

Idaho State University

# **Radiation Safety Manual**

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**Radiation Safety Department  
Idaho State University  
Idaho Accelerator Center  
1500 Alvin Ricken Drive  
Pocatello, Idaho 83201  
(208) 282-5652**

## Table of Contents

1.	Introduction .....	7
2.	Radiation Safety Commitment .....	8
3.	Safety Conscious Work Environment .....	10
4.	Organization Structure and Authority .....	10
5.	Roles and Responsibilities .....	12
5.1.	Executive Management.....	12
5.2.	Radiation Safety Committee .....	13
5.3.	Radiation Safety Committee Chairperson .....	15
5.4.	Radiation Safety Officer .....	15
5.5.	Authorized User .....	17
5.6.	Radiation Worker.....	17
5.7.	Reactor Safety Committee .....	18
5.8.	Reactor Administrator.....	18
5.9.	Reactor Supervisor.....	18
5.10.	Reactor Operator.....	19
5.11.	Senior Reactor Operator .....	19
5.12.	Authorized Operator .....	19
5.13.	Certified Observer.....	19
6.	ALARA Policy and Dose Limits.....	19
6.1.	Dose Limits and ALARA .....	19
6.2.	Pregnant Radiation Workers .....	20
6.3.	Minors.....	21
7.	Authorization and Permitting .....	21
7.1.	Approval of Authorized Users .....	21
7.2.	Radiation Use Permits .....	21
7.3.	Application for Permits.....	22

7.4.	Termination of Permits .....	22
8.	Radiation Safety Training.....	23
8.1.	General Radiation Training .....	23
8.2.	Refresher Training .....	23
8.3.	Program Specific Training.....	24
8.4.	Awareness Training .....	24
9.	Radioactive Material Requirements .....	24
9.1.	Procurement.....	24
9.2.	Shipment and Transfer.....	25
9.3.	Receipt of Radioactive Material .....	26
9.4.	Security of Radioactive Material .....	26
9.5.	Inventory.....	27
9.6.	Accountable Nuclear Material .....	27
9.7.	Labeling of Material and Containers .....	27
9.8.	Radioactive Material Logs.....	28
9.9.	Source Leak Tests.....	28
10.	Control of Areas and Postings .....	28
10.1.	Area Definitions.....	28
10.2.	Area Control .....	29
10.3.	Radiological Postings .....	30
11.	Control of Contamination.....	30
12.	Surveys .....	31
12.1.	User surveys.....	32
12.2.	Radiation Safety Surveys.....	33
12.3.	Release Surveys .....	33
13.	Safe Work Practices.....	33
13.1.	Personnel Surveys.....	33

13.2.	Personal Protective Equipment .....	33
13.3.	Hygiene.....	34
13.4.	Engineering Controls .....	34
13.5.	Shielding .....	34
13.6.	Particulates and Aerosols.....	34
13.7.	Radioactive Gases.....	34
13.8.	Remote Handling Equipment.....	34
13.9.	Maintenance and Storage of Equipment .....	35
14.	Radiation Safety Program Audits .....	35
15.	Dose Measurement and Reporting .....	35
15.1.	External Dosimetry .....	35
15.2.	Internal Dose Measurement .....	36
15.3.	Public Dose Monitoring.....	36
15.4.	Dose Reporting .....	36
16.	Radiation Monitoring Equipment.....	37
16.1.	Portable Survey Instruments .....	37
16.2.	Laboratory Instruments.....	37
17.	Radioactive Waste Management .....	37
17.1.	Waste Segregation and Characterization .....	38
17.2.	Waste Pick Up and Storage.....	39
17.3.	Waste Disposal by Waste Broker .....	39
17.4.	Sewer Disposal .....	39
17.5.	Decay in Storage.....	39
18.	Decommissioning of Laboratories and Facilities .....	40
19.	Radiation Machines .....	40
20.	Emergency Preparedness and Response.....	41
21.	Radiation Safety Records .....	42

21.1.	Dose Records .....	42
21.2.	Training Records.....	42
21.3.	Other Records .....	43
22.	Acronyms.....	44
23.	Glossary .....	45
24.	References .....	47

**Tables**

**Table 1.** Dose Limits and ALARA Goals.....20  
**Table 2.** Area Definitions for Access Control. ....29  
**Table 3.** Area Definitions for Radiation Use. ....29  
**Table 4.** Area Definitions for Radiation Warning. ....29  
**Table 5.** Radiological Area Postings.....30  
**Table 6.** Removable Contamination Control Levels.....31  
**Table 7.** Specific Surface Contamination Limits (dpm/100 cm<sup>2</sup>). ....31  
**Table 8.** Radiation Use Area Survey Frequencies. ....32

**Figures**

**Figure 1.** Organization Chart for Broad Scope and Production Licenses..... 11  
**Figure 2.** Organization Chart for Reactor and SNM Licenses..... 12

## **1. Introduction**

This manual documents the Idaho State University commitment to performing work with radioactive materials and radiation machines in a safe and compliant manner. The manual applies to executive management, the Radiation Safety Committee, the Reactor Safety Committee, the Radiation Safety Officer, the Reactor Administrator and other reactor personnel, Authorized Users, and Radiation Workers. Compliance with the manual will ensure compliance with federal and state regulations and will ensure safety for all affected personnel. The manual is topic driven. For information on a specific aspect of radiation safety consult the table of contents to find specific requirements. If there are any questions regarding the manual, contact the Radiation Safety Officer, the Chairman of the Radiation Safety Committee or any member of the Radiation Safety Department. Additional information regarding radiation safety and specific contact information is available at the ISU Radiation Safety Website:

<https://www.isu.edu/radiationsafety/>

## **2. Radiation Safety Commitment**

### **RADIATION SAFETY STATEMENT OF THE PRESIDENT, IDAHO STATE UNIVERSITY**

Team,

I want to convey to our faculty, staff and students the University's commitment to assuring that our Radiation Safety Program and its implementation in all respects reflect our comprehensive and steadfast commitment to safety on our campus. Please join me in creating a radiation safety culture that our faculty, staff, and students deserve.

Idaho State University holds four different nuclear licenses from the United States Nuclear Regulatory Commission. In addition, we have two state-issued radiological licenses for radiation machines which also fall under our Radiation Safety Program. When taken together, those licenses truly make Idaho State a flagship nuclear science and health care university, essentially allowing us to conduct research and provide teaching opportunities most others in the country cannot. The fact that we have those licenses, and that combination of licenses, means the United States Nuclear Regulatory Commission and the State are trusting us with the responsibility to assure that our Radiation Safety Program and our Radiation Safety Manual conform to those licenses. We have the obligation to assure our Program and Manual are properly implemented for the safety of our students, our faculty, our staff, and our nation.

At Idaho State University, we will instill and live a culture of radiation safety on this campus. I believe strongly that every employee and student is entitled to work under safe and secure conditions. We must continuously work together to develop and foster a comprehensive culture of radiation safety in all of our radiation related operations. The University leadership highly values, and will endeavor to provide, resources to maintain a safe and healthful workplace where free and open communication is encouraged. Please help me in ensuring that this culture is at the forefront of all we do here at Idaho State.

Our Radiation Safety Program is an integral component of our mission that allows us to provide outstanding student instruction and successful research projects. We will hold ourselves to the highest standards and require our program to be safe for our employees, students, and the public. We have a duty to maintain compliance with federal and state licenses, regulations and policy, and ISU radiological program procedures. We have an expectation that our program will meet the goals of "As Low as Reasonably Achievable Exposure," and we will ensure our employees and students of such when working with radioactive materials. The University will provide a safe working environment, training and instruction, and appropriate personal protective equipment within our comprehensive radiation safety program. We will review and appropriately staff our program to achieve these goals. It is my commitment that I will hold leadership and the members of the Radiation Safety Program responsible and accountable to these goals.

Safety is all of our responsibility. We expect that our campus community will openly discuss safety concerns. ISU fully embraces the Nuclear Regulatory Commission Safety Culture Policy Statement. You may, openly or confidentially and free of any retaliation, report any safety concern, and we will investigate and resolve safety issues as they arise. You may also report



violations and concerns to the NRC or Department of Labor in accordance with posted NRC notices.

It is critical that you join with me in actively participating in the promotion and continuous enhancement of our culture of radiation safety at Idaho State University.

PRESIDENT

VICE-PRESIDENT

### **3. Safety Conscious Work Environment**

Any radiation worker may communicate directly, in confidence and without prejudice, with any of the following persons or organizations.

- The Supervisor
- The Authorized User
- The Radiation Safety Officer
- The Radiation Safety Committee Chair
- Any member of the Radiation Safety Committee,
- Any member of the Reactor Safety Committee
- The Reactor Administrator
- Any member of the Radiation Safety Department
- The Idaho Department of Health and Welfare (Radiation machines)
- The U.S. Nuclear Regulatory Commission (Radioactive material)

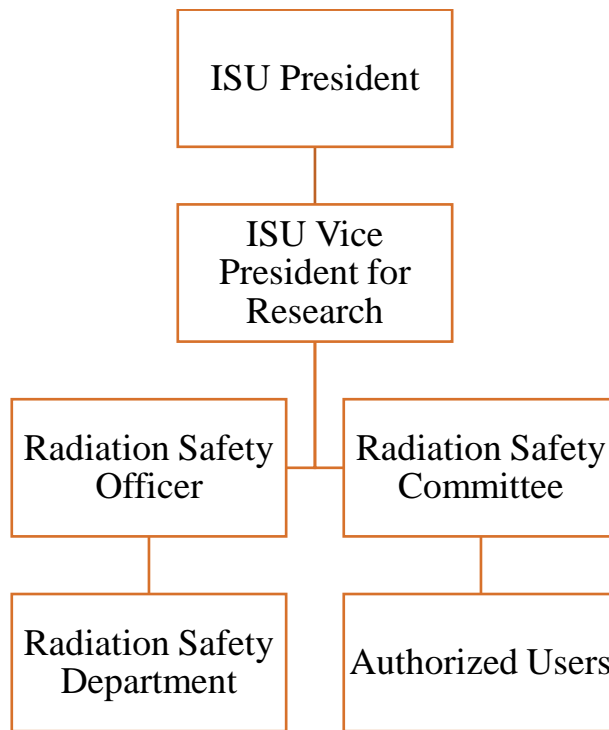
In addition, anyone also may anonymously report safety concerns or non-compliance by calling 1-800-716-9007 or by visiting the Convercent website, <https://app.convercent.com/en-us/Anonymous/IssueIntake/IdentifyOrganization>. Convercent is a service that is available 24 hours a day, seven days a week, on any matter concerning radiation protection.

### **4. Organization Structure and Authority**

The organization of the Radiation Safety Program for NRC License Nos. 11-27380-01 and 11-27380-04 and radiation machines is shown in Figure 1. Use of all radioactive materials and radiation machines at Idaho State University (ISU) is governed by Executive Management, the Radiation Safety Committee, and the Radiation Safety Officer.

The Radiation Safety Committee (RSC) has authority over all uses of radioactive materials at ISU. In addition, the Radiation Safety Committee (RSC) may call an ad-hoc committee as necessary to deal with specific requests. The ad-hoc Accelerator Safety Committee is called to review installations and operational safety assessments (OSA) of radiation producing accelerators.

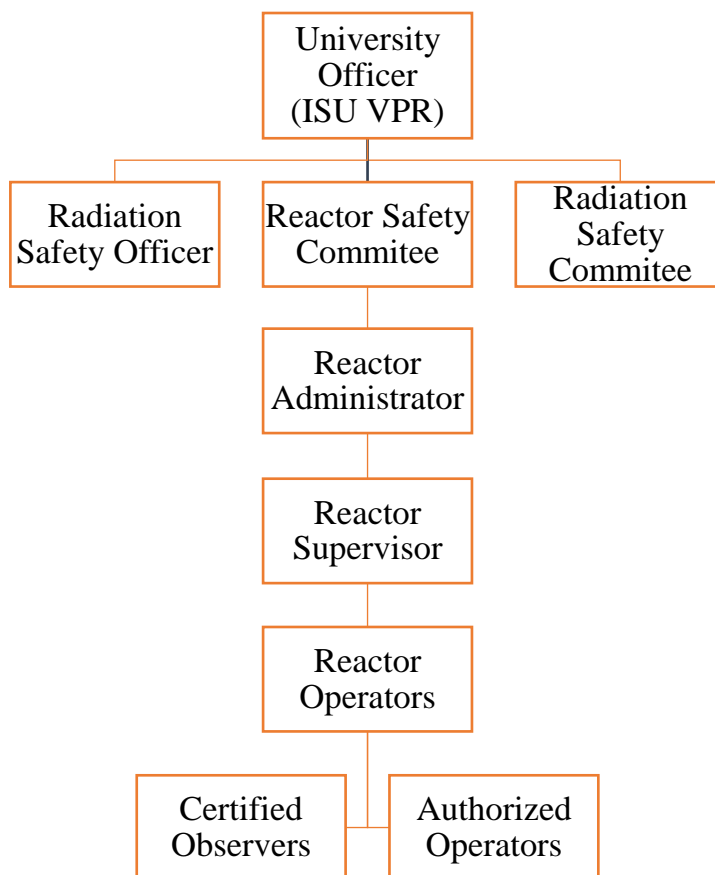
The Radiation Safety Officer (RSO) is appointed by the Vice President of Research (VPR) at ISU, is approved by the NRC and serves as Executive Secretary of the RSC. The RSO is the manager of the Radiation Safety Department. The RSO directs the radiation safety activities necessary to implement and enforce the safety program established by the RSC. The RSO is provided the administrative authority by the VPR to enforce procedures pertaining to the radiation safety program including the authority to temporarily suspend activities involving ionizing radiation deemed to be unsafe, subject to review by the RSC.



**Figure 1.** Organization Chart for Broad Scope and Production Licenses.

The organization of the Radiation Safety Program for NRC License Nos. R-110 and SNM-1373 is shown in Figure 2. Use of the reactor and special nuclear materials at Idaho State University (ISU) is governed by Executive Management, the Reactor Safety Committee, and the Reactor Administrator. The VPR appoints the reactor administrator, and the NRC approves the appointment.

The Reactor Safety Committee has authority over use of the reactor and special nuclear materials for the sub-critical assembly and other special nuclear materials covered in the special nuclear material license. General operation of the reactor and sub-critical assembly are directed by the Reactor Administrator and the Reactor Supervisor in accordance with the reactor license and technical specifications, the reactor emergency plan, the reactor security plan, and the special nuclear material license. The Radiation Safety Committee and Radiation Safety Officer provide assistance and oversight for all radiation safety aspects of operations in the reactor laboratory and use of radioactive materials regulated under the broad scope license.



**Figure 2.** Organization Chart for Reactor and SNM Licenses.

## 5. Roles and Responsibilities

### 5.1. Executive Management

Executive responsibility and authority for administration of Radiation Safety at Idaho State University is assigned to the President. The President has delegated the responsibility and authority to oversee the implementation and management of the Idaho State University radioactive materials licenses and radiation machine permits to the Vice President of Research (VPR). The VPR appoints the RSC chairperson, the Reactor Safety Committee (ReSC) chairperson, members and any alternates for the members of the RSC and of the ReSC. members and any alternates for the members of the RSC and for the Reactor Safety Committee. The VPR also selects and appoints individuals who meets the qualifications for the position of Radiation Safety Officer and Reactor Administrator.

The VPR is a member of the RSC and the Reactor Safety Committee and the VPR or designee will attend all meetings of both committees. The VPR also participates in oversight of the radiation safety program through regular meetings at least bi-monthly with the chairperson of the RSC, the reactor administrator, the RSO, and if available, the chairperson of the ReSC. Proposed radiation safety program modifications are reviewed at the management meeting and specifically evaluated to determine if they should be evaluated by the Radiation Safety

Committee, the Reactor Safety Committee, or both. Based on this review, the program modifications are forwarded to the appropriate committees for evaluation.

## **5.2. Radiation Safety Committee**

The RSC is authorized by the Executive Management to oversee all uses of NRC-licensed radioactive materials and State of Idaho-registered radiation machines at Idaho State University (ISU).

The purpose of ISU's Radiation Safety Committee is to set policy and to promulgate rules and procedures to ensure the safe use of radioactive materials at the University in accordance with NRC regulations and guidance. This duty includes review of training programs, equipment, facilities, supplies, procedures, personnel dosimetry data, survey results, significant events, ALARA performance, Authorized User and Radiation Worker compliance, audits, license reviews and amendments. The RSC also must ensure that appropriate university policies and procedures incorporate elements of the NRC's most current Safety Culture Policy Statement.

Members of the RSC are appointed by the VPR for renewable 3-year terms from the academic and research areas that use ionizing radiation at ISU. The voting RSC membership is based upon the interest of providing representation to those institutional administrative units that have radiation sources. The membership should include at least one person whom meets the requirements of an Authorized User of each type of use permitted by ISU's broad scope and production licenses, the Radiation Safety Officer, and a representative of management who is neither an Authorized User nor the Radiation Safety Officer. Changes to RSC membership are recommended by the RSO and Radiation Safety Committee Chairperson (RSCC) to the VPR. Any change of the RSO or of the RSCC must be approved by the NRC. Other changes are at the discretion of the VPR. Representatives of groups or functions such as Purchasing, Security, and Facilities may be appointed non-voting members to the RSC.

The RSC informs the Vice President of Research, and other ISU administrators as applicable, of the radiation safety program operations, changes, incidents and all situations that have or may result in regulatory intervention.

The RSC meets as often as is necessary to conduct business but not less than four times per calendar year, at least once per quarter, and maintains written minutes of all committee meetings, including members in attendance and members absent, discussions, actions, recommendations, decisions and results of votes. Because academic and calendar quarters may not coincide, the quarterly meeting requirement will be deemed met if the meeting occurs within 10 days of the beginning or ending of the calendar quarter and at least two weeks subsequent to the previous quarterly meeting. Minutes are kept and maintained by the Radiation Safety Department for each RSC meeting. Approved minutes are held on file by the Radiation Safety Department. Meetings are open to Authorized Users, Radiation Workers, Faculty, Management and Staff of ISU.

The RSC shall conduct its meetings and duties with transparency and declaration of any conflicts of interests, real or perceived, by members of the RSC, the RSO, or management.

A quorum of the RSC consists of at least one-half of the voting RSC membership, which must include the VPR or his or her delegate, RSCC, and the RSO.

The duties of the RSC include the following:

- Annually reviewing the University's radiation safety program following the procedure RS-19-01, Management Oversight, that incorporates the guidance of NUREG 1556 Volume 11. All reviewed items must be complete each calendar year and applicable items reviewed by the RSC and documented in the RSC minutes.
- Evaluating new Authorized Users, new uses of licensed material, and new laboratories. Evaluation by the Radiation Safety Committee consists of the following:
  - Evaluation of the training of new Authorized Users to ensure that they meet ISU license requirements.
  - Review of the Authorized User's request to ensure that proper handling procedures will be used when working with radioactive materials or radiation machines.
  - Review of the Authorized User's laboratory for safety adequacy considering the radionuclide(s) or radiation machines to be used. At a minimum, the following will be verified:
    - Laboratory facilities and available equipment are appropriate.
    - User's proposed procedures are appropriate.
    - Survey instruments are appropriate to detect and quantify the types of radiation anticipated.
    - Procedures for inventory control of radioactive material are adequate
    - Required postings and labels are in place
- Reviewing and approving/disapproving all amendments and changes to the Broad Scope and Production licenses. A letter signed by the RSCC and the RSO will be forwarded to the Vice President of Research detailing the amendment.
- Suspending or terminating any operations involving radioactive materials or radiation machines if such action is deemed necessary to protect health and/or minimize danger to public health, safety and/or property.
- Ensuring that radiation and radioactive materials are used consistently with the ALARA philosophy and program.
- Implementing an e-mail ballot procedure when it is necessary to act on matters between Committee meetings. Decisions made via mail ballot shall be reviewed during the next regular meeting and entered into the minutes. Mail ballot decisions do not constitute a meeting.
- Empowering subcommittee(s) and establishing delegation of authority procedures to review and approve user authorizations in the name of the RSC
- Empowering the RSO and establishing delegation of authority procedures to review and issue interim authorizations, and to review and approve certain changes to authorizations in the name of the RSC. All interim authorizations issued by the RSO will be reviewed and approved at the next RSC meeting.

### **5.3. Radiation Safety Committee Chairperson**

The Radiation Safety Committee Chairperson (RSCC) shall be approved by the NRC and named on the radioactive materials license as that individual responsible to fulfill the statutory requirements of that position on behalf of ISU. The responsibilities of the RSCC are listed below.

- Leading the RSC.
- Calling a meeting of the Radiation Safety Committee in accordance with Section 5.2. and whenever deemed necessary.
- Conducting meetings in a fashion that is essentially in agreement with Robert's Rules of Order.
- Making final rulings regarding points of order that may arise during meetings.
- Asking attendees who are thought to be disruptive to leave the meeting
- Acting on behalf of the RSC.
- Working with the RSO to complete the annual assessment of the Radiation Safety Program.
- Working with the VPR to complete the annual independent assessment of the performance of the RSO.

### **5.4. Radiation Safety Officer**

The RSO is the individual appointed and empowered by the VPR and approved by the NRC to establish and enforce such rules and regulations as are necessary to assure compliance with applicable regulations and license conditions, and to ensure effective implementation of the policies and rules established by the RSC. The RSO works in conjunction with the RSC and answers directly to the VPR in all matters related to radiation safety.

The RSO has the authority to establish interim approval of all radiation safety actions as deemed appropriate with the collaborative knowledge of the RSCC. Full and final approval will be considered at the next regular meeting of the RSC.

The RSO directs the Radiation Safety Department, which assists the RSO in performance of radiation safety duties. The RSO is responsible for proper performance of the following activities:

- Serving as primary ISU liaison to the NRC and State of Idaho with regard to the radiation safety program and licenses or registrations.
- Ensuring compliance with rules and regulations, license conditions, and the conditions of project approvals specified by the RSC.
- Informing the RSCC of radiation safety actions taken. All such actions shall be noted and recorded in the minutes of the next subsequent RSC meeting.
- Ensuring that licenses and registrations remain up-to-date.
- Preparing for submittal to the NRC or State of Idaho, in a timely manner, all amendment and renewal applications.
- Ensure that effective corrective actions are developed, implemented, and documented if violations of regulations, or license or registration conditions, or program procedures are identified.
- Inspecting the programs of each Authorized User by the methods and frequency specified in Radiation Safety Department procedures developed in collaboration with the RSC.

- Performing surveillance of overall activities involving radioactive sources, including routine monitoring and special surveys of areas in which radioactive sources are used.
- Monitoring and maintaining any special equipment associated with the use, storage, or disposal of radioactive materials.
- Consulting with ISU personnel about radiation protection.
- Authorizing procurement, receiving, opening, and delivering shipments of radioactive material arriving at ISU to Authorized Users
- Packaging and shipping radioactive materials in accordance with Radiation Safety Department procedures.
- Distributing and processing personnel monitoring dosimeters, determining the need for and evaluation of internal exposure measurements, monitoring personnel exposure and bioassay records, notifying individuals and their supervisors of exposures approaching the maximum permissible amounts and recommending appropriate remedial actions.
- Conducting training programs and otherwise instructing personnel in the proper procedures for handling radioactive material before use, at periodic intervals conducting refresher training, and as required by changes in procedures, regulations, and equipment.
- Supervising and coordinating the radioactive waste disposal program, including maintenance of waste storage and disposal records.
- Storing and securing radioactive materials not in current use, including radioactive wastes.
- Performing or arranging for required leak tests on sealed sources.
- Performing or arranging calibration of radiation survey instruments.
- Maintaining an inventory of radionuclides for ISU and limiting the quantity of radionuclides at the University to the amounts authorized by the licenses.
- Immediately terminating any activity involving radioactive materials or radiation producing machines that is a threat to health or property.
- Performing decontamination and recovery operations.
- Maintaining radiation safety records, such as receipt of radioactive materials, transfer, inventory of special nuclear materials and survey records (as required by 10 CFR 30.51).
- Serving as a voting member of the RSC.
- Assisting in the annual performance evaluation of the University's radiation safety program.
- Comparing the University's policies against NRC's Safety Culture Policy as described in NRC's Regulatory Issue Summary (RIS) 2012-01 dated January 17, 2012, NUREG/BR-0500 dated June 2011 and NRC's Regulatory Issue Summary (RIS) 2005-18 dated August 25, 2005, "Guidance for Establishing and Maintaining a Safety Conscious Work Environment".
- Communicating to workers (including contractors) who are engaged in NRC licensed activities the different options that individuals may use to raise radiation safety concerns.
- Maintaining documentation to demonstrate by measurement or calculation that the total effective dose equivalent to an individual member of the public likely to receive the highest dose from the licensed or registered operation does not exceed the applicable limit for members of the public.
- Serving as an ex officio member of the Reactor Safety Committee.



## **5.5. Authorized User**

An Authorized User (AU) is a faculty or staff member from ISU or an affiliated organization (e.g. UI, BSU, or INL) authorized by the RSC, and named on a permit. An individual is designated to serve as an AU only after they provide the RSC with a detailed plan for the proposed use of radiation sources including secure storage, safe handling, control of exposures and appropriate waste disposal methods. The AU must update such information by means of periodic revisions or renewals of the authorization request as required by the RSC. The AU is responsible for the actions listed below.

- Demonstrating to the satisfaction of the RSO and the RSC sufficient training and experience in the safe use of radiation sources and/or radiation machines.
- Acknowledging acceptance of all requirements in the permit by signing the permit.
- Training Radiation Workers in radiation protection practices specific to their permit for all personnel working with radiation sources and/or within permitted facilities.
- Managing radioactive materials and/or radiation machines under their permit.
- Directly supervising Radiation Workers and operation of radiation machines
- Acquiring and using specific radiation sources.
- Acquiring equipment, supplies and services necessary for the safe use of radiation sources
- Securing radiation sources against misuse or theft
- Maintaining accurate inventory records for all radioactive materials, including acquisitions, uses, transfers, and records concerning disposal.
- Performing internal dose measurements as specified in the permit.
- Performing dose rate and/or contamination surveys as specified in the permit.
- Notifying the RSO of any accident, injury or abnormal incident related to radioactive materials or radiation machines.
- Notifying the RSO well in advance when it is necessary to terminate or transfer the permit for retirement or transfer to another position.
- Completing necessary training to qualify as a Radiation Worker.
- Preparing and implementing specific procedures for safe use of exposed radioactive sources that will create a Radiation Area when in use.

## **5.6. Radiation Worker**

A Radiation Worker is any individual whose official duties or authorized activities include handling, operating or working in the presence of any type of radiation source. The responsibilities of Radiation Workers are listed below.

- Understanding and following the general rules and procedures for working safely with radiation sources.
- Understanding and following the specific rules and procedures specified by the Authorized User.
- Completing initial radiation safety training and refresher training.
- Providing required information to the radiation safety department including primary identification data, e.g. full name, birth date, gender, address and Bengal ID; Previous training and experience with radiation sources; and current employment status, including job title or description, department, supervisor, and work location.
- Reporting radiation safety concerns as discussed in Section [3](#).

### **5.7. Reactor Safety Committee**

The Reactor Safety Committee is responsible for the following activities:

- Reviewing and approving safety standards associated with use of the reactor facility.
- Reviewing and approving all proposed experiments and procedures and changes thereto.
- Reviewing and approving all modifications to the reactor facility which might affect its safe operation.
- Determining whether proposed experiments, procedures, or modifications involve un-reviewed safety questions, as defined in 10 CFR 50.5, and are in accordance with the reactor technical specifications.
- Conducting periodic audits of procedures, reactor operations and maintenance, equipment performance, and records.
- Reviewing all reportable occurrences and violations of the reactor technical specifications, evaluating the causes of such events and the corrective action taken and recommending measures to prevent recurrence.
- Reporting all findings and recommendations concerning the reactor facility to the Reactor Administrator.

### **5.8. Reactor Administrator**

The Reactor Administrator is responsible for the following activities.

- Bearing ultimate responsibility for the operation, maintenance, and safety of the reactor facility within the limitations set forth in the facility license.
- Appointing the Reactor Supervisor.
- Seeking the advice of the Radiation Safety Committee and/or Reactor Safety Committee in all matters concerning unresolved safety questions, new experiments and new procedures, and facility modification which might affect safety.
- Serving as an ex officio member of the Reactor Safety Committee.

### **5.9. Reactor Supervisor**

The Reactor Supervisor is responsible for the following activities:

- Preparing, promulgating, and enforcing, administrative controls including all rules, regulations, instructions, and operating procedures to ensure that the reactor facility is operated in a safe, competent, and authorized manner at all times.
- Directing the activities of operators and technicians in the daily operation and maintenance of the reactor.
- Scheduling reactor operations and maintenance.
- Ensuring preparation, authentication, and storage of all prescribed logs and operating records
- Authorizing all experiments, procedures, and changes, thereto which have received the approval for the Reactor Safety Committee and/or the Radiation Safety Committee and the Reactor Administrator.
- Preparing experimental procedures involving use of the reactor.

- Holding a valid Senior Reactor Operator's license from the NRC.

#### **5.10. Reactor Operator**

Reactor Operators are responsible for the following activities:

- Manipulating reactor controls.
- Monitoring reactor instrumentation.
- Operating reactor-related equipment.
- Maintaining complete and current records during operation of the facility.
- Holding a valid Reactor Operator's license from the NRC.

#### **5.11. Senior Reactor Operator**

The Senior Reactor Operator is responsible for the following activities:

- Performing all activities of a Reactor Operator.
- Being on-call for operations where a Senior Reactor Operator is not present.
- Supervising all reactor maintenance or modification which could affect the reactivity of the reactor.

#### **5.12. Authorized Operator**

Authorized Operators are responsible for the following activities.

- Operating the reactor controls under the direct supervision of a Reactor Operator.

#### **5.13. Certified Observer**

Certified Observers are certified by the Reactor Supervisor to activate manual scram and initiate emergency procedures in the event of an emergency during reactor operation.

### **6. ALARA Policy and Dose Limits**

The University is committed to an effective radiation protection program to eliminate unnecessary exposures to radiation and to reduce all exposures to levels that are As Low As Reasonably Achievable (ALARA). The ALARA principle is a formal requirement of the U.S. Nuclear Regulatory Commission (NRC) and the Idaho Department of Health and Welfare. The ALARA goals for Idaho State University are set by the Radiation Safety Committee. The RSC reviews the University's goal periodically to verify all exposures at ISU are consistent with the ALARA policy of the NRC. The goals are based upon the legal limits set by the NRC, good radiation protection practices, and when available, historical dose information for active radiation programs. Regulatory Dose Limits are set by the NRC and the State of Idaho. These rules may be reviewed in entirety at <http://www.nrc.gov/reading-rm/doc-collections/cfr/> and <http://www.crcpd.org/page/SSRCRs>.

#### **6.1. Dose Limits and ALARA**

Personnel exposure to radiation in any one calendar year must be kept ALARA and specifically below the occupational dose limits specified in 10 CFR 20.1201. Doses received which exceed

the ISU ALARA Investigation Levels, specified in Table 1, are investigated by the RSO and reported to the RSC. The investigation includes the determination of the dose's source, if the dose was truly received by that individual, and if proper dose reduction techniques have been used. Dose results are reviewed during the quarterly RSC meetings to ensure proper oversight of the University's ALARA program.

**Table 1.** ALARA Quarterly and Annual Dose Investigation Levels.

	Quarterly Investigation Level		Annual Investigation Level	
	TEDE [mrem]	Ext. [mrem]	TEDE [mrem]	Ext. [mrem]
Level 1a <sup>1</sup>	300	2,500	1,000	10,000
Level 1b <sup>2</sup>	625	6,250	2,500 <sup>3</sup>	25,000 <sup>3</sup>
Level 2	1,000	10,000	4,000 <sup>4</sup>	40,000 <sup>4</sup>

<sup>1</sup> Applies to all radiation workers not involved in the processing of radioisotopes.  
<sup>2</sup> Only applies to radiation workers involved in the processing of radioisotopes.  
<sup>3</sup> Exceeding ALARA Investigation Level 1b annual limit – monthly monitoring will be instated in-place of quarterly monitoring.  
<sup>4</sup> If an individual meets or exceeds ALARA Investigation Level 2 annual limit, all work with radioactive materials will cease for this individual for the remainder of the year.

## 6.2. Pregnant Radiation Workers

The manner in which the dose limits for the embryo/fetus is handled is at discretion of the pregnant radiation worker. Pregnant Radiation Workers are encouraged to advise their Authorized User and the RSO of any situation that could result in fetal radiation exposure, so that the adequacy of radiation safety precautions can be assessed and pertinent information can be provided to the worker. Information and counseling may be requested at any time from the RSO.

Pregnant workers may choose to officially declare their pregnancy, which restricts the dose to the embryo/fetus to 500 mrem during the gestation period (10 CFR 20.1208). This could result in restrictions in the types of work the declared pregnant worker is allowed to perform. To declare a pregnancy, the worker must submit to the Authorized User a "Letter For Declaring Pregnancy" that may be found on-line on the Radiation Safety web-page or any other written declaration that states her approximate date of conception and that she wishes to be treated as a pregnant radiation worker for purposes of this section. Declarations of pregnancy may be made at any time during the pregnancy.

Pregnant workers may choose not to declare their pregnancy. If a pregnant worker does not declare pregnancy, the lower dose limit of 500 mrem to the embryo/fetus does not apply. If a worker decides not to declare pregnancy, no restrictions in the types of work that may be performed can be imposed based on pregnancy. The option not to declare is available to protect the worker from possible discrimination due to restrictions in work activity. Until a worker officially declares a pregnancy, ISU must assume the worker is not pregnant.

A radiation worker may declare pregnancy when there is a potential that the worker may be pregnant, even if pregnancy has not been confirmed, by following the same procedure for declaring a pregnancy.

A radiation worker who has previously declared pregnancy may revoke the declaration at any time. Since declaration of pregnancy will expire ten months after the declared estimated date of conception, the radiation worker need not revoke pregnancy declaration after the expiration date.

ISU will strive to avoid substantial variation above a uniform monthly dose rate to a declared pregnant worker. If at the time of declaration, the dose to the embryo/fetus has exceeded 450 mrem since the estimated date of conception, the embryo/fetus will be limited to a dose of no more than 50 mrem for the remainder of the pregnancy.

### **6.3. Minors**

Minors are permitted to serve as Radiation Workers if necessary for student employment or as part of an academic program. Radiation dose to minors will be limited as specified above.

## **7. Authorization and Permitting**

This section presents the processes for approving Authorized Users and for developing and approving radiation use permits.

### **7.1. Approval of Authorized Users**

The RSC grants authorization to use radioactive materials and radiation machines at ISU. The RSC also approves Authorized User status. The proposed Authorized User will submit their CV and a statement of their radiation use experience to the RSC who will review the experience and prior training. The RSC will discuss the proposed Authorized User's qualifications and hold a vote to approve or disapprove the Authorized User. The RSC may grant provisional approval pending additional training by the Radiation Safety Department.

### **7.2. Radiation Use Permits**

ISU policy allows for two types of permits, radioactive material and radiation machine. Permits are issued by the RSO upon RSC approval. Permits may be amended as necessary subject to approval process described below.

Radioactive material permits will generally contain:

- The Authorized User information
- Expiration date
- Permitted use locations
- Permitted radionuclides and activity limits
- Permitted uses and restrictions
- Specific conditions
  - Survey frequency and type
  - Internal dose measurements
  - Appropriate instrumentation.
- Additional Hazards
- Approval and confirmation signatures.

Radiation machine permits will generally contain:

- The Authorized User information
- Expiration date
- Permitted use locations
- List of machines and attributes required for registration
- Permitted uses, restrictions
- Specific conditions
- Approval and confirmation signatures.

### **7.3. Application for Permits**

The applicant provides a proposal to the RSO and the RSO submits each proposed new use of radioactive materials and radiation machines to the RSC for review before implementation. The applicant must provide: descriptions of facilities and equipment, radioactive materials or radiation machines, and operating or handling procedures in sufficient detail to permit the RSC to evaluate the safety of the proposed use. A shielding design with accompanying calculations must be submitted with each application for radiation sources capable of (unshielded) creating a high radiation area (100 mrem/hr) at 30 cm from the source and for all radiation machines.

The applicant also must submit with the application details of other hazards or situations in the proposed radiation use area that may affect the security, use and control of radioactive materials or exposures to workers to radiation sources such as:

- BioSafety Level (BSL) 2 or BSL 3 agents
- Research Animals
- Storage of > 20 gallons of flammable liquids
- Storage and use of air reactive or peroxide forming chemicals
- Storage and/or use of flammable gasses in cylinders
- High voltages (> 600 V ac or dc)
- High pressure or other high hazard operations
- Class IV lasers

The RSO and RSCC will review the information and the RSO will develop a draft permit. The RSO will submit the documentation from the user and the draft permit to the RSC for evaluation at the next meeting or by electronic vote if deemed necessary by the RSCC. Once approved by the RSC, the permit will be signed by the RSCC and the RSO and submitted to the AU for compliance signature. Fully signed permits will be retained by the AU and in the Radiation Safety Department records.

### **7.4. Termination of Permits**

Authorized Users who anticipate leaving ISU should notify the RSO as soon as possible but at least thirty days prior to departure or transfer. Permits will be terminated or transferred if the Authorized User leaves or if the laboratory becomes inactive. Termination may occur at any time during the term of the permit or at the end of the permit period. The RSO will work to transfer the material or machines to a new user or to securely store the items and will arrange decommissioning surveys. If necessary, the permit will be archived in the Radiation Safety Department database and records.

## **8. Radiation Safety Training**

Radiation Workers must complete general ISU radiation safety training and specific hands-on training provided by the Authorized User, RSO, or RSO's delegate.

### **8.1. General Radiation Training**

Before Radiation Workers are allowed to use radiation sources or radiation machines, they must participate in the radiation safety training provided online by ISU. This training provided by the Radiation Safety Department serves as documented 10 CFR Part 19.12 radiation safety training.

*General topics covered include the following:*

- Characteristics of ionizing radiation
- Units of radiation dose and quantities
- Biological effects of exposure to ionizing radiation
- Safe handling of radioactive materials
- External exposure limitation (time/distance/shielding)
- Internal exposure limitation (contamination control/bioassays)
- Classification of facilities and postings
- Individual dose limits including special limits for declared pregnant workers
- Mathematics pertaining to the use and measurement of radioactivity
- The ALARA principle
- Emergency procedures
- Worker's rights to raise radiation safety concerns without fear of retaliation
- Workers right to be informed of occupational radiation exposure reports including external and internal dose measurements.
- Prenatal effects of radiations, the declared pregnancy program and administrative controls to reduce radiation doses to pregnant workers.

*ISU-specific topics include:*

- A discussion of the university's policies on safety culture.
- A discussion of the university's policies on safety conscious work environment.
- Response to workers who raise safety concerns.
- The university's process for prioritizing and evaluating radiation safety concerns including providing feedback to the individual who raised the concern.
- The options that individuals have for raising safety concerns, including the option to raise concerns anonymously or to the NRC.
- ISU radiation protection authority structure.
- The obligation to report unsafe conditions.
- ISU Radiation Safety Manual

### **8.2. Refresher Training**

General radiation safety training requires an annual on-line refresher to re-iterate key aspects of the radiation safety program.

### **8.3. Program Specific Training**

Authorized Users shall ensure that Radiation Workers in their facilities are properly trained in radiation safety specific to their program. The Authorized User provides program specific training to Radiation Workers in their laboratories. Topics covered are listed below.

- Special conditions in the permit
- Areas where radionuclides are used in the program.
- Operating and emergency procedures as appropriate for the program.
- Hands-on simulation or on the job training that reinforces selected topics for the program

### **8.4. Awareness Training**

Students, visitors, co-located workers, and minimally exposed personnel (e.g. students who use small, non-dispersible radiation sources) and short-term visitors to labs shall receive awareness training by the Authorized User or designee.

#### *Specific training*

The Radiation Safety Department provides specific awareness training to certain groups applicable to their role at the frequency specified below.

- Custodial personnel annual.
- Public safety personnel annual.
- Emergency response personnel biannual with reactor drill.
- Shipping and receiving personnel annual.
- Purchasing personnel annual

## **9. Radioactive Material Requirements**

This section specifies requirements for safe and compliant use of radioactive material

### **9.1. Procurement**

Radioactive material purchases can only be authorized by the RSO. Normally radioactive materials are ordered by ISU Purchasing services following approval by the RSO. Purchases or transfers of radioactive materials including those materials that are obtained from other entities such as ISU licensed programs (e.g. the reactor program or the Idaho Accelerator Center) must be initiated on form RPR-13F "Radioactive Material Purchase Authorization" that is submitted to the Radiation Safety Department for approval. The Radiation Safety Department will verify that the proposed material is allowed in the Authorized User permit and the license and then the RSO will authorize procurement.

#### *Acquisition of material with significant disposal costs*

Effective 01 July 2018, (and specifically excluding items obtained prior to this date) any university organization that intends to procure radioactive material for any purpose, including equipment with induced radioactivity, or contaminated components with a total volume of



greater than seven cubic feet, or an activity greater than 100  $\mu\text{Ci}$ , or consisting of accountable source or special nuclear material must demonstrate a responsible path for disposal. The following materials are excepted from this requirement.

- Materials with half-life less than 120 days.
- Materials eligible for sewer disposal in accordance with the Pocatello discharge permit.
- Materials that will be returned or transferred to another institution. The receiving organization must state that they will provide necessary packaging and will cover the costs shipment.

The administrator in charge of an academic or research unit interested in procuring or receiving an item with significant disposal costs must send a letter to the Radiation Safety Committee copied to the Vice President of Research that assures that funds will be made available in a timely manner for the disposal of the radioactive material when it becomes obsolete, or has no use or when the project it was procured for has ended or if the Authorized User has left the University with no users to continue his/her work that directly relates to the source.

## **9.2. Shipment and Transfer**

All transfers and shipments of radioactive materials must be approved by the RSO. To request a shipment of radioactive material the Authorized User must complete form RPR-14 and submit it to the RSO. The RSO will review and approve the RPR-14 form authorizing shipment by a Radioactive Material Shipper.

After receiving a completed and signed copy of Form RPR 14, the Radioactive Material Shipper will ship the material in accordance with Procedure RS-08, Transfer and Transport of Radioactive Material. This procedure specifies shipping instructions to ensure shipments comply with DOT and IATA regulations, as applicable.

Radioactive material shippers will use qualified commercial carriers for shipments (e.g. FEDEX, YRC) or may have materials moved in a government vehicle by appropriately trained ISU employees.

Driving radioactive materials by university personnel must take place in a State-owned vehicle. Use of personal vehicles is strictly prohibited. Personnel who act as a carrier for radioactive materials must have a commercial driver license with HAZMAT endorsement or must have received training in accordance with 49 CFR 177.816. Any motor vehicle shipment that involves placarded radioactive material or more than 10,000 pounds of hazardous material must be driven by personnel with a commercial driver license and HAZMAT endorsement in a commercial motor vehicle.

No ISU personnel are authorized to ship Type B containers or fissile material containers that are not excepted under 49 CFR 173.453 without a quality assurance program prepared and approved in accordance with 10 CFR 71.101.

### **9.3. Receipt of Radioactive Material**

The Radiation Safety Department performs radioactive material receipt surveys and package opening surveys in accordance with procedure RS-07, Receipt of Radioactive Material Package, that implements the requirements of 10 CFR 20.1906.

DOT regulated radioactive material shipments will be received at ISU designated facilities. Shipping and receiving personnel must promptly contact Radiation Safety Personnel to request surveys of Radioactive Material marked packages.

Certain radioactive material packages, not regulated by DOT will be received at the Authorized User's permitted location. The Authorized User must notify the Radiation Safety Department to request a package opening survey. Once the package opening survey is complete, the Radiation Safety Department will release the material to the Authorized User.

### **9.4. Security of Radioactive Material**

There are four categories of radioactive material with specific security requirements as specified below:

Exempt quantity materials are materials that do not exceed the activity limits of 10 CFR 30 Schedule B for byproduct material or the limits of 10 CFR 40.13 for source material. These materials should be kept in locked laboratories as a best management practice.

Single barrier materials are materials that exceed the limits for exempt quantity materials but are less than the thresholds for double barrier materials. These materials must be kept in a locked laboratory or cabinet. Single barrier source logs shall be used to document removal and return from storage locations. When in use, single barrier sources must be attended by a Radiation Worker or must be secured with a single barrier.

Double barrier materials are those that meet the definition of IAEA Category 4 (A/D ratio greater than 0.01) as specified in IAEA Safety Guide RS-G-1.9, Categorization of Radioactive Sources. These sources will be specifically identified in user permits by the RSO. Such sources must be secured by two locked barriers, either doors or storage cabinets. If storage cabinets are used they must be fixed to the building. Double barrier source logs shall be used to document removal from and return to secure storage and must be performed by two independent radiation workers. The source log shall contain the following information.

- A unique identifier of the source (e.g. HPassist number, serial number.)
- The source Isotope and Activity
- The printed name of the radiation worker to use the source
- The date and time of removal from storage
- Initials of the custodian at time of removal
- The date and time of return to storage
- Signature of radiation worker
- Initials of the custodian at the time of return

Category 1 and 2 radioactive materials are defined in 10 CFR 37. Security for these materials

will follow the requirements of 10 CFR 37 for security plans and personnel access. Such sources will be addressed as a special condition of the user permit.

### **9.5. Inventory**

Radioactive material and accountable nuclear material inventories are managed in accordance with procedure RS-16, Radioactive Material Inventory which addresses the topics specified below. The overall inventory is tracked in the EH&S Assistant database.

Radiation Safety Department personnel and trained Authorized Users enter data in the database for non-exempt materials received or produced in ISU facilities under applicable licenses. In addition, they virtually delete materials that are shipped off-site or disposed after approval by the RSO on Form RPR-14. Virtual deletion ensures records remain for removed materials.

Authorized Users complete a full physical inventory of all non-exempt materials semi-annually. The RSO participates in at least one physical inventory every six months.

The RSO and applicable Authorized Users together complete a full physical inventory of all accountable nuclear materials every six months. The RSO reports the accountable nuclear material inventory to the RSC at the next meeting.

The Reactor Supervisor will complete a documented physical inventory of all accountable nuclear material on the SNM and reactor licenses twice per year in conjunction with the ten percent survey.

The RSO will perform inventory of all Category I and II sources (10 CFR 37) on an annual basis and will submit confirmation data to the NRC.

The RSO will report all radioactive material receipts and virtual deletions to the RSC at quarterly meetings for the previous quarter.

### **9.6. Accountable Nuclear Material**

Accountable nuclear materials are tracked in the NMMSS database. Thresholds for tracking are given in the Nuclear Materials Management and Safeguards System Users Guide. Radiation Safety Department personnel will complete 741 forms for all accountable nuclear material transfers and receipts and will complete inventory verification reports form 742 each year in accordance with procedure RS-05, NMMSS Report.

### **9.7. Labeling of Material and Containers**

Radioactive materials are labeled in accordance with 10 CFR 20 Subpart J. Instructions for labeling samples and sources are provided in Procedure RS-16, Radioactive Material Inventory.

Cabinets and containers also must be labeled with radioactive material contents and dose rates in accordance with 10 CFR 20 Subpart J. The Radiation Safety Department can provide radionuclide summary data for storage cabinets from the EH&S Assistant database.

All equipment contaminated with radioactive material or activated shall be marked with 'Caution Radioactive Material' stickers.

The labeling of laboratory equipment, such as beakers, flasks, and test tubes, is not required when the work is performed in the presence of the user, in a Contamination Area, or in a work area labeled as Internal Contamination, such as a fume hood or glovebox.

### **9.8. Radioactive Material Logs**

Authorized Users shall maintain laboratory logs that show amount of material used on each day when radioactive materials are handled. This information is necessary for the Radiation Safety Department to confirm that required internal dosimetry measurements are completed.

### **9.9. Source Leak Tests**

The Radiation Safety Department will leak test sources and detector cells as specified in the broad scope license. They will maintain a master list of sources that meet the leak test criteria and will test at the following intervals or at the intervals specified by the source manufacturer in the source registration.

- Alpha sources greater than 10  $\mu\text{Ci}$  every three months.
- Beta gamma sources greater than 100  $\mu\text{Ci}$  every six months
- Sources in storage every 10 years.

Sources in storage must be stored separately from active sources. When removed from storage, sources must be leak tested prior to use. Sources that contain only H-3, gases or nuclides with half-lives less than 30 days do not require leak test.

The leak test shall be capable of detecting the presence of 0.005  $\mu\text{Ci}$  (185 Bq) of radioactive material on the removable contamination test sample. If swipe analysis reveals the presence of 0.005  $\mu\text{Ci}$  or more of removable contamination the following actions must be taken

- A report shall be filed with the NRC in accordance with 10 CFR 30.50(c)(2) within 5 days of when the results of the analysis are known.
- The source shall be removed immediately from service, decontaminated, and prepared for disposal, or repair.

## **10. Control of Areas and Postings**

This section specifies definitions of radiation use areas, appropriate control for areas, and required postings to warn personnel of radiological hazards.

### **10.1. Area Definitions**

The areas defined in Table 2 are used in permits and operating procedures for the purpose of regulating which personnel may enter an area to ensure security of radioactive materials and radiation machines.

**Table 2. Area Definitions for Access Control.**

<b>Area</b>	<b>Definition</b>
Unrestricted Area 10 CFR 20	An area where access is neither controlled nor restricted. Dose rates are less than limits for public (< 2 mrem in an hour and < 100 mrem in a year)
Controlled Area	An area outside of a restricted area where access is controlled for any reason. Access is limited to specific personnel. Dose rates are less than limits for public (< 2 mrem in an hour and < 100 mrem in a year)
Restricted Area 10 CFR 20	An area where access is restricted to authorized Radiation Workers and accompanied visitors as a condition of either a radioactive material or radiation machine use permit. Dose rates may exceed 2 mrem in an hour and/or 100 mrem in a year

The areas defined in Table 3 are used in permits and operating procedures for the purpose of regulating where radioactive material and radiation machines may be used.

**Table 3. Area Definitions for Radiation Use.**

<b>Area</b>	<b>Definition</b>
Radiation Use Area (Machine)	An area in a facility or room authorized for operation of radiation machines
Radiation Use Area (Material)	An area in a facility or room authorized for use and/or storage of radioactive material.
Non-Radiation Use Area	A non-posted area within an authorized radiation use area where radioactive materials are not used, such as desks and other work benches

The areas defined in Table 4 are used in permits and operating procedures for the purpose of warning individuals regarding the intensity of radiation fields in the area and the presence of removable contamination.

**Table 4. Area Definitions for Radiation Warning.**

<b>Area</b>	<b>Definition</b>
Contamination Area	An area with removable radioactive material contamination above levels specified in Table 6 and Table 7
Radiation Area	An area where an individual located 30 centimeters from any source of radiation could receive greater than 5 mrem in one hour
High Radiation Area	An area where an individual located 30 centimeters from any source of radiation could receive greater than 100 mrem in one hour
Very High Radiation Area	An area where an individual located 1 meter from any source of radiation could receive greater than 500 rad in one hour

## **10.2. Area Control**

All radiation use areas for material or radiation machines shall be attended by the Authorized User or Radiation Workers or shall be locked when unattended.

High radiation areas shall be secured by locked doors or by constant attendance of the Authorized User or trained Radiation Workers.

Very high radiation areas only occur in accelerator operations. All such areas are interlocked to prevent any personnel access as required in SSRCR D.1602. All accelerator operations are continuously attended by a qualified operator or an Authorized User.

### 10.3. Radiological Postings

The postings shown in Table 5 are required for the applicable radiological areas

**Table 5.** Radiological Area Postings.

Area	Required Posting
Radiation Use Area (Material)	Caution Radioactive Material*
Radiation Use Area (Radiation Machine)	Caution X-ray Generating Device or similar
Contamination Area	Caution Contamination Area
Radiation Area	Caution Radiation Area
High Radiation Area	Caution High Radiation Area
Very High Radiation Area	Grave Danger Very High Radiation Area

The minimum size for a caution radioactive material posting is a 3.5” x 5” sticker and the posting must be in a conspicuous location (e.g. adjacent to a door handle). Postings shall be placed at all entrances and at intervals around rope boundaries.

### 11. Control of Contamination

ISU controls removable contamination to levels as low as reasonably achievable as specified in Table 6 below. Areas where work is performed with dispersible radioactive materials (fume hoods, bench top areas, etc.) must be covered with absorbent pad and demarcated using radiation safety tape.

Radiological Work Permits developed in accordance with Procedure, RS-14, Radiological Work Permit, are required for all operations in Contamination Areas. These permits specify required PPE and radiation control measures to avoid personnel contamination and spread of contamination beyond the Contamination Area boundaries. Specific contamination control measures for equipment labeled internal contamination must be specified in Authorized User procedures. A generic form for documenting the procedure for contamination control in equipment labeled internal contamination is available in Procedure, RS-14, Radiological Work Permit.

**Table 6. Removable Contamination Control Levels.**

Area	Removable Contamination Limit (dpm/100 cm <sup>2</sup> )
Inside Radiation Use Areas (Material) excluding radiation hoods, glove boxes and hot cells labeled as internal contamination	As low as reasonably achievable but not to exceed the values in Table 7 from NUREG 1556 V.11
Uncontrolled Area or Non-Radiation Use Area	As low as reasonably achievable (essentially non-detectable)
Contamination Areas	Contamination shall be minimized but may exceed the values in Table 7
Fume hoods, glove boxes, and hot-cells labeled Internal Contamination	Contamination shall be minimized but may exceed the values in Table 7

**Table 7. Specific Surface Contamination Limits (dpm/100 cm<sup>2</sup>).**

Nuclide <sup>1</sup>	Average <sup>2,3</sup>	Maximum <sup>2,4</sup>	Removable <sup>2,5</sup>
U-nat, U-235, U-238, and associated decay products	5,000	15,000	1,000
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000	15,000	1,000

<sup>1</sup>Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

<sup>2</sup>As used in this table, disintegrations per minute (dpm) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

<sup>3</sup>Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

<sup>4</sup>The maximum contamination level applies to an area of not more than 100 square centimeters (cm<sup>2</sup>).

<sup>5</sup>The amount of removable radioactive material per 100 cm<sup>2</sup> of surface area should be determined by wiping that area with filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

## 12. Surveys

Radiation and contamination surveys are performed by Authorized Users and Radiation Workers and confirmatory surveys are performed by the Radiation Safety Department. Surveys are performed at the frequency specified in Table 8.

**Table 8.** Radiation Use Area Survey Frequencies.

Source Classification	Radiation Safety Surveys	Authorized User Laboratory Surveys (when in use)
Dispersible radioactive materials	Monthly quarterly or semi-annually as specified in permit	Daily survey of immediate work area documented in laboratory log.  Formal map survey (weekly, monthly or quarterly as specified in permit)
Sealed Sources Only and Storage Areas	Semi-Annually	Not required
Radiation-Producing Equipment excluding medical x-ray equipment	Semi-Annually	When machine is in use except for shielded cabinet systems.

### 12.1. User surveys

Authorized Users and Radiation Workers perform two types of surveys: immediate work area surveys and formal map surveys.

#### *Immediate work area surveys*

Authorized Users and Radiation Workers perform quick surveys of the work area using large area wipes, swipes, and/or direct contamination survey instruments daily as specified in the user permit when dispersible materials are used. Immediate work area surveys documented in the laboratory log book or on survey forms.

If contamination is detected above limits of Table 7, the area must be decontaminated and a map survey must be conducted.

#### *Formal Map Surveys*

Authorized Users or designees will perform periodic surveys of their Radiation Use Area. Surveys shall include dose rate surveys, removable contamination surveys, and/or total contamination surveys as specified in the User Permit. Large area wipe surveys shall be performed in areas likely to have contamination.

Surveys must be documented on Form RPR11 with an attached map. Survey documentation must include the following information:

- The name of the individual who performed the survey
- The date the survey was performed
- The model and serial number of the survey instrument(s) used
- The calibration due date of the instrument used.
- An indication that an instrument response check was performed.
- The measured back ground levels for the survey instruments
- Results of the survey in the appropriate units.



If a Radiation Use Area indicates contamination exceeding the contamination limits of Table 7, perform decontamination. If decontamination is not successful, notify the Radiation Safety Department for assistance.

The AU will post the radiation survey in the laboratory and place the previous survey in records.

### **12.2. Radiation Safety Surveys**

The radiation safety department will perform confirmatory surveys at the frequency specified in the User Permit and Table 8 above. Surveys will include dose rate surveys, removable contamination surveys and total contamination surveys. Total contamination surveys will not be performed in areas with elevated dose rate.

### **12.3. Release Surveys**

Equipment that has been used with dispersible radioactive materials or may have been activated must be surveyed over all accessible surfaces to ensure surface contamination levels are as low as reasonably achievable and less than the contamination limits of Table 7 (NUREG 1556, Vol. 7, Rev. 1, p. M-3) and that no detectable activated materials are present. If internal surfaces may be contaminated, contact the Radiation Safety Department to assist with the survey. Surveys must be conducted and documented as specified in Procedure, RS-03, Radiological Surveys. Materials that may have been activated must be surveyed with contamination survey instruments (GM or alpha/beta detectors) and NaI based  $\mu$ R meter.

Empty radioactive material containers shall be surveyed using a GM or alpha/beta frisker and all radioactive markings shall be removed prior to disposal unless removable contamination is evident from container opening surveys. In that case a full release survey shall be performed.

## **13. Safe Work Practices**

### **13.1. Personnel Surveys**

All persons shall monitor themselves for contamination before leaving a laboratory where dispersible radioactive material is being used. Hand and foot frisks are required for all personnel and whole-body frisks are required for all personnel using dispersible radioactive material. The Radiation Safety Department must be contacted immediately if personal contamination is found.

### **13.2. Personal Protective Equipment**

Protective clothing appropriate to the conditions shall be worn at all times when working with dispersible radioactive materials. At minimum, this includes appropriate eye protection, laboratory coats or coveralls, and two pairs of disposable gloves, with the first pair taped to the lab coat.

Disposable gloves must be worn when handling sealed sources with activity  $> 10 \mu\text{Ci}$  for alpha emitters and  $100 \mu\text{Ci}$  for beta-gamma emitters.

No shorts, skirts, or open toed/heeled shoes are allowed in Radiation Use Areas (Material)

### **13.3. Hygiene**

Eating, drinking and smoking are not permitted in any Radiation Use Areas (Material). If radioactive materials are in use, wounds shall be covered to avoid contamination.

### **13.4. Engineering Controls**

Hoods or glove boxes should be used for handling dispersible radioactive material when possible.

#### *Hoods*

Hoods to be used for radioisotope work shall be tested annually by the EHS Department to ensure that they meet the minimum requirements for air velocity at the face of the hood.

#### *Glove boxes*

Glove box gloves shall be inspected prior to use and shall be changed at least annually.

#### *Biosafety cabinets*

Radioactive materials that can become volatile are prohibited from being used in ductless fume hoods and in Class I, Class IIA, Class IIB1 and Class IIB3 biosafety cabinets without separate special review and approval of the RSO and RSC.

### **13.5. Shielding**

Shielding shall be used for high activity sources and operations. All operations that involve High Radiation Areas shall be evaluated for additional shielding. Radiation safety personnel are available to assist with shielding computations.

### **13.6. Particulates and Aerosols**

Procedures involving aerosols, dusts or gaseous products or procedures which might produce airborne contamination in excess of regulatory limits shall be conducted in a hood, glove box or other suitable closed system. These procedures will be evaluated by the RSC in the permit approval process.

### **13.7. Radioactive Gases**

Radioactive gases must be stored in gas-tight containers and should be stored in radiological fume hoods if possible.

### **13.8. Remote Handling Equipment**

Remote equipment (long-handled tongs, remote pipettes, etc.) shall be used when handling highly radioactive materials (any materials creating beta-gamma/x-ray radiation levels > 1000 mrem/hr on contact). However, an exception to this requirement may be allowed at the discretion of the RSO in consultation with the RSCC and with prior approval from the RSC. Dose rate measurements shall consider gamma and beta radiation.

### **13.9. Maintenance and Storage of Equipment**

Laboratories or laboratory equipment to be serviced by shop, maintenance or custodial personnel, or by commercial contractors, shall be surveyed for release as specified in Section 12. Contaminated equipment when not in use shall be stored in appropriate containers and labeled as radioactive material within the Radiation Use Area.

### **14. Radiation Safety Program Audits**

The RSO and RSC perform annual audits of the ISU radiation safety program in accordance with Procedure, RS-01, Radiation Safety Program Oversight. Results are reported to the Vice President for Research. At the discretion of the VPR, independent audits of the radiation safety program will be requested and implemented.

### **15. Dose Measurement and Reporting**

This section specifies requirements for measuring internal and external dose and requirements for reporting dose to Radiation Workers and external organizations.

#### **15.1. External Dosimetry**

As specified in 10 CFR Part 20.1502 and IDAPA 16.02.27, ISU is required to monitor the occupational external exposure of the following individuals.

- Adults likely to receive greater than 10% of the annual allowable limits specified in 10 CFR 20.1201(a) and SSR CR D.1201a.
- Minors likely to receive a deep dose equivalent greater than 0.1 rem, a lens dose equivalent greater than 0.15 rem or a shallow dose equivalent to the skin or extremities greater than 0.5 rem.
- Declared pregnant women likely to receive a deep dose equivalent in excess of 0.1 rem during the entire pregnancy.
- Individuals entering High or Very High Radiation Areas.
- Individuals working with medical fluoroscopic equipment.
- Extremity dosimeters for personnel operating analytical x-ray equipment in an open beam configuration.

The RSO or designee will determine who meets the criteria above based on expected exposure conditions and/or dose history for the operation.

Whole body dosimeters will be worn on the torso between waist and collar and finger ring dosimeters will be worn on the ring finger of the dominant hand. Two types of dosimeters are available (Pa and Ta). Workers only operating X-ray equipment will be issued Pa dosimeters and all other workers will be issued Ta dosimeters.

Declared pregnant workers will be issued a second dosimeter exchanged monthly to be worn on the front of the abdomen and under the lead apron, if applicable. The purpose of the second dosimeter is to provide monthly dose data for the embryo-fetus.

ISU uses a National Voluntary Laboratory Accreditation Program (NVLAP) accredited dosimetry service for external radiation monitoring.

### **15.2. Internal Dose Measurement**

Monitoring of intake of radioactive materials and assessment of committed effective dose will be performed for individuals likely to have an intake of more than ten percent of the Annual Limit on Intake. ISU developed a conservative screening model to predict potential intake based on NUREG-1400, Air Sampling in the Workplace. The following criteria will be used to require monitoring in an Authorized User permit.

- Individuals handling more than 200 ALI per day will be monitored using either bioassay or personal breathing zone air monitoring. This threshold can be adjusted for specific engineering controls (e.g. fume hoods or glove boxes) using the NUREG 1400 methodology.
- Individuals handling radioiodines in quantities greater than specified in Regulatory Guide 8.20 will be monitored by direct thyroid screening.
- Minors and declared pregnant workers will be evaluated on a case-by-case basis.

Periodic confirmatory air samples will be collected to verify the screening level is protective of worker health. For positive results, committed effective dose equivalent will be computed using air sample data in accordance with 10 CFR 20.1204 or using bioassay measurements and the methodology of NUREG 4884. Results will be included in the radiation worker dose record if greater than 10 mrem.

### **15.3. Public Dose Monitoring**

ISU will perform the following actions to assess and control external dose. For non-radiation use area boundaries, Authorized Users or radiation safety personnel will perform surveys to demonstrate the dose rate remains below 2 mrem in an hour. In addition, ISU will place area monitor dosimeters at the perimeter of facilities to demonstrate the dose to members of the public does not exceed 100 mrem in a year.

### **15.4. Dose Reporting**

Dose reports on NRC Form 5 will be issued to Radiation Workers or organizations as specified below.

- Radiation Workers who formally request copies of their dose records.
- All Radiation Workers who received dose exceeding 100 mrem TEDE or to any organ or tissue in a calendar year will be provided a dose report at the end of the calendar year.
- Organizations formally requesting dose history for Radiation Workers previously monitored in the ISU radiation safety program.

## **16. Radiation Monitoring Equipment**

This section specifies requirements for calibration and use of radiation monitoring equipment.

### **16.1. Portable Survey Instruments**

Each Radiation Use Area (Materials) shall be equipped with an appropriately calibrated, functioning portable or semi-portable survey instrument to be used for personnel and area monitoring. Appropriate radiation monitoring equipment will be specified in the user permit. Portable survey instruments will be calibrated annually  $\pm$  two months by the Radiation Safety Department. All survey instruments must be properly ranged to within  $\pm$  20% of a known source activity and source checked prior to use. The Radiation Safety Department will provide exempt quantity sources for these purposes.

Pursuant to 10 CFR 20.1501(b), Radiation Workers must have access to appropriate equipment for monitoring radiation fields and contamination as specified below.

- Contamination and exposure rate instruments will be approved by the RSO prior to use in facilities that use radioactive materials.
- No instrument may be used if it has not been calibrated within the last  $12\pm 2$  months
- Instruments for measuring exposure rates are calibrated for linearity of response on all useful ranges.
- Instruments used for contamination surveys are calibrated for detection efficiencies for alpha and beta radionuclides, as well as for linearity of response. The detection efficiency is recorded on the instrument.
- Calibration of instruments shall be done using NUREG 1556 Volume 11, Appendix H as a guide.

### **16.2. Laboratory Instruments**

Laboratory instruments include proportional counters, alpha-beta swipe counters, liquid scintillation counters, and gamma spectroscopy systems used to support surveys and material characterization. These instruments will be calibrated with NIST traceable sources and will be verified daily when in use in a measurement control program that includes control charts for detection efficiency.

## **17. Radioactive Waste Management**

ISU radioactive waste is managed by Authorized Users in conjunction with the Radiation Safety Department. Detailed requirements are specified in Procedure, RS-09, Radioactive Waste Management.

## 17.1. Waste Segregation and Characterization

Authorized Users are responsible for segregating waste into the following categories and for estimating radioactive material quantities in their waste.

- Dry active waste is general solid radioactive waste. Liquids, hazardous waste (40 CFR 261), biological materials and sources greater than 100  $\mu\text{Ci}$  are prohibited from this waste stream.
- Aqueous liquid waste is water based liquid with radionuclides but no hazardous waste and pH greater than 2 and less than 12.5.
- Liquid scintillation waste with non-hazardous fluid containing only H-3 and C-14 with activity concentration less than or equal to 0.05  $\mu\text{Ci/g}$ .
- Liquid scintillation waste with non-hazardous fluid and other radionuclides or H-3 and C-14 with activity concentration greater than 0.05  $\mu\text{Ci/g}$ .
- Animal carcasses with only H-3 and C-14 with activity concentration less than or equal to 0.05  $\mu\text{Ci/g}$ .
- Biological waste includes milk, food products, and carcasses not described above.
- Sources with activity greater than 100  $\mu\text{Ci}$ . If the source is tracked by mass the Authorized User will convert to activity to comply with this requirement. Specific activity values are available in 49 CFR 173.435. Sources greater than 100  $\mu\text{Ci}$  require stabilization at the waste disposal facility to meet waste classification requirements.
- Radioactive waste containing radionuclides with half-lives less than 120 days. Solids should be separated from liquids and these waste materials should be segregated from longer lived radioactive materials. Ensure no radioactive labels or markings are present in the waste. These wastes can be disposed by decay in storage by the Radiation Safety Department.
- Mixed waste is waste that contains radioactive material and hazardous waste. Generation of mixed waste must be approved in writing by the RSO. The RSO will ensure a disposal path exists for all mixed waste in accordance with the broad scope license. Common materials that are often hazardous waste include toxic metals (As, Ba, Cd, Cr, Pb, Hg, Se, and Ag), acids and bases, certain organic solvents, flammable liquids, and water reactive materials. Full definitions are given in 40 CFR 261. If waste contains unusual chemicals or you have questions regarding potential hazardous waste contact the RSO or Environmental Programs Manager in the EHS Department.
- Other wastes by written permission from the RSO.
- Greater than Class C (10 CFR 61.55) wastes may not be generated in any circumstances.

Authorized Users or Radiation Workers should track waste materials added to storage containers on a waste addition log. The waste addition log will contain information on the material added and the radionuclide content if known. When a waste container is full, the Authorized User or Radiation Worker will prepare a waste tag form and contact the Radiation Safety Department for pick up.

## **17.2. Waste Pick Up and Storage**

The Radiation Safety Department will evaluate the waste submitted by the user to determine transportation requirements. The waste item may be hand carried to the Pocatello waste storage facility or it may be shipped in a state vehicle. In some cases, the waste material may be stored at the Authorized User facility until it is ready for disposal through the waste broker. An example is when waste can be shipped as LSA-II by the waste broker but would require a Type A package if shipped by ISU.

Wastes will be stored in appropriate containers at the waste storage facility or the Authorized User's facilities. All waste containers will be labeled with waste tag numbers or unique identifiers that link the waste to the characterization data. Liquid wastes will be stored with secondary containment. Wastes for decay in storage will be labeled with a start date to allow determination of appropriate decay time. Biological wastes and carcasses will be stored in freezers at generator facilities or the waste storage facility.

ISU will not compact solid radioactive waste with greater than 200 ALI by mechanical means and will not incinerate any radioactive waste.

## **17.3. Waste Disposal by Waste Broker**

Solid radioactive waste generated by ISU is disposed at the US Ecology facility in Richland Washington as part of the Northwest Compact. The RSO will complete actions necessary to maintain permits for use of the US Ecology site and with the State of Washington.

Approximately once per year, the Radiation Safety Department will work with the waste broker to make a shipment of radioactive and mixed waste to the broker processing facilities and other necessary disposal and treatment facilities. The radiation safety department will ensure that all materials are properly packaged, marked and labeled for disposal. The radiation safety department will review radioactive waste manifests (Forms 540 and 541) and uniform hazardous waste manifests prepared by the broker. Finally, an appropriately trained member of the Radiation Safety Department will sign the manifests as shipper. For uniform hazardous waste manifests, the shipper must be trained for radioactive material and hazardous chemicals.

## **17.4. Sewer Disposal**

The Radiation Safety Department will perform sewer discharge of radioactive waste in accordance with Procedure RS-09, the City of Pocatello Discharge Permit, and 10 CFR 20.2003. In addition, the RSO prepares a quarterly discharge report that is submitted to the City of Pocatello through the EHS Department.

## **17.5. Decay in Storage**

The Radiation Safety Department will perform decay in storage disposal as specified in the broad scope license and NUREG 1556. Decay times will be estimated to achieve an activity of 0.1  $\mu\text{Ci}$  or less (generic exempt quantity). Once the decay time is reached, the parcel will be surveyed with an appropriate survey instrument. If the survey results are indistinguishable from background at the lowest instrument scale, the waste is eligible for disposal. All radioactive markings will be removed and the waste will be disposed as ordinary trash.

## **18. Decommissioning of Laboratories and Facilities**

The AU shall notify the RSO at least thirty days in advance when operations will be terminated in a laboratory. The Radiation Safety Department will coordinate with the AU to remove all radioactive material from the lab by transferring the material to other operations or by transfer for disposal. The AU will decontaminate any contaminated areas if possible. Materials that cannot be decontaminated or are activated will be prepared for disposal. The Radiation Safety Department will perform a final decommissioning survey in accordance with Procedure RS-17, Decommissioning.

In many cases the interior of fume hoods may be surveyed clean but the associated duct work will remain in place. The Radiation Safety Department will mark the duct work as potentially radioactively contaminated and will add the location to a list of locations with potential residual radioactive material that is shared with the ISU Facilities Department. When the ventilation system is ultimately removed, the Radiation Safety Department will conduct surveys of ventilation equipment as it is removed to verify no radioactive material is present or to ensure proper waste disposal.

To decommission an entire facility, the Radiation Safety Department will develop a decommissioning plan considering the guidance in NUREG-1757, Consolidated Decommissioning Guidance and NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual and will submit the plan to NRC for review.

ISU will prepare and maintain a decommissioning financial assurance plan in accordance with 10 CFR 30.35 and will update the plan every three years as required.

## **19. Radiation Machines**

Radiation machines produce ionizing radiation and include particle accelerators, x-ray machines and neutron generators. All operable radiation machines used in Idaho State University facilities must be authorized by the Radiation Safety Committee and must be registered with the Idaho Radiation Control Agency (Idaho Department of Health and Welfare). All registrations shall be submitted to the State of Idaho by the Radiation Safety Officer, or designee. The RSO must be notified before moving, transferring or disposing of any radiation producing machine.

The Authorized User for each accelerator or x-ray machine shall ensure that written operating and emergency procedures are available, that each operator has received appropriate specific training and that all users understand and follow the correct procedures.

Radiation producing machines and facilities will, at minimum, comply with all applicable sections of the Idaho Administrative Code (IDAP 16.02.07 – Idaho Radiation Control rules including referenced sections of SSRCR documents) and the applicable requirements of this manual.



No new or modified radiation producing device may be operated or energized to produce radiation without an approved Authorized User Permit for the radiation machine or interim authorization from the RSO/RSCC.

Installation of new radiation machines or modifications of existing radiation machines must be reviewed by the RSO. The RSO may request a review of the installation by an ad-hoc accelerator or x-ray equipment review committee made up of radiation machine experts. The RSO will require manufacturer information, facility design, anticipated work load, operation training information, and shielding designs to complete the review:

Shielding designs for radiation machines shall contain, as a minimum:

- Name and C.V. of the qualified expert who was consulted in the design of the accelerator installation layout and shielding;
- A floor plan and/or blueprint indicating
  - Shielding materials and thicknesses of all walls, ceilings, floors, barriers and doors,
  - Occupancies of all adjoining spaces
  - Maximum anticipated radiation dose rates both inside and outside of the shielding,
  - The calculation methods used and assumptions made to determine shielding materials, thickness and configuration.

For accelerator installations the Authorize User must develop an Operation Safety Assessment (OSA) for the equipment detailing description of the equipment, facility and controls, operational limitations, interlocks, shielding, signage, ALARA compliance and other pertinent information.

The RSO or RSC may suspend or terminate the operations at a radiation machine facility if such action is deemed necessary to protect health and/or minimize danger to public health and safety and/or property. Only the RSO or RSC will have the authority to authorize the intentional bypass of a safety interlock or interlocks. Such authorizations will be temporary in nature and will be documented in writing.

The Radiation Safety Department will inspect all non-medical radiation machines annually and will include testing of safety interlocks if applicable.

## **20. Emergency Preparedness and Response**

Radiation Workers are trained in basic emergency response as part of general radiation safety training. In addition, Authorized User procedures address emergency response for their specific facilities. In case of a spill of radioactive material, Radiation Workers must respond in a timely manner to minimize exposures and the potential spread of radioactive contamination. Radiation Workers are expected to clean up, survey and document their own spills if it is within their capability. The Radiation Safety Department will assist with spill clean-up upon request. If a Radiation Worker enters a lab with a spill and has no knowledge of the material or feels

uncomfortable with decontamination procedures, he/she should contact the Radiation Safety Department for assistance.

To contact the Radiation Safety Department call extension 5652 during normal working hours OR call Public Safety, at 282-2515 during off duty hours or if no one answers at 5652. Public Safety will contact Radiation Safety personnel.

For larger emergencies, the Radiation Safety Department will respond and will coordinate with the public safety department, off-site responders from the City of Pocatello, the Idaho State Police and medical personnel from Portneuf Medical Center. The Radiation Safety Department maintains an emergency response kit in their laboratory in the Physical Sciences Building. The Radiation Safety Department conducts emergency drills in conjunction with reactor personnel every year. One year is an in-house drill for a personnel contamination type event and the alternate year is a full drill with off-site emergency response personnel.

## **21. Radiation Safety Records**

Radiation Worker records are treated as confidential and are available only to those with a legitimate need for the information. An individual may review the contents of his/her personal radiation worker file at any time.

### **21.1. Dose Records**

All dosimetry records are considered to be confidential documents that are to be maintained indefinitely. Document storage, security, and retention shall be in compliance with university, federal and state requirements. Current external dose records are maintained in an electronic database by the dosimetry vendor. Other current dose records are maintained in individual Radiation Worker files on the ISU Box cloud storage system. Annual reports from each dosimetry group are downloaded as pdf files and saved. Dosimetry records for Radiation Workers include the following.

- Records from external exposure monitoring
- Positive (> 10 mrem) internal dosimetry measurements and analyses
- Dosimetry reports sent to individuals on NRC Form 5.

### **21.2. Training Records**

Initial radiation safety training and annual refresher training are documented in a system e-mail which is included in the specific file for each radiation worker. In addition, the training completion date is maintained in the radiation database. These records satisfy the requirements in 10 CFR 20.2102. Other specialized training records such as shipper and driver training records also are maintained in radiation worker files.

### **21.3. Other Records**

All other current radiation safety records are maintained as electronic files in the ISU Box cloud storage system. Historical records may be in paper form or on the Box system. Current records stored on Box include the following.

- 100 mrem reports
- Authorized User Permits
- Radioactive waste records including manifests, sewer disposal, and decay in storage
- Decommissioning records for labs and facilities and decommissioning cost estimates for financial assurance.
- Radiation safety procedures
- Radiation safety surveys
- Independent assessments
- Laboratory inspections
- Material inventories
- Air emission reports
- NMMSS records 741 and 742 forms
- NRC inspection and enforcement reports
- NRC licenses and amendment documents
- Instrument calibration forms
- Radiation safety manual previous versions
- Radiation safety committee agendas and minutes
- Radiation incident records
- Radioactive material information
- Radioactive transportation manifests, surveys, QA checks, and test data
- Radioactive material procurement authorizations
- Reactor emergency drill
- Reactor safety committee reports
- Receipt surveys
- RSO and RSCC annual inspection reports
- Source certificates
- Source leak tests
- Radioactive material transfer authorizations
- X-ray system inspections
- Accelerator inspections and Operational Safety Assessments
- Memorandum of understanding with Portneuf, Pocatello, and Idaho State Police

## **22. Acronyms**

**ALARA:** As Low As Reasonably Achievable

**ALI:** Annual Limit on Intake

**BSL:** BioSafety Level

**CFR:** The Code of Federal Regulations

**DOT:** U.S. Department of Transportation

**IAC:** Idaho Accelerator Center

**INL:** Idaho National Laboratory

**ISU:** Idaho State University

**MDA:** Minimum Detectible Activity

**NRC:** U.S. Nuclear Regulatory Commission

**NVLAP:** National Voluntary Laboratory Accreditation Program

**RSC:** Radiation Safety Committee

**RSCC:** - Radiation Safety Committee Chairman

**RSO:** Radiation Safety Officer

**RW:** Radiation Worker

**TEDE:** Total Effective Dose Equivalent

**EH&S:** Environmental Health & Safety

**VPR:** Vice-President of Research

## 23. Glossary

**Activity:** A quantity of a radionuclide specified by the rate of spontaneous nuclear transformations which it undergoes. The common unit of activity is the **Curie (Ci)** or the quantity of radioactivity which decays at the rate of  $3.7 \times 10^{10}$  transformations per second. Quantities of radioactivity of are commonly expressed in submultiples of the curie:

$$1 \text{ millicurie (mCi)} = 3.7 \times 10^{10} \text{ s}^{-1}$$

$$1 \text{ microcurie (\mu Ci)} = 3.7 \times 10^4 \text{ s}^{-1} = 2.2 \times 10^6 \text{ (dpm)}$$

$$1 \text{ nanocurie (nCi)} = 37 \text{ s}^{-1} = 2200 \text{ (dpm)}$$

$$1 \text{ picocurie (pCi)} = 0.037 \text{ s}^{-1} = 2.22 \text{ dpm}$$

The international standard unit for activity is the **Becquerel (Bq)**. One Bq equals one transformation per second.

**Authorized User:** An individual authorized by the Radiation Safety Committee to acquire and use specific radioactive material or radiation machines and to supervise their use by others, in compliance with this manual and under conditions of their permit.

**Committed Effective Dose Equivalent ( $H_{E,50}$ ):** The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated, and the dose equivalent received in each organ or tissue during the next 50 years.

**Contamination Survey:** A systematic investigation to determine the presence, or to verify the absence, of radioactive materials in unwanted locations, e.g. on the body or personal clothing, on surfaces of objects that may be touched or handled, on equipment or materials to be removed from a restricted area, etc.

**Controlled Area:** Any area, outside of the restricted area but inside the site boundary, access to which can be limited by the licensee for any reason.

**Deep dose equivalent ( $H_d$ ):** The dose equivalent at a tissue depth of 1 cm (1000 mg/cm<sup>2</sup>).

**Dose:** Refers either to absorbed dose or to dose equivalent, depending upon the context and the units used.

**Dose equivalent ( $H_T$ ):** means the product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the **rem** and **Sievert (Sv)**.

**Exposure:** usually refers to any condition which creates the potential for any individual to receive a radiation dose, either from external irradiation or from internal contamination with radioactive materials. For radiation measurements, "exposure" refers to the intensity of x or gamma irradiation, specified by the ionization produced in air. The common unit of exposure is the **Roentgen (R)**. An exposure of 1 R delivers almost 1 rad (0.869 rad in air or 0.93 rad in soft body tissues).

**Exposure Rate Survey:** A systematic investigation to determine external radiation exposure rates at specific locations where individuals may be present and potentially exposed.

**Extremity:** A hand, elbow or foot, or any region below the elbow or knee.

**Eye dose equivalent:** Applies to the external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 centimeter (300 mg/cm<sup>2</sup>).

**High Radiation Area:** Any accessible area in which an individual could receive a dose equivalent exceeding 100 mrem in 1 hour at 30 cm (1 ft) from the source or from any surface the radiation penetrates.

**Minimally exposed personnel:** Individuals who are unlikely to receive one-tenth (10%) of the ISU occupational radiation dose limit.

**Radiation Machine:** Any device capable of producing ionizing radiation except those which produce radiation only from radioactive material. These include accelerators, neutron generators, and various x-ray machines.

**Radiation Source:** Any radiation-producing machine or radioactive material emitting or capable of producing ionizing radiation.

**Radiation Worker:** Any individual whose official duties or authorized activities include handling, operating, or working in the presence of any type of radiation source or radioactive material as a routine part of their job. It does not include visitors or members of tours in Radiation Use areas or students who are minimally exposed.

**Radionuclide:** Any radioactive nuclide used in unsealed or dispersal form. This terminology is used primarily to characterize the form of the material and the nature of the use.

**Restricted Area:** Any area to which access is limited for the purpose of protecting individuals against undue risks from exposure to radiation and/or radioactive material. The mere presence of any radiation source, if adequately controlled to limit potential exposures, does not necessitate a restricted area designation.

**Sealed Source:** Radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material under the most severe conditions which are likely to be encountered in normal use and handling.

**Shallow Dose Equivalent (Hs):** Applies to the external exposure of the skin or an extremity, is taken as the dose equivalent at a tissue depth of 0.007 centimeter (7 mg/cm<sup>2</sup>) averaged over an area of 1 square centimeter.

**Swipe Test:** The detection and evaluation of removable contamination by measurement of radioactive material wiped from the surface onto an absorbent material such as a filter paper.

**Total Effective Dose Equivalent:** The sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for intake of radioactive material).

## **24. References**

IAEA, Categorization of Radioactive Sources, Safety Guide No. RS-6-1.9

NRC, NUREG 1556 Volume 11, Program-Specific Guidance About Licenses of Broad Scope

NRC, Concentration Averaging and Encapsulation Branch Technical Position, Revision 1

NRC, NUREG-1757, Consolidated Decommissioning Guidance

NRC, NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual

NRC, NUREG-1400, Air Sampling in the Workplace

NNSA, Nuclear Materials Management and Safeguards System Users Guide