3.6.7 Survey working area for contamination after working with unsealed radioactive material.
- 3.6.8 Perform routine lab contamination surveys as directed by RI.
- 3.6.9 Label radioactive material containers appropriately.
- 3.6.10 Inform the RI and RSO of radioactive spills or accidents involving radioactive materials or radiation producing machines.

4 ALARA

The University of Notre Dame is aligned with the philosophy that unnecessary radiation exposure is undesirable, and radiation exposures must therefore be minimized. The University is committed to ensuring that radiation dose to faculty, staff, students, members of the public, and to the environment is as low as reasonably achievable (ALARA) below the limits established by regulatory agencies. The RCC, RSO, RIs, and individual users all have active roles in minimizing radiation exposure at the University. The University's radiation protection program also employs controls that are intended to protect users of radioactive material and radiation producing equipment from unnecessary radiation exposure.

The RSO reviews lab surveys, dose reports, and investigates potential activities that lead to unnecessary dose.

RI and individual users who use radioactive material or radiation producing machines are required to complete training in radiation safety, which includes methods to minimize dose. RIs implement lab-specific practices to ensure doses are ALARA in their respective labs.

4.1 RSO Dose Review

The RSO receives dose summary reports from the dosimetry vendor after dosimeters for a given monitoring period are processed. These reports are compared to results for previous monitoring periods based on Departments and RIs. Results above 50 mrem are flagged for potential investigation and a formal dose investigation is required if the results are above the Investigation Levels in Table 4-1, below.

Table 4-1. Investigation Level Dose Limits for a Two Month Monitoring Period.

Monitored Parameter	Investigation Level I	Investigation Level II
Whole Body (DDE)	80 mrem	240 mrem
Extremity	1250 mrem	3750 mrem
Skin (SDE)	500 mrem	1500 mrem

4.2 RCC Dose Review

The RCC meets regularly and evaluates the results of the most recent dose summary report for all monitored individuals. The RCC evaluates the results for elevated readings

or increasing trends from various departments and work groups. The RCC may request the RSO to conduct a dose investigation into any abnormality or elevated result even if the result is lower than the Investigation Level dose limits.

4.3 RI Dose Review

The RI's are notified by the RSO or Radiation Safety Specialist if any users under their supervision receive a measured whole body dose above 50 mrem. RIs may review dose summary reports for all individuals working under their direction for a given monitoring period at any time.

4.4 Dose Investigations

The RCC has established investigational levels for occupational external radiation doses which, when exceeded, will initiate an investigation by the RSO. These levels are based on a bi-monthly wear period but may be adjusted proportionally if the wear period is altered (i.e., monthly or quarterly).

4.4.1 Investigation Level I

If an Investigation Level I dose limit is reached for an individual, the RSO shall conduct a dose investigation and submit the report to the RCC within 30 days. The report should include the following information:

- Validation that the result is a true result (i.e., not due to equipment error or inadvertent exposure during travel)
- Description of activities conducted involving radioactive sources or radiation producing machines
- Determination of how the exposure likely occurred
- Comparison to peer dosimetry results

4.4.2 Investigation Level II

If an Investigation Level II dose limit is reached for an individual, the RSO shall conduct a radiological survey of the lab area, conduct a dose investigation, and submit the report to the RCC within 10 days. The report should include the following information:

- Determine the validity of the result (i.e., not due to equipment error or inadvertent exposure during travel)
- Results of radiological survey
- Description of activities conducted involving radioactive sources or radiation producing machines

- Determination of how the exposure likely occurred
- Comparison to peer dosimetry results
- Review of individual's training records
- Suggestions on how to avoid further high doses

4.4.3 Responsible Investigator Actions

If a dose investigation is initiated due to a user under their supervision exceeding an Investigation Level I or II limit, the Responsible Investigator shall assist the RSO by providing relevant information such as:

- Radiological activities performed under their direction
- Radiological surveys of the lab
- Training records of users under their direction
- Lab procedures

4.5 Annual Review of Responsible Investigators

The RCC approves qualified faculty to be Responsible Investigators on an annual basis. Current Responsible Investigators who wish to renew their status must submit an application to do so. The RCC's adjudication of the renewal application includes denial, approval, or conditional approval. The RCC may take into consideration relevant information such as the following:

- Annual doses to users under their supervision
- Any changes in experiments or processes
- Any reported incidents of improper radiological practices

4.6 Annual Assessment of the Radiation Protection Program

The University's Radiation Protection Program is required to be assessed at least annually per 10 CFR 20.1101. The assessment is an evaluation of the content and implementation of all major components of the program and to the effectiveness in keeping exposures ALARA. This assessment shall be conducted by the RSO.

Major components of the radiation protection program include the following:

- Dose Monitoring
- Surveys

- Posting and Labeling
- Training
- ALARA
- Instrumentation
- Radioactive Material Controls
- Radioactive Waste Management
- Records

5 Dose Limits

The University is subject to the radiation dose limits in both federal and state regulations. Federal dose limits are found in 10 CFR 20.1201 to 20.1208 (Title 10, Part 20 of the Code of Federal Regulations). State dose limits are found in 410 IAC 5-4 (Title 410 Part 5 Rule 4 of the Indiana Administrative Code). The Nuclear Regulatory Agency (NRC) regulates the use of byproduct radioactive material at the University, and therefore federal dose limits apply to those using radioactive material under the University’s radioactive material license (issued by the NRC). The Indiana State Department of Health regulates the use radiation producing equipment at the University, and therefore state dose limits apply to those using such equipment.

5.1 Occupational Dose Limits

Faculty, staff, and students at the University that are identified as users of radioactive material or radiation producing machines are classified as radiation workers. Radiation dose they might receive while performing research activities is considered occupational dose. The federal and state occupational dose limits are given below in Sections 5.1.1 and 5.1.2, respectively.

5.1.1 Dose Limits from Using Radioactive Material

The dose limits for occupational exposure from using licensed radioactive material are located in Title 10 of the Code of Federal Regulations, Part 20 (10 CFR 20) and summarized below in Table 5-1.

Table 5-1. Federal Occupational Dose Limits for Adults

Dose	Annual Limit (rem)
Total Effective Dose Equivalent (TEDE)	5
Committed Dose Equivalent (CDE) + Deep Dose Equivalent (DDE) to any organ	50

Eye Dose Equivalent (EDE)	15
Shallow Dose Equivalent (skin of whole body or extremity)	50

5.1.2 Dose Limits from Using Radiation Producing Machines

The dose limits for occupational exposure from using radiation producing machines are located in Title 410 of the Indiana Administrative Code, Part 5, Rule 4 (410 IAC 5-4) and summarized below in Table 5-2.

Table 5-2. State of Indiana Occupational Dose Limits for Adults

Dose	Quarterly Limit (rem)
Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads	1.25
Hands and forearms; feet and ankles	18.75
Skin of whole body	7.5

5.1.3 Dose Limits for Declared Pregnant Worker

Dose limits for a declared pregnant worker only apply to an authorized user of radioactive material (i.e., a worker who may receive occupational radiation exposure). A declared pregnant worker is defined in 10 CFR 20.1003 as a worker who has voluntarily informed the licensee, in writing, of her pregnancy and the estimated date of conception.

- 5.1.3.1 To make a declaration, a statement must be made in writing to the RSO stating that the worker is pregnant.
- 5.1.3.2 Declaration may be made using RCC Form 5 or by submitting a written statement.
- 5.1.3.3 Once the declaration is made the following shall occur:
 - the worker's occupational dose limit will be lowered to 500 mrem to the embryo/fetus for the duration of the pregnancy
 - the RSO and the declared pregnant worker will determine the appropriate steps to ensure that the dose to the embryo/fetus does not exceed 500 mrem for the pregnancy
 - the worker will be issued a new dosimeter for monitoring dose to the embryo/fetus that is to be worn in the abdominal region and exchanged monthly for analysis
 - the worker will be issued NRC Regulatory Guide 8.13, Instruction Concerning Prenatal Radiation Exposure

5.2 Dose Limits for Visitors

Visitors at the University of Notre Dame fall into classes: they are either working visitors, or non-working visitors.

5.2.1 A non-working visitor is considered a member of the public. Dose limits for a member of the public are given below in Section 5.3.

5.2.2 A working visitor is considered a radiation worker and any dose received is considered occupational dose. The dose limits in Section 5.1 apply as follows:

- If they work with radioactive materials, the dose limits are in Table 5-1
- If they work with radiation producing machines, the dose limits are in Table 5-2

5.2.2.1 If the worker is performing work under their own license (such as radiography) the worker is not subject to the radiation protection requirements of the University.

5.2.2.2 If the worker is performing work under the University's radioactive materials license, the worker shall:

- complete Radiation Safety Training or have completed equivalent training
- be issued dosimetry
- perform work under the supervision of a Responsible Investigator

5.3 Dose Limits for Members of the Public

Members of the public are not considered radiation workers, and therefore any radiation exposure received is considered non-occupational. Members of the public may be visitors, or they may be part of the University (faculty, staff, or students) but not approved as users of radioactive material or radiation producing machines. Dose limits for members of the public are as follows:

- Annual dose limit is 100 mrem (TEDE)
- Dose shall not exceed 2 mrem in any one hour

5.3.1 Restrictions for Members of the Public

Members of the public may be escorted by a RI, Lab Supervision, or the RSO into posted radioactive materials areas. They may not enter posted radiation areas.

5.4 Dose Limits for Minors



Notre Dame does not employ minors that may receive occupational radiation exposures. Enrolled students that are minors may work with radioactive material or radiation producing machines under the supervision of a Responsible Investigator, however their dose limits shall be the same as a member of the public (see Section 5.3). The RCC or RSO may approve special circumstances involving minors not enrolled at Notre Dame on a case-by-case basis.

6 Personnel Exposure Monitoring

6.1 External Monitoring

External exposure to ionizing radiation is monitored by devices called dosimeters. Notre Dame uses thermoluminescent dosimeters (TLDs) or film badges for measuring whole-body exposure. If extremities require monitoring, ring dosimeters are used. In order to accurately measure external doses, dosimeters must be worn properly, stored in an appropriate location, and exchanged for analysis within the prescribed timeframe.

6.1.1 Whole-body dosimeter issuance

A whole-body dosimeter shall be issued to an individual that meets at least one of the following criteria:

- 6.1.1.1 The individual is likely to receive a dose in excess of 10% of the limits specified in Section 5.1
- 6.1.1.2 The individual requires entry to a posted radiation area
- 6.1.1.3 If directed by the RCC or RSO
- 6.1.1.4 If requested by the RI or the individual

6.1.2 If an individual requires dosimetry and was monitored for radiation exposure at another facility during the current calendar year, any dose received at that facility must be accounted for in accordance with Section 6.3.4.

6.1.3 Whole-body dosimeter Use

- 6.1.3.1 Dosimeters are to be worn only by the individual to whom the dosimeter was issued.
- 6.1.3.2 Whole-body TLDs or film badges should be worn on the front of the individual's outer clothing or lab coat between the waist and neck.
- 6.1.3.3 If a lead apron is worn that covers the area between the waist and neck, the TLD or film badge should be worn under the lead apron.
- 6.1.3.4 Store whole-body dosimeters in locations away from sources of ionizing radiation such as a desk or office area.

6.1.4 Ring dosimeter issuance

A ring dosimeter shall be issued to an individual that meets at least one of the following criteria:

- 6.1.4.1 The individual is handling radioactive sources and is likely to receive an extremity or skin dose in excess of 10% of the limits specified in Section 5.1
- 6.1.4.2 If directed by the RCC or RSO
- 6.1.4.3 If requested by the RI or individual

6.1.5 Ring dosimeter use

- 6.1.5.1 Wear ring dosimeter on a finger of the dominant hand
- 6.1.5.2 Orient the dosimeter so that the detection element is on palm side of the hand (element should be facing material being handled).
- 6.1.5.3 Wear inside disposable gloves or leaded gloves

6.1.6 Exchanging dosimeters

Dosimeters should be exchanged on a routine bases and analyzed using the following guidelines:

- 6.1.6.1 The exchange frequency is determined by the RSO or RCC.
- 6.1.6.2 The RI is responsible for exchanging dosimeters that are issued to individual users under their supervision at the end of the wear period and sending them to RMS.
- 6.1.6.3 The RI is responsible for notifying the RSO or Radiation Safety Specialist of lost, contaminated, or damaged dosimeters.

6.2 Internal Monitoring

Internal dose monitoring is the process of monitoring individuals for potential radiation exposure due to radioactive material that may enter the body through inhalation, ingestion, or absorption through the skin. While there are many methods for internal dose monitoring, Notre Dame employs bioassay using urine samples. In this process, the amount of radioactivity in the urine sample is determined and the resulting internal dose to the individual is calculated.

6.2.1 The RSO provides oversight of the internal dose monitoring program.

- 6.2.1.1 Notre Dame does not analyze bioassay samples or perform internal dose assessments.

6.2.1.2 The RSO ensures arrangements are in place with a qualified vendor to analyze bioassay samples and perform dose assessments.

6.2.2 Routine or Incident based bioassay

6.2.2.1 Routine bioassays may be performed to monitor for small amounts of internal radioactive material that may have entered the body from handling of volatile radioisotopes.

6.2.2.2 Incident based bioassays may be performed following an upset lab condition or incident which could have resulted in an intake of radioactive material (i.e., needle stick while working with radioactive material, inhalation of airborne radioactivity, etc.).

6.2.3 Routine Bioassay Program participation

6.2.3.1 Individual users shall participate in a routine bioassay program as a condition for working with radioactive materials if required by the RSO or RCC.

6.2.3.2 Failure to participate as requested may result in suspension of privileges to work with radioactive materials

6.2.3.3 Typical conditions which may warrant participation in a routine bioassay program include:

- working with loose radioactive material with the potential for the material to become airborne and inhaled
- working with large amounts of volatile radioisotopes
- contamination found outside of fume hoods after working with radioactive material
- RI or individual user requests to participate in a routine bioassay program

6.2.3.4 If the RSO or RCC requires participation in a routine bioassay program, the following actions are required:

- RSO informs RI of bioassay program participation requirements
- RI ensures bioassay sample kits and instructions for sample collection are available to personnel in the routine bioassay program
- RI coordinates with the RSO to identify a suitable storage area for samples
- RI ensures samples are shipped for analysis
- RSO informs the RI of any positive bioassay results or dose assessments

6.2.4 Incident Based Bioassay

The RSO or RCC may request that an individual submit a bioassay sample if circumstances exist such that an intake of radioactive material is suspected. Based on the circumstances that caused the potential intake, follow-up bioassay samples may also be requested.

6.2.4.1 The following process shall be followed if an incident-based bioassay is requested:

- RI coordinates with the RSO to determine which individuals should submit samples, the collection time periods, and the number of required samples
- RI ensures bioassay kits and instructions for sample collection are available and coordinates the distribution and collection of samples
- RI ensures samples are shipped for analysis
- RSO informs all bioassay sample participants of their results and any dose assessments

6.3 Exposure Records

Radiation exposure records for personnel are maintained by the RSO or designee. This includes individual exposure records that are sent to the RSO from previous places of employment.

6.3.1 Individuals may request or review their radiation exposure records at any time by contacting the RSO or Radiation Safety Specialist.

6.3.2 Annual reports are distributed to individuals who were monitored for the previous year (NRC Form 5 or equivalent).

6.3.3 If an organization requests the dosimetry records of a current or former Notre Dame employee, the RSO will provide the records only after receiving the request in writing that includes the signature of the individual giving permission for Notre Dame to release their dosimetry records.

6.3.4 If an individual was monitored for radiation dose at another organization within the current calendar year, the RSO shall attempt to obtain the individual's prior dose history by sending RCC Form 6, Request for Previous Occupational Radiation Exposure.

- 6.3.4.1 RCC Form 6 must be signed by the individual granting the previous organization permission to release the individual's dose records to Notre Dame.
- 6.3.4.2 If the individual received occupational exposure at the previous organization within the current calendar year, the individual's annual dose limit for exposure at Notre Dame shall be lowered accordingly.

7 Responsible Investigator

A Responsible Investigator (RI) is a faculty member designated as such after approval by the RCC. The RI may use, or supervise the use of, licensed radioactive material or radiation producing machines. Specific responsibilities of a RI are listed in Section 3.4.

7.1 Initial Application and Approval Process

- 7.1.1 All individuals that desire to be designated a RI shall complete the RI Application using RCC Form 1 which can be found in this manual or on the Risk Management and Safety website.
- 7.1.2 Submit completed RCC Form 1 to the Radiation Safety Specialist or RSO for initial review and subsequent submission to the RCC.
- 7.1.3 The RCC will review and either approve or deny the application based on the qualifications, experience, and training of the applicant, as well as the facilities planned for use.
- 7.1.4 The RCC requires the following minimum qualifications:
 - 7.1.4.1 A bachelor's degree in the physical or biological sciences, or in engineering
 - 7.1.4.2 At least 40 hours of training and experience in the following:
 - radioactive materials or machine usage
 - radiation dose and radioactive contamination quantification
 - biological effects of ionizing radiation
 - detection of ionizing radiation
- 7.1.5 The RCC shall indicate in writing the approval or denial of the application.
 - 7.1.5.1 The application may be approved with or without additional requirements or restrictions.

- 7.1.6 RI approvals will be granted for periods of not more than one year, after which time an application may be submitted for renewal.
- 7.1.7 The Chairperson of the RCC may grant temporary approval pending official approval by the RCC at the next regular meeting, upon review of the applicant's qualifications, facilities, and with concurrence from the RSO.

7.2 Renewal Applications

Current RIs may apply to renew their approved status. The RCC typically reviews renewal applications on an annual basis, at a regularly scheduled RCC Meeting.

- 7.2.1 RIs may submit a renewal application by completing RCC Form 2 and submitting to the Radiation Safety Specialist or RSO for initial review. RCC Form 2 may found in this manual or on the Risk Management and Safety website.
- 7.2.2 RSO ensures completed RCC Form 2 is submitted to the RCC for review.
- 7.2.3 The RCC shall indicate in writing the approval or denial of the renewal application.

7.3 Amended Application and Approval Process

Current RIs may apply to amend their approved limits for radioisotopes, or add additional radioisotopes. The RCC Chairperson may grant temporary approval until the next regularly scheduled RCC Meeting.

- 7.3.1 RIs may submit an Application for Additional Radionuclides or Quantities (RCC Form 3) if any of the following apply:
- RI desires to work with radionuclides not included on their RI Application or RI Renewal Application
 - RI desires to work with quantities of radionuclides that exceed their current approved limits

8 Radioactive Material Procurement and Tracking

RIs may procure radioactive material provided they are approved for the radioisotopes and quantities they desire. The quantity limits apply to the total quantity in their lab which includes storage, material in use, and radioactive waste.

8.1 Radioactive Material Procurement

- 8.1.1 All orders for radioactive material shall be initiated by a RI

- 8.1.2 Prior to ordering radioactive material the RI should verify the following:
- They are approved to use the radioisotopes they desire to purchase
 - The quantities for each radioisotope, when received in their lab, will not exceed the quantities they are approved to possess in their lab
- 8.1.3 Radioactive procurement requests must be approved by the RSO or designee.
- 8.1.4 The RSO or designee shall verify that receipt of the material will not violate Notre Dame's radioactive materials license:
- 8.1.4.1 the radionuclides requested are allowed to be possessed
- 8.1.4.2 the quantities requested, upon receipt by Notre Dame, will not exceed the possession limits.
- 8.1.5 The RSO or designee may approve the procurement request after verifying that receipt of the material will not violate Notre Dame's radioactive materials license.

8.2 Receipt of Radioactive Material

Central Receiving is the designated receiving and temporary storage location for radioactive packages. Deliveries of radioactive material can only be made to Central during normal working hours.

- 8.2.1 Radioactive material packages are to be delivered to Central Receiving.
- 8.2.2 Radioactive packages received by University Central Receiving shall be secured until pick up by RMS personnel.
- 8.2.3 Central Receiving personnel shall contact the RMS office as soon as possible of the radioactive package delivery, but no later than 3 hours after receipt of the package.
- 8.2.4 In the event of receipt of damaged radioactive material package, the following measures shall be taken:
- Central Receiving shall immediately notify RMS
 - Upon arrival at Central Receiving, RMS shall survey the package, individuals that handled the package, and the delivery truck for contamination. If contamination is detected, immediately notify RSO.

8.2.5 RMS is responsible for picking up radioactive packages at Central Receiving and performing a receipt survey in accordance with the RMS procedure, Radioactive Material Receipt.

8.2.6 RMS delivers radioactive package to RI's lab.

8.2.7 RI or designated individual user in the lab:

- accepts the material from RMS
- ensures the material is stored properly, and
- updates the lab's radioactive material inventory.

8.3 Unsealed Radionuclide Inventory

8.3.1 RIs are responsible for maintaining an inventory of unsealed radioactive material in their possession which includes the following:

- Radioactive material stored or not in use
- Radioactive material in use
- Radioactive waste (i.e., discarded radioactive material) in lab

8.3.2 Once radioactive waste is removed from lab (picked up by RMS) the amount of radioactive material picked up by RMS should be removed from the lab inventory.

8.3.3 RIs or their designee should update their radioactive material inventory at least monthly.

8.3.3.1 Labs using radioisotopes with half-lives less than 90 days should account for radioactive decay when updating their inventory.

8.4 Sealed Source Inventory and Leak Checks

Notre Dame's radioactive materials license requires sealed radioactive sources to be leak checked and inventoried at specified intervals. The license specifies which sources and the required frequency.

8.4.1 RMS is responsible for performing and documenting leak checks and physical inventories of sealed radioactive sources per the license requirements.

8.4.2 RIs are responsible for maintaining an inventory of sealed radioactive sources in their possession and granting RMS access to those sources to perform leak checks and physical inventories.

8.4.3 RMS is responsible for maintaining all documentation for leak checks and physical inventories of sealed radioactive sources.

8.5 Transfer of Radioactive Material

8.5.1 Transfer from one lab to another on campus

8.5.1.1 RI shall notify the RSO and obtain approval prior to transferring radioactive material from one campus facility or lab to another.

8.5.1.2 RSO, upon notification, is responsible for ensuring:

- RI accepting radioactive material is approved to receive the radionuclides and quantities
- The receiving facility or lab is approved for use of the radionuclides and quantities
- Accept or assist in developing transfer protocol (i.e., acceptable packaging, delivery route, storage of material, etc.)
- Approving the transfer if the above criteria are met

8.5.1.3 The RSO shall notify the RI in writing of the approved transfer.

8.5.1.4 If the RI or facility does not have current RCC approval for the radionuclides or quantities, the RCC Chairperson may grant temporary approval until the next RCC Meeting. The RSO may approve the transfer and notify the RI in writing after temporary approval is granted.

8.5.1.5 The RI is responsible for updating their radioactive material inventory to reflect the transfer.

8.5.2 Transfer of Radioactive Material from Notre Dame to another organization

RIs may need to transfer radioactive material to another organization or institution as part of their research activities. RIs must coordinate with RMS to ensure DOT and NRC regulations are followed in the shipping process.

8.5.2.1 RI shall inform the RSO of the need to ship radioactive material to another organization or institution.

8.5.2.2 RSO is responsible for ensuring a copy of the receiving institution's radioactive materials license or Certificate of Authorization has been received and reviewed. This copy should be retained.

- 8.5.2.3 RSO or Radiation Safety Specialist is responsible for ensuring the radiological safety of the packaging.
- 8.5.2.4 An individual with current DOT Shipping Training shall certify that the package meets federal regulations for shipment.
- 8.5.2.5 The RI is responsible for:
 - Ensuring the package is addressed to the correct recipient
 - Notifying the recipient of the shipment and anticipated delivery date
 - Updating their radioactive material inventory to reflect the transfer.

8.5.3 Transfer of Radioactive Material from another Organization to Notre Dame

RI's may need to receive radioactive material from another organization or institution as part of their research activities. The process is similar to that for receiving procured radioactive material.

- 8.5.3.1 RI ensures the RSO is notified of the need to receive radioactive material from another organization or institution.
- 8.5.3.2 RSO is responsible for ensuring:
 - Upon receipt, Notre Dame will remain in compliance with the possession limits of its radioactive materials license.
 - The RI is currently approved by the RCC to use the radionuclides and quantities
 - Upon receipt, the quantities will not exceed the RI's approved limits
 - Approving the transfer if the above criteria are met
- 8.5.3.3 If the RI or facility does not have current RCC approval for the radionuclides or quantities, the RCC Chairperson must grant temporary approval for the RI or facility before the transfer can occur. The RSO approves the transfer after temporary approval is granted.
- 8.5.3.4 The RI should notify the RSO or Radiation Safety Specialist of the incoming radioactive material shipment.
- 8.5.3.5 Once the package arrives, following the steps in Section 8.2, Receipt of Radioactive Material

9 Radiation Detection Instrumentation

Radiation detection instrumentation is used for analyzing samples in research as well as for performing surveys for regulatory compliance. RI's are responsible for the purchase of

instrumentation used in their research as well as survey instruments required to perform surveys in accordance with regulations.

9.1 Survey Instruments

Survey instruments, for the purpose of radiation protection, are generally hand-held radiation detection instruments designed to detect ionization radiation. They are used to detect contamination or radiation levels for personal safety information and for providing readings for radiological surveys used to demonstrate regulatory compliance.

- 9.1.1 All laboratories using radioactive materials and radiation producing machines shall have appropriate survey instruments that are operable and applicable for detecting the radiation hazards in their lab or facility.
- 9.1.2 Survey instruments shall be calibrated at least annually, or prior to use if not currently in service.
- 9.1.3 RIs should coordinate with RMS to ensure calibrated survey instruments (i.e., within the calibration expiration date) are available for use in their lab or facility.
- 9.1.4 A master list of instruments that are in service should be kept by the RSO or Radiation Safety Specialist.
- 9.1.5 RIs should inform RMS of survey instruments that are inoperable or in need of repair.

9.2 Survey Instrument Operability Check

In general, the following criteria must be met for a survey meter to be considered operable:

- 9.2.1 The instrument is within its calibration expiration date.
- 9.2.2 The physical condition of the instrument is satisfactory (probe not broken, cords not kinked, dials not broken).
- 9.2.3 Successful battery check
- 9.2.4 Instrument reading indication is at “background” after turning instrument on (for a GM probe: approximately 50-100 cpm, for an ion chamber: approximately 0).
- 9.2.5 Instrument responds properly when placed near an appropriate radioactive source.

9.3 Fixed Radiation Detectors

Area or wall-mounted radiation detectors that are designed to alert the individual to elevated levels of radiation are sometimes referred to as fixed radiation detectors. These instruments may also be designed to trip alarms or interlocks.

- 9.3.1 Fixed radiation detectors that are integral to the warning or safety systems of an accelerator are governed by state regulations (410 IAC 5-9) and must meet the following requirements:
 - 9.3.1.1 Fixed radiation detectors are to be checked for proper operation on a quarterly basis. Records of the quarterly checks are required to be retained for inspection.
 - 9.3.1.2 Fixed radiation detectors are required to be calibrated on an annual basis or following service or repair. Calibration records are to be maintained for inspection.
- 9.3.2 Fixed radiation detectors not associated with an accelerator shall be calibrated per the manufacturer's recommended frequency (typically annually) and should be checked for proper operation quarterly.
 - 9.3.2.1 Records of calibrations and proper operation shall be maintained by the RI or RSO.

10 Safe Use of Radioactive Material

The use of radioactive material at Notre Dame is governed by federal regulations and the University's radioactive materials license. This section includes the requirements for the safe and responsible use of radioactive materials and to ensure regulatory and license compliance.

10.1 Facility Requirements

- 10.1.1 Facility Approval
 - 10.1.1.1 Each facility that uses or intends to use radioactive material must be approved by the RCC.
 - 10.1.1.2 The initial approval for facility use requires the RI to submit RCC Form 4 for RCC approval.
 - 10.1.1.3 Subsequent approvals are granted through the annual RI Renewal process.
- 10.1.2 Typical facility requirements include the following:

- Adequate space for storing radioactive materials and radioactive waste
- Physical security measures to prevent unauthorized access to the radioactive material or to the laboratory itself
- Access to a phone or the ability to make cell phone calls
- The ability to perform work in a fume hood if necessary, to ensure materials do not become airborne in the lab or facility (HEPA filtration may be required)
- Ability to monitor personnel in a low background area

10.2 Physical Controls and Postings

10.2.1 Doors to laboratories that use radioactive materials must be closed and locked when personnel are not present to prevent unauthorized entry or removal of radioactive material, unless all radioactive materials are secured and locked.

10.2.2 The entrance to labs that use or store radioactive materials shall be posted with:

10.2.2.1 A sign bearing the radiation caution symbol and the words "Caution Radioactive Materials".

10.2.2.2 NRC Form 3 "Notice to Employees"

10.2.2.3 Contact information of the RI and RSO

10.3 Individual User Requirements

Individual users are considered by regulations to be radiation workers and therefore they must be trained and monitored for radiation exposure accordingly

10.3.1 Training

10.3.1.1 All individual users shall complete Radiation Safety Training prior to working with radioactive materials (see Section 13, Radiation Safety Training for requirements).

10.3.1.2 All individual users shall complete applicable job-specific training prior to working with radioactive materials. Typical job-specific training includes training on lab-specific procedures, safe handling of certain radioisotopes, using radiation detection instruments, and performing personal and lab contamination surveys.

10.3.1.3 All individuals shall maintain current Radiation Safety Training and Job-Specific training requirements (i.e., training has not expired) to work with radioactive materials.

10.3.2 Dosimetry

Individual users may be monitored for radiation exposure if working with quantities of radionuclides or radioactive sources where measurable radiation exposure is possible. If radiation exposure monitoring is required, individual users will be assigned a personal dosimeter. The following apply if issued a personal dosimeter:

- Wear the dosimeter only assigned to you
- Wear dosimeter at all times when working with radioactive materials
- Wear dosimeter on the front torso between the neck and waste (collar, pocket, or belt)
- Store dosimeter in an area away from radioactive materials such as an office or break room

10.4 Safe Practices

The following provide safe practices for using or working with radioactive materials.

10.4.1 Wear proper PPE when work with radioactive materials:

- Lab coat or coveralls
- Safety glasses or safety goggles
- Disposable gloves (surgical gloves or similar)
- Pants (no shorts)
- Shoes (closed toe)

10.4.2 Cover cuts or abrasions sufficiently so that they are protected against coming into contact with radioactive material. Contact RSO for additional guidance.

10.4.3 Plan work to minimize radiation exposure:

- Avoid standing near radiation sources
- Consider the use of shielding or tools
- Become familiar with processes so that work is perform efficiently

10.4.4 Contamination Control of Personnel

10.4.4.1 Eating, drinking, or applying cosmetics is prohibited in areas where radioactive materials are used or stored.

10.4.4.2 Food, drinks, or personal items may not be stored with radioactive materials

- 10.4.4.3 Pipetting by mouth is prohibited.
- 10.4.4.4 Monitor gloves for contamination periodically and change gloves if contamination is detected or suspected.
- 10.4.4.5 Wear more than one pair of gloves if practical, periodically changing outer gloves.
- 10.4.4.6 Laboratory coats or coveralls worn in labs while working with radioactive materials should be stored in the lab.

10.4.5 Contamination Control of Lab and Equipment

- 10.4.5.1 Set up work areas to minimize the chance of spilling radioactive materials.
- 10.4.5.2 Work on absorbent paper or similar material when working with unsealed radioactive material to avoid contaminating working surfaces.
- 10.4.5.3 Isolate materials that are potentially contaminated to avoid spreading contamination.
- 10.4.5.4 Work under fume hood if radioactive material has the potential to become airborne.
- 10.4.5.5 Unattended sources of radioactive materials must be labeled “Caution, Radioactive Materials.”
- 10.4.5.6 Dispose of radioactive waste only in designated, labeled, and properly shielded receptacles.

10.5 Personal Contamination Surveys

Personal contamination surveys are required after working with unsealed radioactive materials for the protection of the individual and to avoid inadvertent spreading of contamination outside of the lab.

- 10.5.1 All personnel shall perform a personal contamination survey prior to leaving the lab if they worked with or handled unsealed radioactive material.
- 10.5.2 Personal contamination surveys may be performed using a portable survey meter (GM meter with a pancake probe) or by using fixed personal contamination monitors with appropriate alarm set points.
- 10.5.3 Verify the operability of the portable survey meter or personal contamination monitor prior to use.
- 10.5.4 A personal contamination survey shall consist of monitoring, as a minimum, the individual’s hands, feet, and face.

10.5.5 If using a portable survey meter to perform a personal contamination survey:

10.5.5.1 Detector probe should be no more than ½ inch away from the body.

10.5.5.2 Move the detector probe over the area of interest at a rate of approximately 2 inches/second.

10.5.5.3 If the count rate on the detector increases, hold the detector still for a few seconds and verify the count rate drops back to background levels.

10.5.5.4 If an elevated count rate persists and is reproducible, contact the RSO or Radiation Safety Specialist.

10.5.6 Decontamination of individuals shall only occur under the direct supervision of the RSO, RCC Chairperson, or RI after consultation with the RSO or RCC Chairperson.

10.6 Laboratory Contamination Surveys

Laboratory surveys are required for labs that use unsealed radioactive material to demonstrate compliance with federal regulations as they pertain to evaluating the extent of hazards that may be present in a given area. They are also an essential part of contamination control by identifying contamination before it is spread to other areas.

10.6.1 RIs shall ensure that labs under their responsibility are surveyed for contamination by a trained individual user at least weekly, except when no work with radioactive materials has occurred.

10.6.1.1 Weekly surveys should include areas where work is typically performed (bench tops, fume hoods) and areas with the potential for contamination (sinks, door handles, cabinet doors).

10.6.1.2 Daily surveys of the work areas or when work is complete is recommended.

10.6.1.3 Document weekly surveys on RCC Form 7 (or similar survey form).

10.6.1.4 Daily surveys should be logged as completed.

10.6.2 RMS Radiological Surveys

10.6.2.1 The RSO or Radiation Safety Specialist shall perform a survey of each lab using radioactive materials at least bi-monthly (every other month).

10.6.2.2 The RSO or Radiation Safety Specialist shall perform a survey of each lab using actinides or transuranics at least monthly.

10.6.2.3 The RSO or Radiation Safety Specialist shall perform a survey of unrestricted areas adjacent to labs with radioactive materials at least quarterly (typical areas are hallways).

10.6.2.4 RMS radiological surveys are documented and retained in the RMS Office.

10.7 Action Limits and Decontamination

Areas in labs with removable contamination that is detected above the levels listed below should be decontaminated. Removable contamination is taken to mean removable amounts of activity above background as determined by a standard wipe covering a surface area approximately of 100 square centimeters.

Table 10-1. Action limits for removable contamination

Isotope	Instrument	Contamination Limit (dpm/100cm ²)
H-3, C-14, S-35	Liquid Scintillation	100
P-32 & other Beta emitters	GM Pancake Probe ¹	1000
Beta/gamma emitters	GM Pancake Probe ¹	1000
Alpha emitters	Liquid Scintillation	20
	Alpha Scintillator	20

¹GM pancake probe efficiency is approximately 10%. Contamination limit is therefore approximately 100 cpm above background.

- 10.7.1 Decontaminate areas with removable contamination levels above those in Table 10-1 using disposable wet wipes or rags.
- 10.7.2 Discard wipes and rags in radwaste containers.
- 10.7.3 If decontamination effort is unsuccessful in reducing levels to below those in Table 10-1, then contact RSO or Radiation Safety Specialist for assistance.

10.8 Movement of Material or Equipment on Campus

Equipment or material in labs posted “Caution, Radioactive Material” should be considered contaminated until proven otherwise.

- 10.8.1 If moving equipment or material from a lab posted “Caution, Radioactive Material” to another lab posted “Caution, Radioactive Material” either verify it does not have removable contamination above the limits in Section 10.9.2 prior to moving, or bag/containerize it prior to moving.

10.8.2 If moving equipment or material from a lab posted “Caution Radioactive Materials” to lab or area on campus without radiological controls (i.e. a hallway, storage room, or lab with no radiological postings):

10.8.2.1 IF only sealed sources are used in the lab, verify equipment or material does not have removable contamination above the limits in Section 10.9.2 prior to moving.

10.8.2.2 IF unsealed sources are used or present in the lab, contact the RSO or Radiation Safety Specialist to perform a survey of the equipment or material to verify removable contamination is less than the limits in Section 10.9.2 prior to moving.

10.9 Unrestricted Release of Material or Equipment

The unrestricted release of material or equipment is taken to mean that material or equipment in a posted radiological area is released without any restrictions to an area, either on campus or off-campus. This would include lab equipment originally located in a posted radiological area that is no longer needed and released to be sold to an offsite organization, donated to a local charity, or sent to a landfill for disposal.

10.9.1 The RSO or the Radiation Safety Specialist shall authorize the unrestricted release of equipment or material from labs that use unsealed radioactive material.

10.9.2 Equipment or material shall only be released for unrestricted use if removable contamination is less than:

- 1000 dpm/100 cm² beta/gamma using a GM probe
- 100 dpm/100 cm² beta using a liquid scintillation
- 20 dpm/100 cm² alpha using liquid scintillation or alpha scintillation

10.9.3 Items with removable contamination above these limits will be discarded as radioactive waste if they cannot be decontaminated to meet these criteria.

10.10 Radioactive Waste

Radioactive waste is radioactive material that is discarded as waste. Typical waste items include potentially contaminated items such as disposable gloves, contaminated lab equipment, and liquid scintillation vials.

10.10.1 The radionuclides and quantities discarded in radioactive waste containers should be tracked to maintain the lab’s inventory of radioactive material.

10.10.2 Collection and Storage in Lab

- 10.10.2.1 Solid radioactive waste should be placed in storage containers with a disposable liner to prevent the container from becoming contaminated.
- 10.10.2.2 Liquid radioactive waste shall be stored in non-breakable containers, preferably in polyethylene containers.
- 10.10.2.3 Radioactive waste shall be stored in labs that are secured and posted with a “Caution, Radioactive Material” sign.
- 10.10.2.4 Radioactive waste containers shall be shielded such that the exposure rate at one foot from the surface does not exceed 2.0 mR/hr.
- 10.10.2.5 Radioactive waste containers shall bear a “Caution, Radioactive Material” sign.

10.10.3 Removal from Lab

- 10.10.3.1 RMS shall remove radioactive waste from labs.
- 10.10.3.2 Bags containing radioactive waste shall bear a “Caution, Radioactive Material” sign and contain a label with exposure information and contents (radionuclides and quantities).
- 10.10.3.3 Liquid radioactive waste shall be placed in appropriate containers with radioisotopes and quantities entered on the record of deposition tag attached to each container.
- 10.10.3.4 Organic liquid radioactive waste shall be placed in appropriate containers with radioisotopes and quantities entered on the record of deposition tag attached to each container.
- 10.10.3.5 Vials containing H-3 or C-14 only should be kept separate from vials containing other radionuclides. Radioisotopes and quantities shall be entered on the record of deposition tag.

10.10.4 The RI is responsible for ensuring the lab inventory of radioactive material is updated after radioactive waste has been removed from the lab.

10.11 Animal Research with Radioactive Materials

Animals are rarely used in research involving radioactive material and each research project requires different radiological controls. The RI shall consult with the RSO to establish the radiological control protocols for conducting research using animals with internal radioactive material.

11 Radiation Producing Machine Procurement and Tracking

11.1 Procurement

- 11.1.1 All orders for radiation producing machines shall be initiated by a RI
- 11.1.2 Radiation producing machine procurement requests must be approved by the RSO or designee.
- 11.1.3 Prior to ordering radiation producing machines the RI should verify the following:
- they are approved to use the machine they desire to purchase
 - the facility is approved for using that machine
- 11.1.4 The RSO or designee shall verify that the RI and facility are approved to use the machine prior to approving the procurement request.
- 11.1.5 If the RI or facility is not currently approved to use the machine, the RCC Chairperson may grant temporary approval. The RSO or designee may then approve the procurement request.

11.2 Receipt

- 11.2.1 RI shall take possession of the radiation producing machine upon delivery and verify the machine meets the procurement specifications.

11.3 Registration

- 11.3.1 The RSO shall ensure the radiation producing machine is registered with the Indiana State Department of Health.

11.4 Inventory

- 11.4.1 The RSO or designee shall perform an annual physical inventory of all radiation producing machines and ensure they are registered with the Indiana State Department of Health.
- 11.4.2 The RI is responsible for notifying the RSO if there is any change which would render the registration inaccurate such as:
- Change in location

- Transfer to another campus facility
- Transfer to an outside organization
- Disposal of machine

11.5 Transfer to another Lab or Facility

11.5.1 On-campus transfer

- 11.5.1.1 Machines shall not be transferred from one area to another or to another individual without approval of the RSO.
- 11.5.1.2 Prior to transfer approval, the RSO shall verify the RI and facility are approved for use by the RCC
- 11.5.1.3 If the receiving RI or facility is not currently approved by the RCC, the RCC Chairperson may grant temporary approval, at which time the RSO may approve the transfer.

11.5.2 Off-campus transfer

- 11.5.2.1 The RSO shall approve all transfers of radiation producing machines from Notre Dame to an outside organization and update the inventory accordingly.

12 Safe Use of Radiation Producing Machines

12.1 Lab or Facility Requirements

12.1.1 Facility approval

- 12.1.1.1 Each facility that uses or intends to use radiation producing machines must be approved by the RCC.
- 12.1.1.2 The initial approval for facility use requires the RI to submit RCC Form 4 for RCC approval.
- 12.1.1.3 Subsequent approvals are granted through the annual RI Renewal process.

12.2 Typical facility requirements include the following:

- Ability to limit access to the machine or operational area
- Physical security measures to prevent inadvertent exposures
- Interlocks to prevent inadvertent exposures
- Access to a phone or the ability to make cell phone calls

- Suitable means of egress, so that any person may escape the interior of the room or area without delay
- An effective means within the room for preventing or terminating operations
- Shielding design or dose calculations may be required prior to construction or remodeling facilities that contain or will contain radiation producing machines.

12.3 Physical Controls and Postings

12.3.1 Doors to labs or facilities that use radiation producing machines must be closed and locked when personnel are not present to prevent unauthorized entry or operation or the machine rendered inoperable such as the use of a key.

12.3.2 The entrance to labs of facilities that use radiation producing machines shall be posted with:

12.3.2.1 For X-ray machine facilities, a sign bearing the radiation caution symbol and the words "Caution – X-RAY Equipment".

12.3.2.2 NRC Form 3 "Notice to Employees"

12.3.2.3 Emergency Contact Information (RCC Form 8).

12.4 Prior to Initial Use

12.4.1 Prior to initial use of a new machine, the radiation producing machine shall be inspected by an individual certified by the Indiana State Department of Health.

12.5 Surveys and Testing for Accelerators

12.5.1 Routine surveys and testing of interlocks, alarms, and area radiation monitors is required in accordance with standards of 410 IAC 5, at frequencies specified in the Rule.

12.5.2 Completed surveys and surveillance forms (for testing interlocks and alarms) should be maintained locally or with the RSO.

12.5.3 Surveys and surveillances should be completed for the Physics Department and Radiation Lab accelerators.

12.5.4 Surveys for human-use X-ray machines should be completed as part of the registration renewal with the State.

12.6 Individual User Requirements

12.6.1 Training

12.6.1.1 Machine Produced Radiation Training and Radiation Safety Training is required to be completed prior to operating or working in the immediate area of radiation producing machines.

12.6.1.2 Training is maintained current by completing refresher training annually.

12.6.1.3 The RSO shall approve the course content.

12.6.2 Dosimetry

12.6.2.1 RIs and individual users under their supervision that will work with or around radiation producing machines shall be issued a personal dosimeter.

12.6.2.2 The following apply if issued a personal dosimeter:

- Wear the dosimeter assigned only to you
- Wear dosimeter at all times when working with or around radiation producing machines
- Wear dosimeter on the front torso between the neck and waste (collar, pocket, or belt)
- Store dosimeter in an area away from radiation producing machines such as an office or break room

12.7 Safe Practices

12.7.1 Operators must be trained and approved to use radiation producing machines

12.7.2 The principles of time, distance and shielding apply to minimizing radiation exposure during operation of radiation producing equipment:

- minimize the time around equipment when energized
- move as far away from the source of the radiation as possible during operation
- employ shielding

12.7.3 Wear proper PPE per lab SOPs such as:

- Lab coat
- Safety glasses
- gloves

12.8 Release of Equipment or Material from accelerator facilities

Equipment or Material in the direct beam path, or near the beam path of accelerators may be activated.

- 12.8.1 The RI is responsible for contacting the RSO or Radiation Safety Specialist prior to removing equipment or material from accelerator facilities with the potential to be activated.

12.9 Vendor Radiography Operations

- 12.9.1 Vendors that operate their own radiography equipment while on campus work under their own radiation protection program therefore adhere to their own radiological procedures and controls.
- 12.9.2 University organizations that contract vendors to perform radiography operations on campus shall notify the RSO prior to commencing operations so that the RSO is cognizant of location and duration of the planned radiography.

13 Radiation Safety Training

13.1 Individual Users

- 13.1.1 All individual users shall complete Radiation Safety Training (Modules 1, 2, and 3) prior to working with radioactive materials.
- 13.1.2 Individual users shall maintain current training by completing refresher training annually.
- 13.1.3 Training is administered online.
- 13.1.4 The RSO shall approve the course content.

13.2 RIs and Lab Supervision

- 13.2.1 RIs and Lab Supervisors who are responsible for research activities using radioactive material shall complete Radiation Safety Training.
- 13.2.2 Training shall be maintained current by completing refresher training annually.
- 13.2.3 Training is administered online.

13.2.4 The RSO shall approve the course content.

13.3 Lab Personnel who are not Individual Users

13.3.1 Lab personnel who are not Individual Users, and do not work in labs that use radioactive materials but enter such labs occasionally must only complete Radiation Awareness Training annually.

13.3.2 Lab personnel who are not Individual Users but routinely work in labs where radioactive materials are used must complete Radiation Safety Training, and maintain their training current by completing annual refresher training.

13.3.3 The RI or Lab Supervisor has the discretion to require lab personnel who are not Individual Users to complete Radiation Safety Training prior to entering their lab.

13.4 Radiation Producing Machine Users

13.4.1 All users of radiation producing machines that are registered with the state of Indiana must complete Machine Produced Radiation Training prior to operating or working with such machines. This training is in addition to Radiation Safety Training.

13.4.2 Training is maintained current by completing training annually.

13.4.3 Training is administered online.

13.4.4 The RSO shall approve the course content.

14 Enforcement Actions

The RCC has the delegated authority as a condition of the University's radioactive materials license to approve RIs for using radioactive material, and has the authority to approve RIs to use radiation producing machines. Retention of approval to use radioactive materials and radiation emitting machines by an RI is contingent upon adherence to applicable federal and state regulations, the University's license conditions, and the requirements of the RCC and this manual. The RCC may take enforcement actions as deemed necessary; however, the following are guidelines for classifying violations and for administering enforcement actions.

14.1 Major Violations

14.1.1 More than three minor violations in any twelve-month period

14.1.2 Transfer of radioactive materials or radiation emitting machines to an unapproved facility or individual

14.1.3 Not securing radioactive material and/or the laboratory to prevent unauthorized access

14.2 Enforcement Actions for Major Violations

14.2.1 First Violation: Retraining for all involved, and written response from the RI describing actions to prevent re-occurrence. Letter to the Department Chair describing the violation and the corrective actions to be taken.

14.2.2 Second Violation (within a one-year period): Ninety-day suspension of approval to use radioactive materials and/or radiation producing machines. RI shall reapply to RCC for approval if wishing to resume use after ninety days. Letter to the Department Chair describing the violation and the corrective actions to be taken.

14.2.3 Third Violation (within a one-year period): Permanent suspension of approval to use radioactive materials and/or machines. Notification of Department Chair of permanent suspension.

14.3 Minor Violations

14.3.1 Not informing RSO or Radiation Safety Specialist of

- new individual users
- Known or suspected contamination, leaks, or spills.
- Lost, damaged, or contaminated dosimetry

14.3.2 Not wearing appropriate personal protective equipment (PPE) such as:

- Safety eyewear
- Disposable gloves
- Laboratory coat

14.3.3 Not wearing dosimetry

14.3.4 Failure to perform required laboratory surveys.

14.3.5 Failure to post required warning signs or labels, or failure to label items such as radioactive waste.

14.3.6 Storing food and/or beverages in the laboratory.

14.4 Enforcement Actions for Minor Violations

14.4.1 First Violation: Written warning to RI, copied to Department Chair and RSO

14.4.2 Second Violation: Additional training and written response from RI describing corrective measures.

14.4.3 Third violation: Repeat the Enforcement Actions for the First and Second Violations. A follow-up unannounced inspection will be conducted by RMS Personnel within thirty days of the finding of the violation. If the previous violation still exists or a new minor violation is found at the time of that inspection, a First Major Violation will result.

15 Emergency Procedures

In the event of a radiological accident or emergency, the health and safety of personnel are the primary concern. Actions taken will be to minimize personnel exposures first, then address the secondary issues. The following give immediate actions to take in the event of:

- Fire or explosion in radiological lab
- Spill of radioactive material
- Accidental exposure using a radiation producing machine
- Missing radioactive material

15.1 Fire or Explosion in Lab

15.1.1 Evacuate lab immediately

15.1.2 Warn other individuals in adjacent areas to evacuate

15.1.3 Call 911

15.1.4 Notify RSO and RCC Chairperson

15.1.5 Notify RI

15.2 Spill of Radiological Material

- 15.2.1 Notify persons in the lab that a radioactive spill has occurred.
- 15.2.2 Cover the spill with absorbent paper if it is a small spill
- 15.2.3 Evacuate the lab
- 15.2.4 Notify RSO and RCC Chairperson
- 15.2.5 Notify RI

15.3 Accidental exposure from radiation producing machine

- 15.3.1 De-energize equipment
- 15.3.2 Move all affected personnel to a non-restricted area
- 15.3.3 Notify RSO and RCC Chairperson
- 15.3.4 Notify RI

15.4 Missing radioactive material

- 15.4.1 Notify RSO
- 15.4.2 Notify RI

15.5 Decontamination of Labs or Individuals

- 15.5.1 The RSO or RCC Chairperson shall oversee the decontamination of individuals or labs due to radiological emergencies requiring personnel evacuation of the lab area.

Revision Log

History	Effective Date
Procedure Developed	June 2016
Minor changes	March 2018
<p>Complete overhaul of Manual. Major Changes:</p> <ul style="list-style-type: none"> • Re-organized document • Added new Sections for: Introduction, ALARA, Instrumentation, External and Internal Monitoring, and Dose Limits • Revised Roles and Responsibilities; removed Area RSO and added Radiation Safety Specialist • Removed references to film badges (TLDs are used) • Updated bioassay guidance to be incident based • Updated radioactive material safety guidance • Updated guidance on radionuclide inventories • Updated radiation producing machine safety guidance • Added guidance for radwaste storage and labeling • Added guidance for free-release of equipment • Updated training guidance • Added personal contamination survey guidance • Updated decontamination procedures • Updated emergency response procedures • Updated forms and removed accelerator checklists 	September 2021



UNIVERSITY OF
NOTRE DAME

RCC Form 1

University of Notre Dame
Responsible Investigator Application

Name: _____ Department: _____
Office: _____ Lab: _____ Phone: _____

Educational History:

Degree	University	Date

Training:

Subject Area	Location	Duration (Hrs)	Type: Formal or On-the Job
Principles and Practices of Radiation Protection			
Radioactive Monitoring and Instrumentation			
Measurement of Radioactivity			
Biological Effects of Radiation			

Formal Courses: List any formal coursework pertaining to the safety use and handling of radioactive material such as nuclear physics, radiation protection, radiation biology, shielding, etc.

Course Title	Location	Duration

Experience with radioactive material:

Radionuclide	Maximum Quantity	Location	Duration



List Requested Radionuclides and Location(s) for Use

Radionuclide	Quantity (Max)	Building and Room(s)

Experience with Radiation Producing Machines:

Machine Type	Location	Duration

Describe Intended Use of Radioactive Material:

Statement of Agreement:

The below named individual signifies that he/she has read and is willing to abide by the University of Notre Dame regulations governing the use of radioisotopes and other sources of ionizing radiation. The undersigned agrees to comply strictly with all such rules and regulations and hereby waives any right or recourse against the University of Notre Dame for any damage whatsoever resulting from any failure to conform with said regulations. He/She further assumes responsibility for ascertaining that employees, students and associates working under his/her direction shall comply with the regulations of the University of Notre Dame governing the use of radioactive materials and radiation sources.

Name	Signature	Date

RCC Approval/Date: _____

Approval is for a period not to exceed one year.



RCC Form 2a

University of Notre Dame

Application for Continued Use of Radioactive Material

Name: _____ Department: _____
Office: _____ Lab: _____ Phone: _____

List the radionuclides and quantities you are currently approved to use and possess:

Table with 3 columns: Radionuclide, Quantity (Max), Building and Room(s)

List the radionuclides and quantities you would like to remove or reduce:

Table with 3 columns: Radionuclide, Quantity (Max), Building and Room(s)

List the radionuclides and quantities you would like to add or increase:

Table with 3 columns: Radionuclide, Quantity (Max), Building and Room(s)

Describes any significant changes that are anticipated in the use of radioactive material or the use of laboratory facilities:

The undersigned agrees to comply with all University policies related to radiation safety, the Radiation Safety Manual requirements, and the University's radioactive material license. The undersigned agrees to assume the responsibility for the radiological safety of those working under their direction.

Name: _____ Signature: _____ Date: _____

RCC Approval: _____ Date: _____

Note: Approval valid for 1 year.



RCC Form 2b

University of Notre Dame

Application for Continued Use of Radiation Producing Machines

Name: _____ Department: _____
Office: _____ Lab: _____ Phone: _____

List the radiation producing machines you are currently approved to use:

Table with 2 columns: Machine, Building and Room(s). 4 empty rows.

List the radiation producing machines you would like to remove:

Table with 2 columns: Machine, Building and Room(s). 4 empty rows.

List the radiation producing machine you would like to add:

Table with 2 columns: Machine, Building and Room(s). 4 empty rows.

Describes any significant changes that are anticipated in the use of laboratory facilities:

The undersigned agrees to comply with all University policies related to radiation safety, the Radiation Safety Manual requirements, and the University's radioactive material license. The undersigned agrees to assume the responsibility for the radiological safety of those working under their direction.

Name: _____ Signature: _____ Date: _____

RCC Approval: _____ Date: _____

Note: Approval valid for 1 year.



RCC Form 3

University of Notre Dame

Application for Additional Radionuclides or Quantities

Name: _____ Department: _____
Office: _____ Lab: _____ Phone: _____

Check below as appropriate:

- _____ This is an application to possess new radionuclides not previously authorized.
_____ This is an application to possess quantities of radionuclides above current authorization.

List the radionuclides and quantities you are currently approved to use and possess:

Table with 3 columns: Radionuclide, Quantity (Max), Building and Room(s)

List the radionuclides and quantities you would like to add or increase:

Table with 3 columns: Radionuclide, Quantity (Max), Building and Room(s)

Describe below the reason for requesting new radionuclides or additional quantities:

Table with 5 columns: Name, Signature, Date

Temporary Approval Date: _____
RCC Approval: _____
Date: _____



RCC Form 4
University of Notre Dame
Facility Approval for Radionuclide Use

Department: _____ Building and Room: _____

Responsible Investigator: _____ Date Submitted: _____

Table with 3 rows: Byproduct Material to be Used, Chemical or Physical Form, Maximum Possession Quantity. Each row has 7 empty columns.

Sketch of Facility:

Type of Floor Covering _____ Bench Top Materials _____ Walls & Ceilings _____
Hood(s) Singly Ducted Yes _____ No _____

Large empty rectangular box for sketching the facility.

Flow Rate With Sash Openings FPM _____ FPM _____ FPM _____

Number of Persons Normally Working Area: _____

Number of Individuals in the Following Educational Categories:

Undergrad _____ Grad _____ Technician _____ Postdoc or Faculty _____

Are other personnel working in this facility approved radioisotope workers?

Is this area also used as a study/office area for research personnel?



List monitoring devices located in this facility: (Make, Model, Type, Range)

—

List special handling facilities: (Shielding, Glove boxes etc.)

Approved: (Radiation Safety Officer) _____ Date:

Approved: (Radiation Control Committee) _____

Date: _____



RCC Form 5
University of Notre Dame
Declaration of Pregnancy

Name: _____

PI Name: _____ Department: _____

Building/ Room: _____ Phone: _____

Per NRC regulation (10 CFR 20.1208) the radiation dose to the embryo/fetus of a declared pregnant worker is limited to 5 mSv (0.5 rem) over the entire gestation period. By declaring one's pregnancy, a worker is able to take advantage of special dose limits intended to protect the fetus. Declaration is not mandatory. Furthermore, the declaration of pregnancy does not need to remain permanent, as the worker's dose limits are adjusted based on her state of declaration: an employee may declare her pregnancy but may later decide to revoke the declaration. All workers are specifically protected from discharge or discrimination by their employer resulting from exercise of any option afforded by this code. This declaration and all records relating to it are confidential and will be maintained in a separate file from personnel radiation dosimeter records.

By signing this form, I am declaring that I am pregnant. I believe that I have been pregnant for about _____ months (provided for estimating dose for the duration of the pregnancy). In consultation with the Radiation Safety Officer, we will agree to continue or modify my working conditions to ensure the radiation dose to my embryo/fetus will be as low as reasonably achievable.

Signature: _____

Date: _____



RCC Form 6
University of Notre Dame
Authorization to Release Radiation Exposure History

TO: _____

ATTENTION: _____

You are hereby authorized to furnish to the Radiation Safety Officer, University of Notre Dame, any or all information concerning my radiation exposure history as developed while I was employed or assigned at during the period from _____ to _____. You are further authorized to include in your transmittal to said person any or all information concerning my radiation exposure history acquired by you from other persons, employers or agencies if such records are in your possession.

Please transmit my radiation exposure record to:

Radiation Safety Officer
Risk Management & Safety
636 Grace Hall
University of Notre Dame
Notre Dame, Indiana 46556

Signature _____

Date _____



RCC Form 7

University of Notre Dame
Laboratory Radiological Surveys

Laboratory Location: _____

Date: _____

Person Conducting Survey: _____

RI or Lab Supervisor: _____

Instruments Used						
Manufacturer:	_____	Model:	_____	Cal. Date:	_____	Bkgd (cpm): _____
Manufacturer:	_____	Model:	_____	Cal. Date:	_____	Bkgd (cpm): _____

Lab Diagram

Survey Meter Results

Location	cpm

Wipe Test Results

Location	cpm

If contamination levels greater than 1.5 times the instrument background are detected, decontaminate the area using wet wipes or rags. Contact Lab Supervisor or Radiation Safety Specialist for assistance.

Radiation Level Limits for Radiation Sources

If dose rate at the surface of any stored radioactive material, such as stock solutions or waste, exceeds 5.0 mR/hr contact the Radiation Safety Specialist or RSO.



RCC Form 8

University of Notre Dame
Emergency Contact Information

EMERGENCY # 911 (**From a Campus Phone only, cell phones call 574-631-5555**)
(Fire, explosion, personal injury, etc.)

1. **Security Dispatch 1-5555** (after hours spill, non-injury accidents)

(This number is open 24 hours and should be called to arrange for an ambulance.)

2. **Risk Management and Safety**

Radiation Safety Officer – Mike Domal 574-631-6702

3. **Radiation Control Committee**

Chairman - Dr. Peter Burns 574-631-7852
After Hours 574-258-9034

4. **Notre Dame Fire Department** 574-631-6200

5. **Memorial Hospital** 574-284-6800

Memorial Hospital of South Bend is the designated Treatment center for radiation ingestion or injury due to the "Poison Control Center" facilities located there and the existence of radioisotope treatment program at the hospital.