



31 January 2003

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Re: Response to Request for Additional Information:
Idaho State University AGN-201 Renewal, TAC No. M94199
Docket No. 50-284, License No. R-110

Dear Madam/Sir:

Transmitted herewith is our formal response to your Request for Additional Information (RAI) regarding the renewal of the AGN-201 reactor operating License No. R-110 at Idaho State University (ISU). The response is submitted with complete supporting information as requested, including a copy of the ISU Radiation Safety Manual and Procedures and a copy of the corrected Safety Analysis Report.

In addition, we are submitting the following revised facility documents at this time for NRC review and approval: Facility Technical Specifications (TS), rev. 5; Facility Emergency Plan (EP), rev. 6; Facility Physical Security Plan (PSP), rev. 5. Please note that the PSP contains proprietary information that is to be withheld from public disclosure in accordance with 10 CFR 2.790(d)(1). The PSP is sealed in a separate envelope.

Should you have any questions or require additional information, please call me at (208) 282-2902, or the Reactor Manager/Supervisor, Dr. John Bennion at (208) 282-3351.

Sincerely,

Jay F. Kunze
Jay F. Kunze, PhD, PE, CHP

Dean and Reactor Administrator

Affirmation:

I certify under penalty of perjury that the foregoing is true and correct.

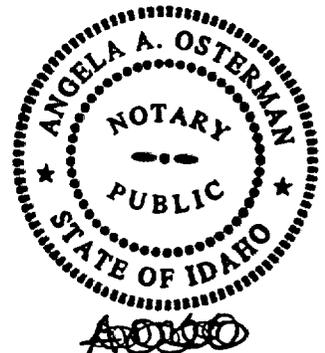
Executed on 31 January 2003.

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Response to Request for Additional Information

This document provides the Idaho State University's response to the U.S. Nuclear Regulatory Commission's Request for Additional Information (RAI), dated March 20, 1997, regarding the renewal of the ISU AGN-201 reactor operating license (License No. R-110, Docket No. 50-284). Each question posed in the RAI is repeated below followed by the response. The responses given below have been reviewed and approved by the ISU Reactor Safety Committee.

1. The ISU renewal application says a revision to the Technical Specifications (TS) would be submitted in early 1996. The TS submitted with the application for renewal do not meet the guidance of NUREG-1537, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors," in particular the worth of the non-scrammable rod is not accounted for in the Minimum SDM calculations. Provide an updated TS that meet the guidance of NUREG-1537.

Response: The Technical Specifications have been revised and are submitted with this response to the RAI. In addition, the Control Rod Reactivity Worth Calculation Form, which was drafted in 1997, explicitly takes into account both the most reactive scrammable rod and the non-scrammable rod (Fine Control Rod) remain in their most reactive positions for the Minimum Shutdown Margin (SDM) calculation. This form was approved by the Reactor Safety Committee in 1998 and has been in use ever since to perform the minimum SDM calculation.

2. A radiation protection program and at least an annual review is required by 10 CFR 20.1101. Provide a description or copy of the radiation protection program, and describe the administrative controls that ensure the review of the program.

Response: A copy of the ISU Radiation Safety Manual and Procedures is submitted with this response to the RAI. Review of the ISU radiation protection program is accomplished by a quarterly review of personnel dosimetry records to determine if university ALARA goals are being met. The Radiation Safety Officer (RSO), who is an ex officio member of the Reactor Safety Committee (RSC), provides a report at each RSC meeting that summarizes the support from the Radiation Safety Office provided to the reactor facility, including, but not limited to, review of dosimetry records of facility personnel, review of facility radiological and contamination surveys, review of radiation safety training provided to reactor personnel, calibration of radiation survey instrumentation, and maintenance of memoranda of understanding with off-site emergency response organizations. The ISU Radiation Safety Committee, of which the RSO is a voting member, is charged with conducting audits of the radiation safety program and performing reviews of personnel dosimetry data, survey results, significant events, ALARA, and responsible user compliance. The Radiation Safety Committee also evaluates new responsible users, new uses of licensed materials, and new laboratories where licensed materials are to be used. The Radiation Safety Manual and Procedures is reviewed annually by the Radiation Safety Committee to ensure compliance with applicable rules and regulations

concerning licensed materials. Both the Radiation Safety Committee and the Radiation Safety Officer conduct formal annual reviews of the Radiation Safety Program.

3. Many typos were found during the review process. (e.g., the definition of "Removal Experiment" on page 3 of the Technical Specifications, the word "turned" on page 35 of the SAR, and on page 39 "Figure 3.2-1" instead of "Figure 3.1-3") SAR should be reviewed for such typos.

Response: The TS have been revised and, it is believed that, all of the typos that appeared in the current, approved revision have been corrected. The SAR has been corrected as well. A copy of the revised SAR is submitted with the response to the RAI.

4. The Operator Requalification Program exempts both the Reactor Supervisor (RS) and the Reactor Administrator (RA) from taking the written examination. Current licensing practice is to exempt one individual during one requalification cycle for the purpose of preparing the written examination. The individual tasked with preparing the written examination would alternate for subsequent requalification cycles, thus assuring that a person would be administered a written examination at least every other cycle.

Response: The current Operator Requalification Program, approved by the NRC on August 17, 1995, provides that "The Reactor Supervisor (RS) and the Reactor Administrator (RA) shall be responsible to prepare, administer, and grade the written examination. Therefore, the RS and RA are exempt from the written examination." However, during periods when both the RA and RS held valid SRO licenses, the facility established a policy of exempting the RS and RA from the written examination in alternating years, so that individual who was exempt from taking the written examination in a given year prepared, administered, and graded the examination for the other individual. The Reactor Operator Requalification Program will be amended so that when both the RA and RS are not licensed SROs, the RA prepares, administers, and grades the written examination for the RS in alternating years. This policy will ensure that the RS is administered a written examination in alternating years. The Reactor Operator Requalification Program will be amended and submitted to the NRC for review and approval before 30 June 2003.

5. SAR, Section 5.2, Reactivity Considerations, asserts that the insertion of 2 percent reactivity into the glory hole is highly improbable and should not damage the core as a result of the ensuing excursion. Provide justification for this statement and a more definitive conclusion.

Response: The instantaneous insertion of 2% reactivity into the glory hole is the maximum hypothetical accident (MHA) that has been postulated for the AGN-201 reactor ever since the original Hazard Summary Report was submitted to the Atomic Energy Commission as part of the first operating license for this reactor design. As such, this scenario provides the extreme bounding condition for possible consequences as a result of the power excursion that would ensue from step insertion of a large amount of reactivity. Therefore, this scenario will easily encompass any possible fissionable material insertions because of the reactor's scram systems and inherent safety.

The statement that this scenario is highly improbable is justified based on the amount of fuel material that could reasonably be inserted into the glory hole in a step fashion. The inside diameter of the glory hole is approximately 2.2 cm. The diameter of the reactor core is 25.5 cm, and including 5 cm in the reflector region on both sides of the core, the total length of the glory hole in which fuel would have its most reactive worth is about 35.5 cm. Thus, the volume occupied by the glory hole can be estimated at about 138 cm³. The volume bounded by the glory may be compared with the volume occupied by fuel material contained in one of the three scrammable rods. These rods have a diameter of about 5 cm and an active fuel length of about 15 cm, thereby giving a volume of about 295 cm³, or roughly 214% greater than the volume of the glory hole. The nominal reactivity worth of these rods is given in the SAR as 1.25% $\Delta k/k$, referenced to the position of a particular rod in the core. Because the active volume of the glory hole is only 47% of that of a scrammable rod, it is highly unlikely that sufficient fuel material could be inserted into the glory hole to cause a 2% step increase in reactivity, especially in view of the fact that spare AGN fuel is the most reactive material that may be found in the Reactor Laboratory. And therefore, it is highly improbable that the 2% step increase in reactivity could occur. Nonetheless, it should be noted that an optimally-moderated mixture of highly enriched uranium could possibly cause such a large step change in reactivity. However, such materials are not in use at or possessed by the reactor facility, so that the potential for such a scenario is negligibly small.

The justification for the statement that the event would not damage the core is provided in the results of the calculations given in the SAR. The analysis of the MHA shows that during the event, the reactor would reach 150 MWt peak power and have a total energy release of about 5.8 MJ in a time interval of approximately 300 ms. The resulting final average temperature of the fuel would rise to about 120°C, and the temperature at the center of the core would rise to about 170°C, well below the melting temperature of the polyethylene fuel. It is reasonable to assume that the thermal safety fuse would deploy and the surrounding fuel would not melt because the thermal fuse consists of fuel material at twice the concentration found in the polyethylene fuel homogeneously dispersed in polystyrene, which melts below 120°C. Therefore, the fission products would be contained within the core and the primary and secondary fission-product barriers. The small amount of gaseous fission

products that would be released from the fuel in the fuse when it melted would be contained within the sealed core can.

The power excursion is self-limiting because of core expansion resulting from the temperature rise in the core. The prompt expansion of the fuel elements causes a decrease in the density of the moderator, which increases neutron leakage out of the core. This excursion is strongly dependent on the magnitude of the negative temperature coefficient of reactivity.

The use of polyethylene fuel elements makes the reactor extremely safe. The inherent safety of these elements, even for reactor transient periods as short as 4 to 6 ms, is based primarily on the arrangement of the fuel within the moderator. The homogenous dispersal of the fissile material in the polyethylene results in a negligible delay in transferring the energy released from the uranium dioxide particles to the surrounding plastic moderator. The prompt heating of the polyethylene increases the average thermal energy of the neutrons, which results in a decreased fission-to-capture probability for these neutrons. The net result of this prompt heat transfer is that the reactor shuts down safely.

6. SAR, Section 5.3.1, Shielding, states that the sliding shield doors for the overhead shielding may be opened to permit access to the thermal column when the reactor is shut down or operating at low power. Describe the radiation hazards associated with access to the reactor and the measures that will prevent opening the shield doors at full power.

Response: The area above the reactor is treated as a high radiation area whenever the reactor is operated, and access to this area is restricted by a barrier that is in place at the bottom of the stairs leading to the top of the reactor. The radiation hazards are evaluated annually by performing a comprehensive radiological survey of the Reactor Laboratory room and at exterior points to the Reactor Laboratory that are most proximal to the reactor, including the roof of the facility directly above the reactor. During a recent survey while the reactor was operating at 80% power the dose equivalent directly above the centerline of the closed shield doors at one meter above the shielding was 65 mrem/hr (beta and gamma) and 30 mrem/hr (neutron). The dose equivalent at the edge of the sliding doors was 25 mrem/hr (beta and gamma) and 12 mrem/hr (neutron). These measurements verify that the area immediately above the reactor is a high radiation area when the reactor is operating at 100% power. The dose equivalent on the roof of the Reactor Laboratory directly above the reactor while operating at 80% full power with closed shielding doors was 0.5 mrem/hr (beta and gamma) and 0.3 mrem/hr (neutron).

The administrative controls that are currently in place to prevent opening the shield doors at full power have been satisfactory. Personnel are not allowed on top of the reactor without explicit instructions from the reactor operator, and they are not

allowed to open the shield doors at power levels above 0.5 W. The reactor operator maintains visual observation of the bottom of the stairs leading to the top of the reactor and the area on top of the reactor above the sliding shield doors, and is cognizant of personnel entering the restricted area leading to the top of the reactor.

Additional rules shall be put into the facility operating rules that provide: "Personnel shall not be permitted on top of the reactor while it is operating at a power level greater than 0.5 W without the direct knowledge and explicit permission of the Reactor Supervisor. Under no circumstances, shall the sliding shield doors be opened when the reactor is operating at a power greater than 0.5 W."

APPENDIX A
TO FACILITY OPERATING
LICENSE NO. R-110
TECHNICAL SPECIFICATIONS
FOR
IDAHO STATE UNIVERSITY AGN-201 M REACTOR (SERIAL NO. 103)
DOCKET NO. 50-284

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1.0 DEFINITIONS

The terms Safety Limit (SL), Limiting Safety System Setting (LSSS), and Limiting Conditions for Operation (LCO) are as defined in 10 CFR 50.36.

- 1.1 Authorized Operators – An authorized operator is an individual authorized by the Reactor Supervisor to operate the reactor controls and who do so with the knowledge of the Reactor Supervisor and under the direct supervision of a Reactor Operator.
- 1.2 Certified Observers – A certified observer is an individual certified by the Reactor Supervisor as qualified to activate manual scram and initiate emergency procedures.
- 1.3 Channel Calibration – A channel calibration is an adjustment of the channel such that its output responds, within acceptable range and accuracy, to known values of the parameter which the channel measures. Calibration shall encompass the entire channel, including equipment, actuation, alarm, or trip.
- 1.4 Channel Check – A channel check is a qualitative verification of acceptable performance by observation of channel behavior. This verification may include comparison of the channel with other independent channels or methods measuring the same variable.
- 1.5 Channel Test – A channel test is the introduction of a signal into the channel to verify that it is operable.
- 1.6 Coarse Control Rod – The scrammable control rod that can be mechanically withdrawn/inserted at two possible speeds (25 to 55 seconds full insertion time or 75 to 125 seconds full insertion time).
- 1.7 Control Rod – Any of the four moveable rods loaded with fuel that are manipulated by the reactor operator to change the reactivity of the reactor.
- 1.8 Excess Reactivity – The amount of reactivity above critical ($k_{eff} = 1$). The excess reactivity is the amount of reactivity that would exist if all control rods were moved to their maximum reactive positions from the point where the reactor is exactly critical.
- 1.9 Experiment –
 - a. An experiment is any of the following:
 - (1) An activity utilizing the reactor system or its components or the neutrons or radiation generated therein;
 - (2) An evaluation or test of a reactor system operational, surveillance, or maintenance technique; or
 - (3) The material content of any of the foregoing, including structural components, encapsulation or confining boundaries, and contained fluids or solids.

- b. **Secured Experiment** – Any experiment, or component of an experiment is deemed to be secured, or in a secured position, if it is held in a stationary position relative to the reactor by mechanical means. The restraint shall exert sufficient force on the experiment to overcome the expected effects of hydraulic, pneumatic, buoyant, or other forces which are normal to the operating environment of the experiment or which might arise as a result of credible malfunctions.
 - c. **Unsecured Experiment** – Any experiment, or component of an experiment is deemed to be unsecured whenever it is not secured as defined in 1.9.b above. Moving parts of experiments are deemed to be unsecured when they are in motion.
 - d. **Movable Experiment** – A movable experiment is one which may be inserted, removed or manipulated while the reactor is critical.
 - e. **Removable Experiment** – A removable experiment is any experiment, experimental facility, or component of an experiment, other than a permanently attached appurtenance to the reactor system, which can reasonably be anticipated to be moved one or more times during the life of the reactor.
- 1.10 **Experimental Facilities** – Experimental facilities are those portions of the reactor assembly that are used for the introduction of experiments into or adjacent to the reactor core region or allow beams of radiation to exit from the reactor shielding. Experimental facilities shall include the thermal column, glory hole, and access ports.
- 1.11 **Explosive Material** – Explosive material is any solid or liquid which is categorized as a Severe, Dangerous, or Very Dangerous Explosion Hazard in Dangerous Properties of Industrial Materials, by N. I. Sax, 7th ed., (1989), or is given an Identification of Reactivity (Stability) Index of 2, 3, or 4 by the National Fire Protection Association in its publication 704-M, 1966, Identification System for Fire Hazards of Materials, also enumerated in the Handbook for Laboratory Safety, 2nd ed. (1971) published by the Chemical Rubber Company.
- 1.12 **Fine Control Rod** – A low worth, non-scrammable control rod used primarily to maintain an intended power level. Its position may be varied manually.
- 1.13 **Measured Value** – The measured value is the value of a parameter as it appears on the output of a channel.
- 1.14 **Measuring Channel** – A measuring channel is the combination of sensor, lines, amplifiers, and output devices which are connected for the purpose of measuring or responding to the value of a process variable.
- 1.15 **Operable** – Operable means a component or system is capable of performing its intended function in its normal manner.
- 1.16 **Operating** – Operating means a component or system is performing its intended function in its normal manner.
- 1.17 **Potential Reactivity Worth** – The potential reactivity worth of an experiment is the maximum absolute value of the reactivity change that would occur as a result of

intended or anticipated changes or credible malfunctions that alter experiment position or configuration.

Evaluations of potential reactivity worth of experiments also shall include effects of possible trajectories of the experiment in motion relative to the reactor, its orientation along each trajectory, and circumstances which can cause internal changes such as creating or filling of void spaces or motion of mechanical components. For removable experiments, the potential reactivity worth is equal to or greater than the static reactivity worth.

- 1.18 Reactor Component – A reactor component is any apparatus, device, or material that is a normal part of the reactor assembly.
- 1.19 Reactor Operation – Reactor operation is any condition wherein the reactor is not shutdown.
- 1.20 Reactor Safety System – The reactor safety system is that combination of safety channels and associated circuitry which forms an automatic protective system for the reactor or provides information which requires manual protective action be initiated.
- 1.21 Reactor Secured – The reactor is secured when:
- a. Either: (1) All safety and control rods are fully withdrawn from the core, or
(2) The core fuse melts resulting in separation of the core,
and:
 - b. The reactor console key switch is in the “off” position and the key is removed from the console and under the control of a licensed operator.
 - c. No work is in progress involving core fuel, core structure, installed control rods, or control rod drives unless they are physically decoupled from the control rods, and
 - d. No experiments are being moved or serviced that have, on movement, a reactivity worth exceeding the maximum value allowed for a single experiment, or one dollar, whichever is smaller.
- 1.22 Reactor Shutdown – The reactor is shutdown if it is subcritical by at least one dollar in reactivity in the reference condition with the reactivity worth of all experiments included. The reactor shall be considered shutdown whenever:
- a. Either: (1) All safety and control rods are fully withdrawn from the core, or
(2) The core fuse melts resulting in separation of the core,
and:
 - b. The reactor console key switch is in the “off” position and the key is removed from the console and under the control of a licensed operator.

- 1.23 **Restricted Area** – A restricted area is an area in which access to personnel is controlled for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.
- 1.24 **Safety Channel** – A safety channel is a measuring channel in the reactor safety system.
- 1.25 **Safety Control Rod** – One of two scrammable control rods that can be mechanically withdrawn/inserted at only one speed (25 to 55 seconds full insertion time).
- 1.26 **Scram Time** – The time for the control rods acting under gravity to change the reactor from a critical to a subcritical condition. In most cases, this time is less than or equal to the time it takes for the rod to fall from a full-in to full-out position.
- 1.27 **Shall, Should and May** – The word “shall” is used to denote a requirement; the word “should” is used to denote a recommendation; and the word “may” is used to denote permission—neither a requirement nor a recommendation.
- 1.28 **Shutdown Margin** – Shutdown margin shall mean the minimum shutdown reactivity necessary to provide confidence that the reactor can be made subcritical by means of the control and safety systems starting from any permissible operating condition assuming that the most reactive scrammable rod and the Fine Control Rod remain in their most reactive positions, and that the reactor will remain subcritical without any further operator action.
- 1.29 **Static Reactivity Worth of Experiments** - The static reactivity worth of an experiment is the value of the reactivity change which is measurable by calibrated control or regulating rod comparison methods between two defined terminal positions or configurations of the experiment. For removable experiments, the terminal positions are fully removed from the reactor and fully inserted or installed in the normal functioning or intended position.
- 1.30 **Surveillance Time** – A surveillance time indicates the frequency of tests to demonstrate performance. Allowable surveillance intervals shall not exceed the following:
- a. Two-year - interval not to exceed 30 months.
 - b. Annual - interval not to exceed 15 months.
 - c. Semiannual - interval not to exceed seven and one-half months (30 weeks).
 - d. Quarterly - interval not to exceed four months.
 - e. Monthly - interval not to exceed six weeks.
- 1.31 **True Value** – The true value is the actual value of a parameter.
- 1.32 **Unscheduled Shutdown** – An unscheduled shutdown is defined as any unplanned shutdown of the reactor caused by actuation of the reactor safety system, operator error, equipment malfunction, or a manual shutdown in response to conditions that could adversely affect safe operation, not including shutdowns that occur during testing or check-out operations.

2.0 SAFETY LIMITS AND LIMITING SAFETY SYSTEM SETTINGS

2.1 Safety Limits

Applicability

This specification applies to the maximum safe steady-state power level and maximum core temperature during steady-state or transient operation.

Objective

To assure that the integrity of the fuel material is maintained and all fission products are retained in the core matrix.

Specification

- a. The reactor power level shall not exceed 100 watts.
- b. The maximum core temperature shall not exceed 200°C during either steady-state or transient operation.

Basis

The polyethylene core material does not melt below 200°C and is expected to maintain its integrity and retain essentially all of the fission products at temperatures below 200°C. The Hazards Summary Report dated February 1962 submitted on Docket F-15 by Aerojet-General Nucleonics (AGN) calculated a steady-state core average temperature rise of 0.44°C/watt. Therefore, a steady-state power level of 100 watts would result in an average core temperature rise of 44°C. The corresponding maximum core temperature would be below 200°C, thus assuring integrity of the core and retention of fission products.

2.2 Limiting Safety System Settings (LSSS)

Applicability

This specification applies to the parts of the reactor safety system which will limit maximum power and core temperature.

Objective

To assure that automatic protective action is initiated to prevent a safety limit from being exceeded.

Specification

- a. The safety channels shall initiate a reactor scram at the following limiting safety system settings:

<u>Channel</u>	<u>Condition</u>	<u>LSSS</u>
Nuclear Safety No. 2	High Power	6 watts
Nuclear Safety No. 3	High Power	6 watts

- b. The core thermal fuse shall melt when heated to a temperature of about 120°C resulting in core separation and reactivity loss greater than 5% $\Delta k/k$.

Basis

Based on instrumentation response times and scram tests, the AGN Hazards Report concluded that reactor periods in excess of 30-50 milliseconds would be adequately arrested by the scram system. Since the maximum available excess reactivity in the reactor is less than one dollar the reactor cannot become prompt critical and the corresponding shortest possible period is greater than 200 milliseconds. The high power LSSS of 6 watts in conjunction with automatic safety systems and/or manual scram capabilities will assure that the safety limits will not be exceeded during steady state operation or as a result of the most severe credible transient.

In the event of failure of the reactor to scram, the self-limiting characteristic due to the large negative temperature coefficient, and the melting of the thermal fuse at a temperature below 120°C will assure safe shutdown without exceeding a core temperature of 200°C.

3.0 LIMITING CONDITIONS FOR OPERATION

3.1 Reactivity Limits

Applicability

This specification applies to the reactivity condition of the reactor and the reactivity worths of control rods and experiments.

Objective

To assure that the reactor can be shut down at all times and that the safety limits will not be exceeded.

Specification

- a. The available excess reactivity with all control and safety rods fully inserted and including the potential reactivity worth of all experiments shall not exceed 0.65% $\Delta k/k$ (\$0.878) referenced to 20°C.
- b. The shutdown margin with the most reactive safety or control rod fully inserted and the fine control rod rod fully inserted shall be at least 1% $\Delta k/k$ (\$1.35).
- c. The reactivity worth of the control and safety rods shall ensure subcriticality on the complete withdrawal of the coarse control rod or any one safety rod.

Basis

The limitations on total core excess reactivity assure reactor periods of sufficient length so that the reactor protection system and/or operator action will be able to shut the reactor down without exceeding any safety limits. The shutdown margin and control and safety rod reactivity limitations assure that the reactor can be brought and maintained subcritical if the highest reactivity scrammable rod fails to scram and the Fine Control Rod remains in its most reactive position.

3.2 Control and Safety Systems

Applicability

These specifications apply to the reactor control and safety systems.

Objective

To specify lowest acceptable level of performance, instrument set points, and the minimum number of operable components for the reactor control and safety systems.

Specification

- a. The total scram withdrawal time of the safety rods and coarse control rod shall be less than 1 second.
- b. The average reactivity addition rate for each control or safety rod shall not exceed 0.065% $\Delta k/k$ per second (\$0.00877 per second).
- c. The safety rods and coarse control rod shall be interlocked such that:
 - (1) Reactor startup cannot commence unless both safety rods and coarse control rod are fully withdrawn from the core.
 - (2) Only one safety rod can be inserted at a time.
 - (3) The coarse control rod cannot be inserted unless both safety rods are fully inserted.
- d. All reactor safety system instrumentation shall be operable in accordance with Table 3.1 with the exception that, with the approval of the Reactor Supervisor, Safety Channel No. 1 may be bypassed whenever the reactor control or safety rods are not in their fully withdrawn position.
- e. The shield water level interlock shall be set to prevent startup and scram the reactor if the shield water level falls 10 inches below the highest point on the reactor shield tank manhole opening.
- f. The shield water temperature interlock shall be set to prevent reactor startup and scram the reactor if the shield water temperature falls below 15°C.
- g. The seismic displacement interlock sensor shall be installed in such a manner to prevent reactor startup and scram the reactor during a seismic displacement.
- h. A manual scram shall be provided on the reactor console.
- i. A loss of electric power shall cause the reactor to scram.
- j. An operable installed area radiation monitor capable of detecting gamma radiation shall be immediately available to reactor operating personnel whenever the reactor is not secured. When required monitors are inoperable, portable instruments may be substituted for any installed monitor for periods up to two weeks, while the installed monitor is being repaired.

Basis

The specifications on scram withdrawal time in conjunction with the safety system instrumentation and set points assure safe reactor shutdown during the most severe foreseeable transients. Interlocks on control and safety rods assure an orderly approach to criticality and an adequate shutdown capability. The limitations on reactivity addition

rates allow only relatively slow increases of reactivity so that ample time will be available for manual or automatic scram during any operating conditions.

The neutron detector channels (Nuclear Safety Channels Nos. 1 through 3) assure that reactor power levels are adequately monitored during reactor startup and operation. Requirements on minimum neutron levels will prevent reactor startup unless channels are operable and responding, and will cause a scram in the event of instrumentation failure. The power levels initiate redundant automatic protective action at power level scrams low enough to assure safe shutdown without exceeding any safety limits. The period scram conservatively limits the rate of rise of reactor power to periods which are manually controllable and will automatically scram the reactor in the event of unexpected large reactivity additions.

The AGN-201's negative temperature coefficient of reactivity causes a reactivity increase with decreasing core temperature. The shield water temperature interlock will prevent reactor operation at temperatures below 15°C thereby limiting potential reactivity additions associated with temperature decreases.

Water in the shield tank is an important component of the reactor shield and operation without the water may produce excessive radiation levels. The shield tank water level interlock will prevent reactor operation without adequate water levels in the shield tank.

The reactor is designed to withstand 0.6g accelerations and 6 cm displacements. A seismic instrument causes a reactor scram whenever the instrument receives a horizontal acceleration that causes a horizontal displacement of 1/16 inch or greater. The seismic displacement interlock assures that the reactor will be scrambled and brought to a subcritical configuration during any seismic disturbance that may cause damage to the reactor or its components.

The manual scram allows the operator to manually shut down the reactor if an unsafe or otherwise abnormal condition occurs that does not otherwise scram the reactor. A loss of electrical power de-energizes the safety and coarse control rod holding magnets causing a reactor scram and thus assuring safe and immediate shutdown in case of a power outage.

An area radiation monitor must always be available to operating personnel to provide an indication of any abnormally high radiation levels so that appropriate action can be taken to shut down the reactor and assess the hazards to personnel.

Table 3.1 Reactor control and safety systems set-point specifications.

<u>SAFETY CHANNEL</u>	<u>SET POINT</u>	<u>FUNCTION</u>
Nuclear Safety Channel No. 1 (Startup Count Rate Channel) Low Power	5% Full Scale	Scram at levels < 5% of Full Scale
Nuclear Safety Channel No. 2 (Log Power Channel) High Power	6 watts (120% of licensed power)	Scram at power > 6 watts
Nuclear Safety Channel No. 2 (Log Power Channel) Low Power	3.0×10^{-13} amps	Scram at source levels < 3×10^{-13} amps
Reactor Period	5 sec	Scram at periods < 5 sec
Nuclear Safety Channel No. 3 (Linear Power Channel) High Power	6 watts (120% of licensed power)	Scram at power > 6 watts
Nuclear Safety Channel No. 3 (Linear Power Channel) Low Power	5% Full Scale	Scram at levels < 5% of Full Scale
Manual Scram	---	Scram at operator option
Area Radiation Monitor	≤ 10 mR/hr	Alarm at or below level set to meet requirements of 10 CFR 20

3.3 Limitations on Experiments

Applicability

This specification applies to experiments installed in the reactor and its experimental facilities.

Objective

To prevent damage to the reactor or excessive release of radioactive materials in the event of an experiment failure.

Specification

- a. Experiments containing materials corrosive to reactor components or which contain liquid or gaseous, fissionable materials shall be doubly encapsulated.

- b. Explosive materials shall not be inserted into experimental facilities of the reactor or stored within the confines of the reactor facility.
- c. The radioactive material content, including fission products of any experiment shall be limited so that the complete release of all gaseous, particulate, or volatile components from the experiment will not result in:
 - (1) A total effective dose equivalent to any person occupying an unrestricted area continuously for a period of two hours starting at the time of release in excess of 0.1 mSv (10 mrem) as a result of any airborne pathway, or
 - (2) A total effective dose equivalent to any person occupying an unrestricted area continuously for a period of two hours starting at the time of release in excess of 1 mSv (100 mrem) as a result of all pathways, or
 - (3) A total effective dose equivalent to any radiation worker occupying a restricted area during the length of time required to evacuate the restricted area in excess of 50 mSv (5 rem).

Basis

These specifications are intended to reduce the likelihood of damage to reactor components and/or radioactivity releases resulting from an experiment failure and to protect operating personnel and the public from excessive radiation doses in the event of an experiment failure. Specification 3.3c conforms to the regulatory position put forth in 10 CFR 20, issued January 1993.

3.4 Radiation Monitoring, Control, and Shielding

Applicability

This specification applies to radiation monitoring, control, and reactor shielding required during reactor operation.

Objective

To protect facility personnel and the public from radiation exposure.

Specification

- a. An operable portable and an installed radiation survey instrument capable of detecting gamma radiation shall be immediately available to reactor operating personnel whenever the reactor is not secured.
- b. The reactor room shall be considered a restricted area whenever the reactor is not secured.
- c. The following shielding requirements shall be fulfilled during reactor operation:

- (1) The reactor shield tank shall be filled with water to a height within 10 inches of the highest point on the manhole opening.
- (2) The thermal column shall be filled with water or graphite except during a critical experiment (core loading) or during measurement of reactivity worth of thermal column water or graphite, or when the neutron radiography collimator is being used, or other approved experiments which require the thermal column to be empty.
- (3) The movable shield doors above the thermal column shall be maintained in a closed position whenever the reactor is operated at a power greater than 0.5 watts.

Basis

Radiation surveys performed under the supervision of a qualified health physicist have shown that the total gamma, thermal neutron, and fast neutron radiation dose rate in the reactor room, at the closest approach to the reactor outside the designated high radiation areas is less than 250 $\mu\text{Sv/hr}$ (25 mrem/hr) at reactor power levels less than 5.0 watt.

The facility shielding in conjunction with designated restricted radiation areas is designed to limit radiation doses to facility personnel and to the public to a level below 10 CFR 20 limits under operating conditions, and to a level below Criterion 19, Appendix A, 10 CFR 50 recommendations under accident conditions.

4.0 SURVEILLANCE REQUIREMENTS

Actions specified in this section are not required to be performed if during the specified surveillance period the reactor has not been brought critical or is maintained in a shutdown condition extending beyond the specified surveillance period. However, the surveillance requirements must be fulfilled prior to subsequent startup of the reactor.

4.1 Reactivity Limits

Applicability

The specification applies to the surveillance requirements for reactivity limits.

Objective

To assure that reactivity limits for Specification 3.1 are not exceeded.

Specification

- a. Safety and control rod reactivity worths shall be measured annually.
- b. Total excess reactivity and shutdown margin shall be determined annually.
- c. The reactivity worth of an experiment shall be estimated or measured, as appropriate, before or during the first startup subsequent to the experiment's insertion.

Basis

The control and safety rods are inspected and their reactivity worths measured annually to assure that no degradation or unexpected changes have occurred which could adversely affect reactor shutdown margin or total excess reactivity. The shutdown margin and total excess reactivity are determined to assure that the reactor can always be safely shutdown with one rod not functioning and that the maximum possible reactivity insertion will not result in reactor periods shorter than those than can be adequately terminated by either operator or automatic action. Based on experience with AGN reactors, significant changes in reactivity or rod worth are not expected within a 15-month period.

4.2 Control and Safety System

Applicability

This specification applies to the surveillance requirements of the reactor control and safety system.

Objective

To assure that the reactor control and safety systems are operable as required by Specification 3.2.

Specification

- a. Safety and control rod scram times and average reactivity insertion rates shall be measured annually.
- b. Safety and control rods and drives shall be inspected for deterioration at intervals not to exceed 2 years.
- c. A channel test of the following safety channels shall be performed prior to the first reactor startup of the day or prior to each operation extending more than one day.

Nuclear Safety Channel No. 1, No. 2, and No. 3
Manual Scram

- d. A channel test of the seismic displacement interlock shall be performed annually.
- e. A channel check of the following safety channels shall be performed daily whenever the reactor is in operation:

Nuclear Safety Channel No. 1, No. 2, and No. 3

- f. Prior to each day's operation or prior to each operation extending more than one day, Safety Rod No. 1 shall be inserted and scrammed to verify operability of the manual scram system.
- g. The period, count rate, and power level measuring channels shall be calibrated and set points verified annually.
- h. The shield water level interlock, shield water temperature interlock, and seismic displacement safety channel shall be calibrated by perturbing the sensing element to the appropriate set point. These calibrations shall be performed annually.
- i. The radiation monitoring instrumentation shall be calibrated annually.

Basis

The channel tests and checks required daily or before each startup will assure that the safety channels and scram functions are operable. Based on operating experience with reactors of this type, the annual scram measurements, channel calibrations, set point verifications, and inspections are of sufficient frequency to assure, with a high degree of confidence, that the safety system settings will be within acceptable drift tolerance for operation.

4.3 Reactor Structure

Applicability

This specification applies to surveillance requirements for reactor components other than control and safety rods.

Objective

To assure integrity of the reactor structures.

Specification

- a. The shield tank shall be visually inspected every two years. If apparent excessive corrosion or other damage is observed, corrective measures shall be taken prior to subsequent reactor operation.
- b. Visual inspection for water leakage from the shield tank shall be performed prior to each startup. Leakage sufficient to leave a puddle on the floor shall be corrected prior to subsequent reactor operation.

Basis

Based on experience with reactors of this type, the frequency of inspection and leak test requirements of the shield tank will assure capability for radiation protection during reactor operation.

4.4 Radiation Monitoring and Control

Applicability

This specification applies to the surveillance requirements of the radiation monitoring and control systems.

Objective

To assure that the radiation monitoring and control systems are operable and that all radiation areas within the reactor facility are identified and controlled as required by Specification 3.4.

Specification

- a. All portable and installed radiation survey instruments assigned to the reactor facility shall be calibrated annually under the supervision of the Radiation Safety Officer.
- b. Prior to each day's reactor operation or prior to each reactor operation extending more than one day, the reactor room high radiation alarm shall be verified to be operable.
- c. A radiation survey of the reactor room and reactor control room shall be performed under the supervision of the Radiation Safety Officer annually, to determine the location of radiation and high radiation areas corresponding to reactor operating power levels.

Basis

The periodic calibration of radiation monitoring equipment and the surveillance of the reactor room high radiation area alarm will assure that the radiation monitoring and control systems are operable during reactor operation.

The periodic radiation surveys will verify the location of radiation and high radiation areas and will assist reactor facility personnel in properly labeling and controlling each location in accordance with 10 CFR 20.

5.0 DESIGN FEATURES

5.1 Reactor

- a. The reactor core, including control and safety rods, contains approximately 670 grams of ^{235}U in the form of <20% enriched UO_2 dispersed in approximately 11 kilograms of polyethylene. The lower section of the core is supported by an aluminum rod hanging from a fuse link. The fuse melts at temperatures below 120°C causing the lower core section to fall away from the upper section reducing reactivity by at least $5\% \Delta k/k$. Sufficient clearance between core and reflector is provided to insure free fall of the bottom half of the core during the most severe transient.
- b. The core is surrounded by a 20-cm-thick high-density (1.75 gm/cm^3) graphite reflector followed by a 10-cm-thick lead gamma shield. The core and part of the graphite reflector are sealed in a fluid-tight aluminum core tank designed to contain any fission-product gases that might leak from the core.
- c. The core, reflector, and lead shielding are enclosed in and supported by a fluid-tight steel reactor tank. An upper or "thermal column tank" may serve as a shield tank when filled with water or as a thermal column when filled with graphite.
- d. The 198-cm-diameter, fluid-tight shield tank is filled with water constituting a 55-cm-thick fast neutron shield. The fast neutron shield is formed by filling the tank with approximately 3785 liters of water. The complete reactor shield shall limit doses to operating personnel in restricted and unrestricted areas to levels less than permitted by 10 CFR 20 under operating conditions.
- e. Shielding is provided by a concrete wall constructed of 4" x 8" x 16" concrete blocks and 4" x 8" x 12" barytes concrete blocks for 5 watt operation. The blocks are held to close dimensional tolerance in manufacture and stacked in such a manner that voids in the completed wall are at a minimum. Near the beam ports and glory hole, high-density blocks are used between 40 inches and 112 inches above the base. The use of these blocks further reduces radiation level in these areas. Overhead shielding is provided by 8-inch-thick barytes blocks (minimum density 3.7 gm/cm^3). Results of shielding calculations are summarized in the ISU AGN-201 Reactor Safety Analysis Report.
- f. Two safety rods and one control rod (identical in size) contain up to 20 grams of ^{235}U each in the same form as the core material. These rods are lifted into the core by electromagnets, driven by reversible DC motors through lead screw assemblies. De-energizing the magnets causes a spring-driven, gravity-assisted scram. The fourth rod or fine control rod (approximately one-half the diameter of the other rods) is driven directly by a lead screw. This rod may contain polyethylene with or without fuel.

5.2 Fuel Storage

Fuel, including fueled experiments and fuel devices not in the reactor, shall be stored in locked rooms in the College of Engineering laboratories. The storage array shall be such that k_{eff} is no greater than 0.9 for all conditions of moderation and reflection.

5.3 Reactor Room

- a. The reactor room houses the reactor assembly and accessories required for its operation and maintenance.
- b. The reactor room is a separate room in the Lillibridge Engineering Laboratory, constructed with adequate shielding and other radiation protective features to limit doses in restricted and unrestricted areas to levels no greater than permitted by 10 CFR 20, under normal operating conditions, and to a level below Criterion 19, Appendix A, 10 CFR 50 recommendations under accident conditions.
- c. Access doors to the reactor room are self-locking.

6.0 ADMINISTRATIVE CONTROLS

6.1 Organization

The administrative organization for control of the reactor facility and its operation shall be as set forth in Figure 1. The authorities and responsibilities set forth below are designed to comply with the intent and requirements for administrative controls of the reactor facility as set forth by the Nuclear Regulatory Commission.

6.1.1 University Officer

The University Officer is an administrative officer responsible for the University and in whose name the application for licensing is made.

6.1.2 Dean, College of Engineering

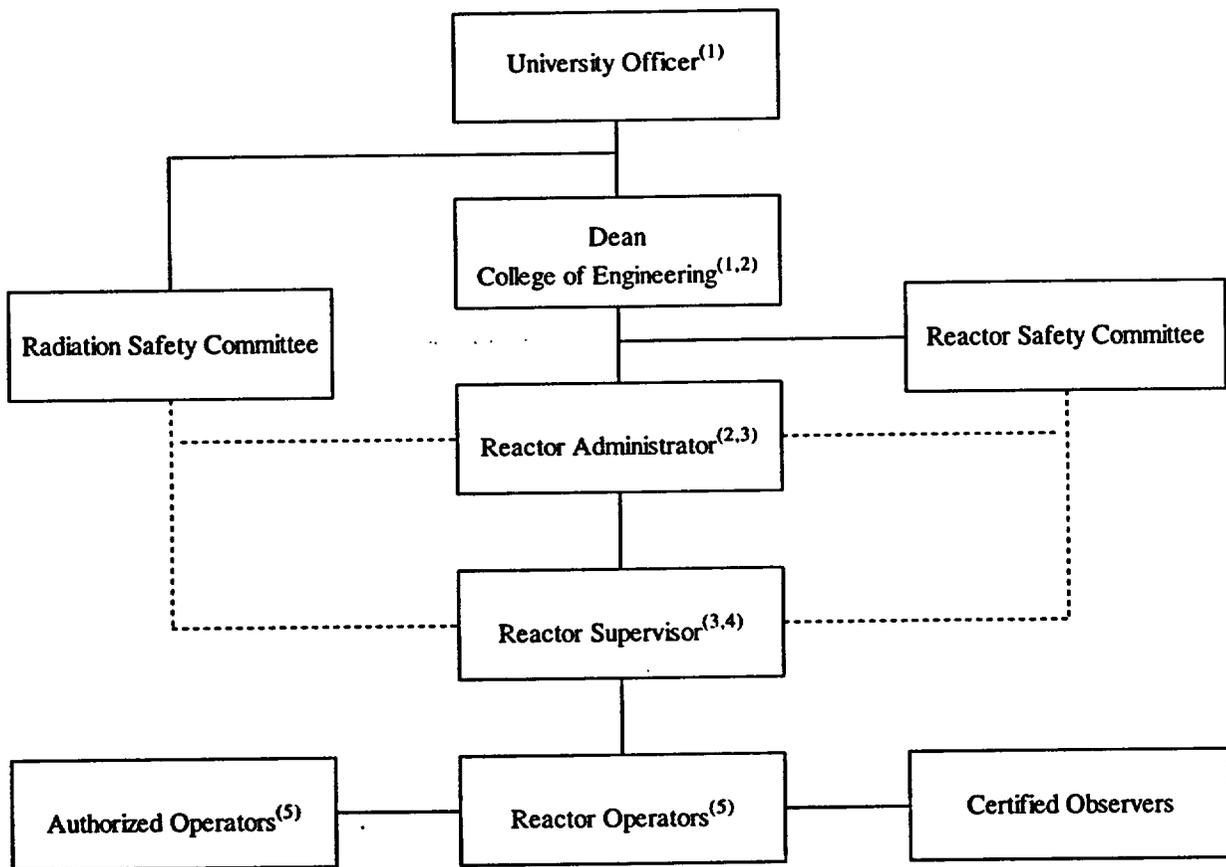
The dean of the College of Engineering is the administrative officer responsible for the operation of the College of Engineering.

6.1.3 Reactor Administrator

The Reactor Administrator (RA) is the administrative officer responsible for the operation of the AGN-201M Reactor Facility. In this capacity the RA shall have final authority and ultimate responsibility for the operation, maintenance, and safety of the reactor facility within the limitations set forth in the facility license. The Reactor Administrator shall be responsible for appointing the Reactor Supervisor, who reports to the Reactor Administrator. The RA shall seek the advice and approval of the Radiation Safety Committee and/or the Reactor Safety Committee in all matters concerning unresolved safety questions, new experiments and new procedures, and facility modifications which might affect safety. The RA shall be an ex officio member of the Reactor Safety Committee.

6.1.4 Reactor Supervisor

The Reactor Supervisor (RS) shall be responsible for the preparation, promulgation, and enforcement of 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. The RS shall direct the activities of operators and technicians in the daily operation and maintenance of the reactor; schedule reactor operations and maintenance; be responsible for the preparation, authentication, and storage of all prescribed logs and operating records; authorize all experiments, procedures, and changes thereto which have received the approval of the Reactor Safety Committee and/or the Radiation Safety Committee and the RA; and be responsible for the preparation of experimental procedures involving use of the reactor. The RS shall hold a valid Senior Reactor Operator's license issued by the U.S. Nuclear Regulatory Commission.



- (1) University Officer and Dean of the College of Engineering may be same individual.
- (2) Dean of the College of Engineering and Reactor Administrator may be same individual.
- (3) Reactor Administrator and Reactor Supervisor may be same individual.
- (4) Requires NRC Senior Reactor Operators License.
- (5) Requires NRC Reactor Operators License except where exempt per 10 CFR 55.13.

Figure 1. Administrative Organization of the ISU AGN-201M Reactor Facility, NRC License R-110.

Persons holding positions on the Administrative organization shall meet or exceed the qualification requirements of ANSI/ANS-15.4-1988, "Selection and Training of Personnel for Research Reactors."

6.1.5 Reactor Operators

Reactor Operators shall be responsible for the manipulation of the reactor controls, monitoring of instrumentation, operation of reactor-related equipment, and maintenance of complete and current records during operation of the facility. Reactor Operators shall hold a valid Reactor Operator's license issued by the U.S. Nuclear Regulatory Commission.

6.1.6 Authorized Operators

Individuals authorized by the Reactor Supervisor to operate the reactor controls and who do so with the knowledge of the Reactor Supervisor and under the direct supervision of a Reactor Operator.

6.1.7 Certified Observers

Individuals certified by the Reactor Supervisor as qualified to activate manual scram and initiate emergency procedures in the event of an emergency situation during reactor operation.

6.1.8 Reactor Safety Committee

The Reactor Safety Committee shall be responsible for, but not limited to, reviewing and approving safety standards associated with the 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 unreviewed safety questions, as defined in 10 CFR 50.59, and are in accordance with these Technical Specifications; conducting periodic audits of procedures, reactor operations and maintenance, equipment performance, and records; review all reportable occurrences and violations of these Technical Specifications, evaluating the causes of such events and the corrective action taken and recommending measures to prevent reoccurrence; reporting all their findings and recommendations concerning the reactor facility to the Reactor Administrator.

6.1.9 Radiation Safety Committee

The Radiation Safety Committee shall advise the University administration and the Radiation Safety Officer on all matters concerning radiological safety at University facilities.

6.1.10 Radiation Safety Officer

The Radiation Safety Officer shall review and approve all procedures and experiments involving radiological safety. He shall enforce all federal, state, and university rules, regulations, and procedures relating to radiological safety. He shall perform routine radiation surveys of the reactor facility and report his findings to the Reactor Administrator. He shall provide personnel dosimetry and keep records of personnel radiation exposure. He shall advise the Reactor Administrator on all matters concerning radiological safety at the reactor facility. The Radiation Safety Officer shall be an ex officio member of the Reactor Safety Committee.

6.1.11 Operating Staff

- a. The minimum operating staff during any time in which the reactor is not secured shall consist of:
 - (1) One licensed Reactor Operator in the reactor control room.
 - (2) One Certified Observer in the reactor control room.
 - (3) One licensed Senior Reactor Operator readily available on call. This requirement can be satisfied by having a licensed Senior Reactor Operator perform the duties stated in paragraph (1) or (2) above or by designating a licensed Senior Reactor Operator who can be readily contacted by telephone and who can arrive at the reactor facility within 30 minutes.
- b. A licensed Senior Reactor Operator shall supervise all reactor maintenance or modification which could affect the reactivity of the reactor.
- c. A listing of reactor facility personnel by name and phone number shall be conspicuously posted in the reactor control room.

6.2 Staff Qualifications

The Reactor Administrator, the Reactor Supervisor, licensed Reactor Operators, and technicians performing reactor maintenance shall meet the minimum qualifications set forth in ANSI/ANS-15.4, "Standards for Selection and Training of Personnel for Research Reactors." Reactor Safety Committee members shall have a minimum of five (5) years experience in their profession or a baccalaureate degree and two (2) years of professional experience. Generally, these committee members will be made up of University faculty, but outside experience will be sought in areas where additional experience is considered necessary by the Reactor Administrator.

6.3 Training

The Reactor Supervisor shall be responsible for directing training as set forth ANSI/ANS-15.4, "Standards for Selection and Training of Personnel for Research Reactors." All licensed reactor operators shall participate in requalification training as set forth in 10 CFR 55.

6.4 Reactor Safety Committee

6.4.1 Meetings and Quorum

The Reactor Safety Committee (RSC) shall meet as often as deemed necessary by the RSC Chair but shall meet at least annually. A quorum for the conduct of official business shall consist of not less than one-half of the current RSC membership and shall include the Chair or designated alternate. At no time

shall the operating organization comprise a voting majority of the members at any RSC meeting.

6.4.2 Reviews

The RSC shall review:

- a. Safety evaluations for changes to procedures, equipment or systems, and tests or experiments, conducted without Nuclear Regulatory Commission approval under the provision of 10 CFR 50.59, to verify that such actions do not constitute an unreviewed safety question.
- b. Proposed changes to procedures, equipment or systems that change the original intent or use, and are non-conservative, or those that involve an unreviewed safety question as defined in 10 CFR 50.59.
- c. Proposed tests or experiments which are significantly different from previously approved tests or experiments, or those that involve an unreviewed safety question as defined in 10 CFR 50.59.
- d. Proposed changes in Technical Specifications or other license documents.
- e. Violations of applicable statutes, codes, regulations, orders, Technical Specifications, license requirements, or of internal procedures or instructions having nuclear safety significance.
- f. Significant operating abnormalities or deviations from normal and expected performance of facility equipment that affect nuclear safety.
- g. Reportable occurrences.
- h. Audit reports.

6.4.3 Audits

Audits of facility activities shall be performed under the cognizance of the RSC but in no case by the personnel responsible for the item audited. These audits shall examine the operating records and encompass but shall not be limited to the following:

- a. The conformance of facility operation to the Technical Specifications and applicable license conditions, at least annually.
- b. The performance, training, and qualifications of the entire facility staff, at least every two years.
- c. The results of all actions taken to correct deficiencies occurring in facility equipment, structures, systems or method of operation that affect nuclear safety, at least annually.

- d. The Facility Emergency Plan and implementing procedures at least every two years.
- e. The Facility Security Plan and implementing procedures, at least every two years.

6.4.4 Authority

The RSC shall report to the dean of the College of Engineering and shall advise the Reactor Administrator on those areas of responsibility outlined in Section 6.1.6 of these Technical Specifications.

6.4.5 Minutes of the Reactor Safety Committee

The RSC Chair shall direct the preparation, maintenance, and distribution of minutes of its activities. These minutes shall include a summary of all meetings, actions taken, audits, and reviews. Minutes should be distributed to all administrative levels and RSC members within 3 months after each meeting.

6.5 Approvals

The procedure for obtaining approval for any change, modification or procedure which requires approval of the RSC shall be as follows:

- a. The Reactor Supervisor shall prepare the proposal for review and approval by the Reactor Administrator.
- b. The Reactor Administrator shall submit the proposal to the RSC for review, comment, and possible approval.
- c. The RSC shall approve the proposal by majority vote.
- d. The Reactor Administrator shall provide final approval after receiving the approval of the RSC.

6.6 Procedures

There shall be written procedures that cover the following activities:

- a. Startup, operation, and shutdown of the reactor.
- b. Fuel movement and changes to the core and experiments that could affect reactivity.
- c. Conduct of irradiations and experiments that could affect the safety of the reactor.
- d. Preventive or corrective maintenance which could affect the safety of the reactor.
- e. Surveillance, testing, and calibration of instruments, components and systems as specified in Section 4.0 of these Technical Specifications.

- f. Implementation of the Security Plan and Emergency Plan.
- g. Radiation Safety Protection for all reactor-related personnel.

The above listed procedures shall be approved by the Reactor Administrator and the RSC. Temporary procedures which do not change the intent of previously approved procedures and which do not involve any unreviewed safety question may be employed on approval by the Reactor Supervisor.

6.7 Experiments

- a. Prior to initiating any new reactor experiment an experimental procedure shall be prepared by the Reactor Supervisor and reviewed and approved by the Reactor Administrator and the RSC.
- b. Approved experiments shall only be performed under the cognizance of the Reactor Supervisor.

6.8 Safety Limit Violation

The following actions shall be taken in the event a Safety Limit is violated:

- a. The reactor will be shutdown immediately and reactor operation will not be resumed without authorization by the Nuclear Regulatory Commission (NRC).
- b. The Safety Limit violation shall be reported to the Reactor Administrator immediately. The violation shall be reported to the NRC and the RSC Chair or designated alternate not later than the next working day.
- c. A Safety Limit Violation Report shall be prepared for review by the RSC. This report shall describe the applicable circumstances leading to the violation including, when known, the cause and contributing factors; the effects of the violation upon facility components, systems, or structures and on the health and safety of personnel and the public; and corrective action to prevent recurrence.
- d. The Safety Limit Violation Report shall be submitted to the NRC and RSC within 14 days of the violation.

6.9 Reporting Requirements

In addition to the applicable reporting requirements of Title 10, Code of Federal Regulations, the following reports shall be submitted to the Director, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Attention: Document Control Desk, Washington, D.C., 20555.

6.9.1 Annual Operating Report

Routine operating reports covering the operation of the reactor during the previous calendar year should be submitted prior to June 30 of each year.

The annual operating reports made by licensees shall provide a comprehensive summary of the operating experience having safety significance that was gained during the year, even though some repetition of previously reported information may be involved. References in the annual operating report to previously submitted reports shall be clear.

Each annual operating report shall include:

- (1) A brief narrative summary of:
 - a. Changes in facility design, performance characteristics, and operating procedures relating to reactor safety that occurred during the reporting period.
 - b. Results of major surveillance tests and inspections.
- (2) A monthly tabulation showing the hours the reactor was operated and the energy produced by the reactor in watt-hours.
- (3) List of the unscheduled shutdowns, including the reasons therefore and corrective action taken, if any.
- (4) Discussion of the major safety-related corrective maintenance performed during the period, including the effects, if any, on the safe operation of the reactor and the reasons for the corrective maintenance required.
- (5) A brief description of:
 - a. Each change to the facility to the extent that it changes a description of the facility in the application for license and amendments thereto.
 - b. Changes to the procedures as described in Facility Technical Specifications.
 - c. Any new or untried experiments or tests performed during the reporting period.
- (6) A summary of the safety evaluation made for each change, test, or experiment not submitted for NRC approval pursuant to 10 CFR 50.59 which clearly shows the reason leading to the conclusion that no unreviewed safety question existed and that no change to the Technical Specifications was required.
- (7) A summary of the nature and amount of radioactive effluents released or discharged to the environs beyond the effective control of the licensee as determined at or prior to the point of such release or discharge.
 - a. Liquid waste

Total estimated quantity of radioactivity released (in curies) and total volume (in liters) of effluent water (including diluent) released.

b. Airborne waste

Total estimated quantity of radioactivity released (in curies) determined by an approved sampling and counting method.

c. Solid waste

(i) Total amount of solid waste packaged (in cubic meters).

(ii) Total activity in solid waste (in curies).

(iii) The dates of shipments and disposition (if shipped off site).

(8) A description of the results of any environmental radiological surveys performed outside the facility.

(9) Radiation Exposure - A summary of radiation exposures received during the reporting period by facility personnel and visitors.

6.9.2 Reportable Occurrences

Reportable occurrences, including causes, probable consequences, corrective actions and measures to prevent recurrence, shall be reported to the NRC. Supplemental reports may be required to fully describe final resolution of the occurrence. In case of corrected or supplemental reports, an amended licensee event report shall be completed and reference shall be made to the original report date.

a. Prompt Notification with Written Follow-up

The types of events listed below are considered reportable occurrences and shall be reported as expeditiously as possible by telephone and confirmed by overnight mail, mailgram, or facsimile transmission to the NRC Document Control Desk no later than the first working day following the event, with a written follow-up report within two weeks. Information provided shall contain narrative material to provide complete explanation of the circumstances surrounding the event.

- (1) Failure of the reactor protection system subject to limiting safety system settings to initiate the required protective function by the time a monitored parameter reached the set point specified as the limiting safety system setting in the technical specifications.
- (2) Operation of the reactor when any parameter or operation subject to a limiting condition is found to be less conservative than the limiting condition for operation established in the technical specifications, without evaluation and permitted remedial action.

- (3) Abnormal degradation discovered in a fission-product barrier.
- (4) Reactivity balance anomalies involving:
 - (i) Disagreement between expected and actual critical positions exceeding 0.3% $\Delta k/k$;
 - (ii) Exceeding excess reactivity limits;
 - (iii) Shutdown margin less conservative than specified in Technical Specifications.
- (5) Failure or malfunction of one (or more) component(s) which prevents, or could prevent, by itself, the fulfillment of the functional requirements of systems used to cope with accidents analyzed in Safety Analysis Report.
- (6) Personnel error or procedural inadequacy which prevents, or could prevent, by itself, the fulfillment of the functional requirements of systems required to cope with accidents analyzed in Safety Analysis Report.
- (7) Errors discovered in the transient or accident analyses or in the methods used for such analyses as described in the Safety Analysis Report or in the basis for the Technical Specifications that have permitted reactor operation in a manner less conservative than assumed in the analyses.
- (8) Performance of structures, systems, or components that requires remedial action or corrective measures to prevent operation in a manner less conservative than assumed in the accident analyses in the Safety Analyses Report or Technical Specification basis, or discovery during plant life of conditions not specifically considered in the Safety Analysis Report or Technical Specifications that require remedial action or corrective measures to prevent the existence or development of an unsafe condition.
- (9) Deployment of the thermal fuse.

6.9.3 Special Reports

Special reports which may be required by the NRC shall be submitted to the U.S. NRC Document Control Desk within the time period specified for each report. These reports include notification of changes in Level 1, 2, or 3 administration, as defined in ANSI/ANS-15.2 and shown in Figure 1, which shall be reported within 45 days of such a change.

6.10 Record Retention

6.10.1 Records to be retained for a period of at least five years:

- a. Operating logs or data which shall identify:
 - (1) Completion of pre-startup checkout, startup, power changes, and shutdown of the reactor.
 - (2) Installation or removal of fuel elements, control rods or experiments that could affect core reactivity.
 - (3) Installation or removal of jumpers, special tags or notices, or other temporary changes to reactor safety circuitry.
 - (4) Rod worth measurements and other reactivity measurements.
- b. Principal maintenance operations.
- c. Reportable occurrences.
- d. Surveillance activities required by technical specifications.
- e. Facility radiation and contamination surveys.
- f. Experiments performed with the reactor.

This requirements may be satisfied by the normal operations log book plus:

- (1) Records of radioactive material transferred from the facility as required by license.
 - (2) Records required by the RSC for the performance of new or special experiments.
- g. Records of training and qualification for members of the facility staff.
 - h. Changes to operating procedures.
- ### 6.10.2 Records to be retained for the life of the facility:
- a. Gaseous and liquid radioactive effluents released to the environs.
 - b. Appropriate off-site environmental monitoring surveys.
 - c. Fuel inventories and fuel transfers.
 - d. Radiation exposures for all personnel.
 - e. Updated as-built drawings of the facility.

- f. Records of transient or operational cycles for those components designed for a limited number of transients or cycles.
- g. Records of reviews performed for changes made to procedures or equipment or reviews of tests and experiments pursuant to 10 CFR 50.59.
- h. Records of meetings of the RSC.

**IDAHO STATE UNIVERSITY
RADIATION SAFETY POLICY MANUAL
Revision 3**

Prepared and issued under the auspices of
THE RADIATION SAFETY COMMITTEE

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Radiation Safety Officer



Chair, Radiation Safety Committee

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1.0 PURPOSE

This manual conveys the official policies of Idaho State University for the control of all sources of, and exposures to, ionizing radiation that are within the jurisdiction of the University. The manual defines responsibilities of individuals and organizations for radiation control, it specifies the policies that guide specific decisions on radiation control matters, and it provides general safety rules and procedures that are obligatory for all users of radiation sources. Requirements and procedures not included in this manual are developed, promulgated and enforced as necessary to implement the overall philosophy and policies for radiation protection as presented herein.

Federal and State regulations require a written radiation protection program, which includes provisions for keeping doses As Low As Reasonably Achievable (ALARA). All radiation users must be included in the program and must be informed of the program and of their individual responsibilities. This manual is intended to satisfy these regulatory requirements.

2.0 EMERGENCY PROCEDURES

2.1 Radiation Emergency

Any accident, injury or loss of control of a radiation source that could cause an excessive or uncontrolled radiation exposure to any individual is referred to as a radiation emergency. The proper response to any radiation emergency depends upon a thorough understanding of the magnitude of risks, priorities for action, and the application of common sense. Each user of radiation sources should be familiar with the basic emergency responses listed below and methods for applying them in his or her own work area.

2.2 Protect People

The first consideration in any emergency is to assist injured persons and to prevent any further injury. If the situation involves a radiation producing machine, the machine should be turned off to prevent unnecessary exposure to the injured individual or to individuals providing assistance. For medical assistance, dial 8-911 immediately and report the nature of the illness or injury. Inform the 911 dispatcher that the injured individual may be contaminated with radioactive material. If you are qualified to render first aid, do so without regard to the presence of radioactivity. **There are no radioactive sources at the University that produce radiation exposure risks large enough to prevent giving first aid!** Notify University Security, at 282-2515 of the situation. Security will provide assistance and will aid in directing emergency response personnel to the scene. Except for the usual precautions for moving an injured person, individuals

should immediately leave the room or area until the extent of the radiological hazard has been evaluated. However, all individuals should remain available in the vicinity until checked for contamination or exposure.

2.3 Get Help

Each individual using radiation sources should know in advance who to call in case of a radiation emergency. If fire, injury or other emergency conditions, in addition to radiation are involved, first call the appropriate numbers listed on page I of the Campus Directory. Then call the Radiation Safety Division of the Technical Safety Office: extension 2311 during normal office hours; extension 2514 or 2515 (Security) during off duty hours. When reporting any emergency, be sure to state the exact nature of the emergency; then give your name and the phone number from which you are calling, the exact location of the emergency (building, room, nearest entrance, etc.) and the name of the Responsible User, if known. **Do not hang up!** Let the person called end the conversation after all pertinent information is clearly understood.

2.4 Contain the Hazard

Any of the following actions appropriate to the situation should be performed provided they can be carried out safely:

1. Turn off radiation producing machines.
2. Cover containers of radioactive materials.
3. Place absorbent material on spilled liquids.
4. Close the sash on fume hoods, but do not turn off hood exhaust fans.
5. Close doors to the area and post signs or guards to prevent unauthorized entry.
6. Allow no one to leave the area without being checked for contamination.

2.5 Follow-up Action

Any necessary decontamination or repairs required after a radiation emergency shall be performed only under the direction of the Radiation Safety Officer (RSO). Reentry or re-occupancy must be authorized by the RSO. The RSO shall evaluate, record and report, as necessary, any radiation exposures to personnel, loss of radioactive material, or damage to radiation facilities resulting from the emergency. If required by the RSO, individuals involved in a radiation emergency shall submit specimens for bioassay, surrender personal clothing or other articles for decontamination or assay, and provide pertinent information.

The Vice President for Academic Affairs is the official spokesperson for the University on matters pertaining to radiation protection. Individuals involved in radiation emergencies should refrain from discussing the event with anyone other than University officials until after a complete evaluation has been made.

3.0 BASIS FOR RADIATION PROTECTION POLICY

Ionizing radiation is capable of producing biological effects that may be detrimental to human health. It is assumed that any radiation dose, no matter how small, could produce some risk of an effect. The purpose of a radiation safety program is to prevent unnecessary radiation exposures, and to control those that are necessary.

Each person who is exposed to radiation must be informed of the risks and of appropriate protection methods, and must accept personal responsibility for using the available protection.

3.1 Radiation-Induced Health Effects

Health effects from exposure to ionizing radiation may be stochastic (random in an exposed population) or non-stochastic (predictable for an individual).

3.1.1 Non-stochastic effects

Non-stochastic effects may be observed in an exposed individual when a very large radiation dose, exceeding a threshold value, is received, usually in a rather short time. A dose smaller than the threshold value will not produce the effect. Once the threshold dose for a particular effect is exceeded, the effect is almost sure to occur, but the severity of the effect is proportional to the dose.

3.1.2 Stochastic effects

Stochastic effects are those that occur randomly in an exposed population, usually after a long latent period. Since these effects cannot be distinguished from those that occur in an unexposed population, the cause-and-effect relationship cannot be established on an individual basis, but only on a statistical basis. For these effects it is assumed that there is no threshold dose and that the probability of occurrence is proportional to the dose. However, the severity of the effect, if it occurs, is independent of the dose.

3.2 Principles of Radiation Protection

Two basic principles apply to every individual that may be exposed to radiation:

1. all radiation doses are to be kept **As Low As Reasonably Achievable (ALARA)**

2. no dose to an individual shall exceed the appropriate individual dose limit.

The ALARA principle is applicable even when the potential dose is well below the individual dose limit because it is assumed that some risk may be associated with any dose of radiation, no matter how small. ALARA also means balancing the benefits of dose reduction against social needs and economic considerations.

Dose limits are intended to limit the individual's lifetime risk of stochastic effects from small chronic exposures as well as to prevent harmful non-stochastic effects from large doses. For individuals who are exposed to ionizing radiation as a direct result of their employment, individual dose limits are based on the philosophy that their total health risks should be no greater than the risks accepted by workers in comparable occupations or industries who are not exposed to radiation. For anyone who does not receive a direct benefit, e.g. a salary or educational benefit, related to their radiation exposure, the individual dose limits are much smaller than those for radiation users. These "non-occupational" limits are based on comparisons with the ordinary risks of living, rather than on risks due to employment.

3.3 Radiation Doses and Risks

Radiation dose limits are specified in units of millirem (mrem) or Sievert (Sv). One milliSievert (mSv) is equal to 100 mrem. The doses and related health risks produced by non-occupational radiation exposures may be helpful for understanding the risks from occupational doses. In the U.S., the annual average whole-body dose from cosmic rays and other natural sources is 100 mrem, the effective dose from radon in homes is 200 mrem, medical examinations contribute an average of 53 mrem and consumer products and other manmade sources deliver another 9 mrem, for a total of approximately 360 mrem per year.

The risk of fatal cancer from all causes, averaged over the entire U.S. population, is approximately 1 in 5, or 20%. It is recognized, however, that certain sub-groups, e.g. smokers or residents of large cities, have cancer risks that are above average while other groups have risks that are below the average. For most stochastic effects, a given dose of radiation is believed to increase the baseline risk for a population group by a constant fraction or proportion. According to a National Academy of Sciences report, a continuous dose rate of 400 mrem per year to the U.S. population can be estimated to contribute 12% to the baseline risk of fatal cancer. The majority of radiation users receive occupational doses of much less than 400 mrem per year. An additional dose of 400 mrem per year for 20 years can be calculated to increase the baseline risk by as much as 3%.

3.4 Individual Dose Limits

3.4.1 Nuclear Regulatory Commission Occupational Dose Limit (applies to radioactive materials users)

According to the Federal Regulations (10CFR20) the annual adult (persons 18 years of age or older) occupational dose limits are the more limiting of:

1. The total effective dose equivalent being equal to 5,000 mrem;
2. The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50,000 mrem.
3. An eye dose equivalent of 15,000 mrem, and
4. A shallow dose equivalent of 50,000 mrem to the skin or to each of the extremities.

3.4.2 Idaho Department of Health and Welfare Occupational Dose Limits (applies to radiation machines users)

In addition to the annual occupational dose limits, which are based on Federal Regulations, there are quarterly occupational dose limits based on Idaho State Regulations (IDAPA 16). These quarterly limits are:

1. Whole body; head and trunk; active blood-forming organs; lens of eye or gonads 1250 mrem/cal qtr
2. Hands and forearms; feet and ankles 18750 mrem/cal qtr
3. Skin of whole body 7500 mrem/cal qtr

3.4.3 General Public Dose Limits

The dose limit for members of the general public, including all persons who are not classified as radiation users, is a total effective dose equivalent not to exceed **100 mrem per year** exclusive of the dose contributions from background radiation, from any medical procedure and other situations specified in Federal Regulations.

3.4.4 Fetal Dose

The embryo-fetus may be more susceptible to radiation effects than an adult and is, therefore, subject to a lower dose limit. **The dose limit for the embryo-fetus is 500 mrem (5 mSv) during the entire gestation period.** As a further precaution, it is

advisable to keep the monthly doses below 50 mrem. This degree of protection for the embryo-fetus can only be achieved with the cooperation of the employee, who should notify her supervisor or the RSO as soon as the pregnancy is known.

3.4.5 Idaho State University Occupational Dose Limit

The annual adult occupational dose limit is the more limited of:

1. The total effective dose equivalent being equal to 1,000 mrem.
2. The sum of the deep-doses equivalent and the committed dose equivalent to any individual organ or tissue, other than the lens of the eye, being equal to 10,000 mrem.
3. An eye dose equivalent of 3,000 mrem, and
4. A shallow dose equivalent of 10,000 mrem to the skin or to each of the extremities.

3.4.6 Dose Limits for Minors

The dose limits for minors (persons under 18 years of age) are 10% of the adult occupational dose limits.

3.5 ALARA Policy

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)**, taking into account all social and economic considerations. The ALARA principle is a formal requirement of the U.S. Nuclear Regulatory Commission and the Idaho Department of Health and Welfare.

The ALARA principle is implemented by a comprehensive radiation protection program that includes specific requirements and procedures for:

1. training of all radiation users,
2. safety evaluations of proposed facilities or projects utilizing radiation in any way,
3. regular surveys of work areas for contamination and exposure rates,
4. monitoring of radiation exposures to groups and individuals,
5. investigations of all exposures that exceed predetermined levels, and
6. reviews of the program by the Radiation Safety Committee.

Each facility or program utilizing radiation machines or radioactive materials must be justified on its merits and must be specifically authorized by the Radiation Safety Committee. The review and evaluation by the Committee covers the training and experience of individuals authorized to use radiation sources, the adequacy of facilities and equipment, and procedures for the safe use of radiation sources.

Specific rules and procedures may be issued by the Radiation Safety Officer (RSO) in support of the ALARA concept as well as to assure compliance with all legal and regulatory requirements. The RSO and supporting staff provide training, consultation and other services to radiation users to assist them in controlling radiation sources and reducing exposures.

3.5.1 Idaho State University's ALARA Goals

The ALARA goals for Idaho State University are set by the Radiation Safety Committee (RSC). The RSC reviews the University's goal at least annually 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 Nuclear Regulatory Commission, good radiation protection practices, and when available, historical dose information for each active radiation program. The following goals have been set by the Radiation Safety Committee:

Radiation Technology Program:

1. The total effective dose equivalent being equal to 800 mrem/year;
2. The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue, other than the lens of the eye, being equal to 8,000 mrem/year.
3. An eye dose equivalent of 2,400 mrem/year, and
4. A shallow dose equivalent of 8,000 mrem/year to the skin or to each of the extremities.

All Other Radiation Safety Programs:

1. The total effective dose equivalent being equal to 100 mrem/year.
2. The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue, other than the lens of the eye, being equal to 1,000 mrem/year.
3. An eye dose equivalent of 300 mrem/year, and

4. A shallow dose equivalent of 1,000 mrem/year to the skin or to each of the extremities.

The Technical Safety Office (TSO) monitors all exposure records to ensure that the ALARA goals are appropriate for the particular activity. If an ALARA goal is exceeded, the TSO will perform an investigation. The TSO's investigation is intended to determine if the personnel are following good radiation protection practices and if the ALARA goals are appropriate for the particular activity. Appropriate action will be taken based upon the results of the TSO's investigation. In order to reach a good control on the individual exposures during a calendar year RSO may employ quarterly notification levels (four times lower than the above ALARA goals).

4.0 RESPONSIBILITIES

The possession and use of radioactive materials and other sources of ionizing radiation are governed by regulations of several Federal and State agencies, and by conditions of specific licenses issued to the University. The University permits the use of ionizing radiation sources for beneficial applications in teaching, research, and used in accordance with the policies, principles and rules contained in this manual. The protection of the health and welfare of each member of the faculty, staff, student body and general public is of primary importance; however, the financial, legal and societal obligations of the University are also considered in the implementation of practical radiation protection practices.

Rules and procedures promulgated for use within the University shall comply with the regulations and requirements of the Federal and State agencies that license and regulate radiation sources and uses. Technical assessments, evaluations and interpretations shall also be consistent with the guidance and recommendations of authoritative advisory bodies, such as the International Commission on Radiological Protection, the National Council on Radiation Protection and Measurements, the Committee on the Biological Effects of Ionizing Radiation of the National Academy of Sciences and the American National Standards Institute.

4.1 Executive Management

The Vice President for Academic Affairs is the Senior Management representative for radiation protection matters at ISU. The Vice President for Academic Affairs has appointed and empowered a Radiation Safety Committee (RSC) to act on the University's behalf to promulgate policies, rules, and procedures for the safe use of radiation sources/materials at the University. A Radiation Safety Officer (RSO) has been appointed by the Vice President for Academic Affairs and approved by the NRC, to assist the Committee in the performance of its duties. The RSC and RSO report directly to the Vice President for Academic Affairs for matters concerning the use of

radiation sources at ISU. An organization chart for radiation safety at ISU is given in Figure 4.1.

The Vice President for Academic Affairs meets with the Radiation Safety Committee Chairperson and the Radiation Safety Officer at least once per year to discuss the University's radiation safety program. In addition to the annual meetings with the RSC Chairperson and the RSO, the Vice President for Academic Affairs is a voting, ex-officio member of the RSC. The Vice President for Academic Affairs is expected to attend at least one meeting of the RSC per year. The Vice President for Academic Affairs also participates in periodic audits and reviews of the radiation safety program through annual briefings with the chairman of the RSC and the RSO. An alternate, executive management representative may be sent to the remaining meetings not attended by the Vice President for Academic Affairs.

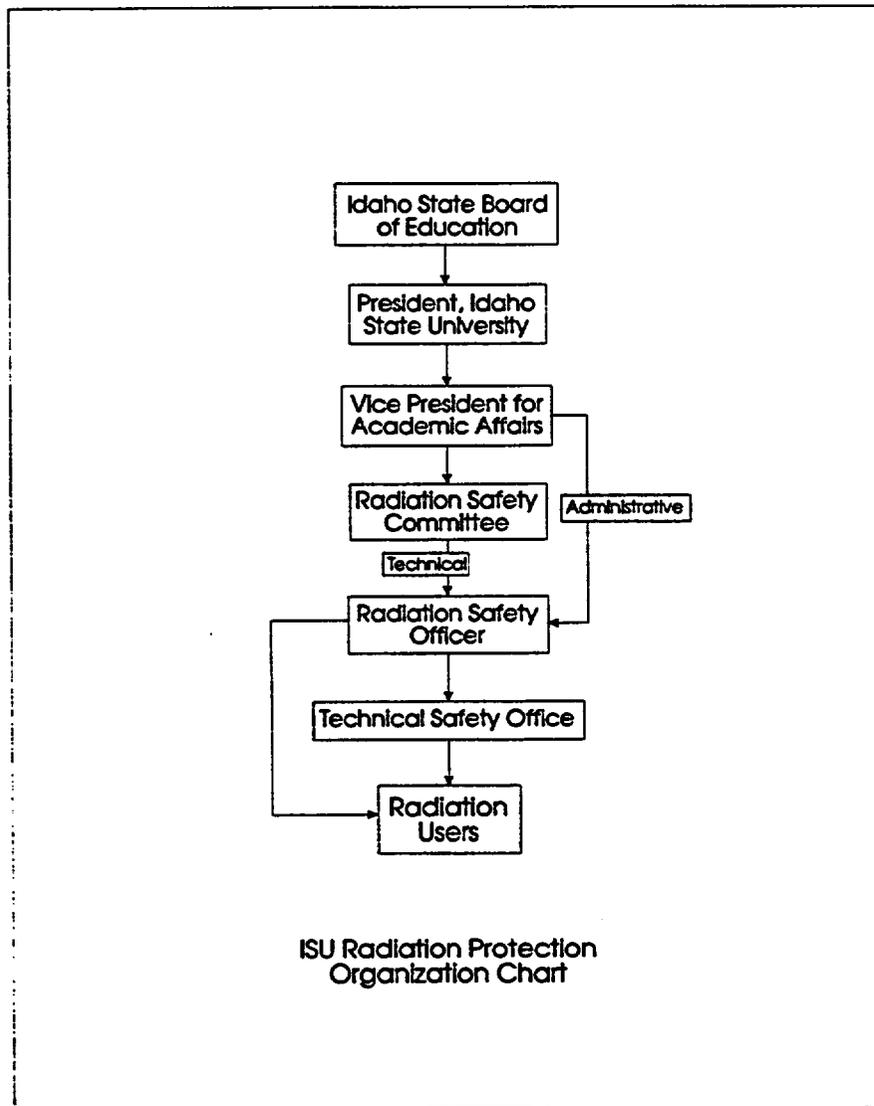


Figure 4.1 Organization chart for radiation safety at ISU

4.2 Radiation Safety Committee (RSC)

The Vice President for Academic Affairs has established a Radiation Safety Committee. The purpose of ISU's Radiation Safety Committee (RSC) is to set policy and to promulgate rules and procedures to ensure the safe use of radioactive sources at the University.

Members of the RSC are appointed from the major academic and research areas that use ionizing radiation at ISU. RSC members are appointed to the Committee by the Vice President for Academic Affairs for indefinite terms. Changes to RSC membership are recommended by the respective departments to the Vice-President for Academic Affairs. Any change of the RSO or of the RSC chairperson must be approved by the NRC. Other changes are at the discretion of the Vice-President for Academic Affairs.

The RSC meets as often as is necessary to conduct business but not less than once per calendar quarter. Minutes are kept and maintained by the Radiation Safety Division Staff for each RSC meeting. Approved minutes are held on file in the TSO.

A quorum of the RSC consists of at least one-half of the voting RSC membership, which must include the Committee chairperson and the RSO. The current voting RSC membership is as follows: Vice President for Academic Affairs, Radiation Safety Officer, and ISU faculty from the following departments (one member from each area unless stated otherwise): Biology Department (2 members), Geology Department, Physics Department (2 members), College of Pharmacy, College of Engineering, School of Applied Technology, Radiographic Science Department, School of Dental Hygiene, and ISU Purchasing Department (non-voting member unless functioning as Executive Management Representative in absence of the Vice President for Academic Affairs).

The RSC conducts audits of and discusses issues pertaining to the radiation safety program. Reviewing personnel dosimetry data, survey results, significant events, ALARA, responsible user compliance, etc. are activities performed and discussed by the RSC. The findings of audits (and the associated audit responses) by the RSC are maintained on file in the TSO.

The RSC evaluates new responsible users, new uses of licensed material, and new laboratories. Evaluation by the Radiation Safety Committee (RSC) consists of the following:

1. Evaluation of the training of new responsible users and individuals working under the supervision of the responsible user to ensure that it meets ISU license requirements.
2. Review of the Responsible User's request to ensure that proper handling procedures will be used when working with radionuclides.

3. Review of the responsible user's laboratory for adequacy for the radionuclide(s) to be used. At a minimum, the following will be verified.
 - a. Appropriateness of laboratory classification and available equipment and facilities,
 - b. User's proposed procedures are appropriate for the task,
 - c. Survey instruments are appropriate for the radionuclide used,
 - d. Method for inventory control of the radionuclide is adequate,
 - e. Signs and labels are posted as required.

The RSC publishes its policies and rules for radiation use in the "Idaho State University Radiation Safety Policy Manual". The Policy Manual is divided into a policy section containing the University's guidelines for the use of radioactive materials and a procedure section. The policy Manual is reviewed annually by the RSC to ensure compliance with applicable rules and regulations concerning licensed material.

The RSC currently reviews ministerial changes to the following aspects of the radiation safety program that can be made without amending the license: (1) changes dictated by NRC rule changes, (2) changes in contractors for bioassay, waste disposal, dosimetry services, radiation survey instrumentation, and other equipment required to administer the broad scope license, (3) internal management form changes, (4) references to particular equipment, and (5) administrative changes to the radiation safety program such as: ALARA goals, forms, telephone numbers, and procedures not specifically made a part of the license application.

4.3 Radiation Safety Officer (RSO)

The RSO is the individual appointed and empowered by the Vice-President for Academic Affairs (VPAA) and approved by the Nuclear Regulatory Commission 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 Radiation Safety Committee. The RSO works in conjunction with the RSC and reports directly to the Vice-President for Academic Affairs. The RSO is also the Director of the University's TSO which includes the Radiation Safety Office Staff (RSOS).

The RSO is responsible for the proper performance of the following activities:

- Surveillance of overall activities involving radioactive sources, including routine monitoring and special surveys of areas in which radioactive sources are used.
- Compliance with rules and regulations, license conditions, and the conditions of project approvals specified by the Radiation Safety Committee.

- Monitoring and maintaining any special mechanisms associated with the use, storage, or disposal of radioactive materials.
- Furnishing consulting services to University personnel on radiation protection.
- Ordering, receiving, opening, and delivering shipments of radioactive material arriving at the University to authorized University personnel and packaging and shipping radioactive materials pursuant to the operation of the University's Type A Broad-Scope nuclear materials license.
- Distributing and processing personnel monitoring dosimeters, determining the need for and evaluation of bioassays, monitoring personnel exposure and bioassay records and 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 radioactive material before use, at periodic intervals conducting refresher training, and as required by changes in procedures, regulations, and equipment, etc.
- Supervising and coordinating the radioactive waste disposal program, including maintenance of waste storage and disposal records.
- Storing radioactive materials not in current use, including radioactive wastes.
- Performing or arranging for required leak tests on sealed sources and calibration of radiation survey instruments.
- Maintaining an inventory of radionuclides at the University and limiting the quantity of radionuclides at the University to the amounts authorized by the license.
- Immediately terminating any activity that is a threat to health or property.
- Decontamination and recovery operations.
- Records, e.g., receipt, transfer, and survey records as required by 10 CFR, Part 30.51.
- Serving as a voting member of the RSC.

The term "RSO" is also used to mean any individual designated by the RSO to perform certain functions on behalf of, and under the supervision of, the RSO.

4.4 Radiation Safety Office Staff (RSOS)

The RSO is assisted in the operation and maintenance of the Broad-Scope license by the Radiation Safety Division of the TSO.

The Radiation Safety Division is the organizational entity that provides the administrative and technical services in support of the radiation protection program. The Director of the Technical Safety Office, who is normally also the RSO, reports to the Vice President for Academic Affairs.

4.5 Responsible User

A "responsible user" is an individual authorized by the Radiation Safety Committee to acquire and use specific radiation sources, and to supervise such use by others. An individual is designated to serve as a responsible user only after:

1. providing to the RSC a detailed plan for the proposed use of radiation sources including secure storage, safe handling, control of exposures and appropriate waste disposal methods and updating such information by means of periodic revisions or renewals of the authorization request as required by the Committee;
2. demonstrating to the satisfaction of the RSO and the RSC that he or she has had sufficient training and experience in the safe use of radiation sources;
3. acknowledging and accepting in writing the responsibility for:
 - a. instruction in radiation protection practices for all personnel working with radiation sources and/or within facilities for which he or she is responsible;
 - b. acquisition of equipment, supplies and services necessary for the safe use of radiation sources;
 - c. security against misuse or theft of radiation sources;
 - d. maintaining accurate inventory records for all radionuclides, including acquisitions, uses, transfers, disposals and decay;
 - e. performing regular bioassays, exposure and/or contamination surveys and records as appropriate to the nature of the radiation use and as specified by the RSO;
 - f. notification of the RSO of any accident, injury or abnormal incident related to radiation sources; and
 - g. arranging for authorization of another individual (alternate responsible user) to assume the preceding responsibilities, or to suspend or terminate all radiation uses, prior to any extended absence.

4.6 Radiation Users and Potentially Exposed Personnel

A *radiation user* is any individual whose official duties or authorized activities include handling, operating, or working in the presence of, any type of radiation source, whether or not such use is confined to a restricted area. Radiation user includes all the *badged personnel* as well as the *minimally exposed personnel*.

Badged personnel are individuals who could receive more than one tenth (10%) of the ISU occupational radiation dose limit. This category includes those personnel who rarely receive more than 100 mrem/year, but who work with radiation sources that could produce a significant dose accidentally. Radiation doses to these individuals are individually monitored.

Minimally exposed personnel are individuals who are unlikely to receive one-tenth (10%) of the ISU occupational radiation dose limit. This category includes individuals who routinely handle only small quantities of radioactive materials (e.g. students that use small, non-dispersible radiation sources as part of a scheduled laboratory course under the supervision of an instructor).

Potentially exposed personnel are individuals who have a need to enter the Controlled or even the Restricted Areas as part of their job description or have a potential of exposure to a radiation source but do not normally work in the presence of a radiation field. This category includes janitorial, receiving and security personnel. The potentially exposed personnel should not enter in a High Radiation Area. A potentially exposed individual is very unlikely to receive one-tenth (10%) of the ISU occupational radiation dose limit.

Each Radiation User must understand and follow the general rules and procedures for working safely with radiation sources as presented in this manual. Each radiation user must participate in radiation safety training as specified by the RSO.

As a condition of employment, each radiation user for whom personal monitoring is required must provide certain personal information to the RSO. The required information includes (1) primary identification data, e.g. full name, birth date, sex, address and social security number; (2) previous training and experience with radiation sources; and (3) current employment status, including job title or description, department, supervisor, and work location.

Personal records of radiation users also contain the scores obtained on tests taken to demonstrate knowledge of radiation safety procedures, data obtained from monitoring of external and internal radiation exposures, and reports on any injuries or abnormal incidents related to the use of radiation sources. Individual radiation user 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 or her personal radiation user file at any time, and will be provided a summary of their radiation history annually, and upon termination of employment.

Any radiation user may communicate directly, in confidence and without prejudice, with the RSO, any member of the Radiation Safety Committee or Radiation Safety Division, the Idaho Department of Health and Welfare or the U.S. Nuclear Regulatory Commission on any matter concerning radiation protection.

5.0 RADIATION SAFETY TRAINING

Each individual working with or in the presence of radioactive materials or other radiation sources is required to receive training or provide documentation showing they have received training in the applicable provisions of regulations and license conditions, in the potential health problems associated with exposure to radiation, in the precautions and procedures required for safe use of radiation, and in the proper use of protective and measurement devices. The extent of the training is to be commensurated with the potential risk of radiation exposure to the individual. Responsible users shall have their prior training evaluated by the RSO or RSOS or shall be trained by the RSOS. Responsible users shall ensure that subordinate employees or students working in their facilities are trained. This may be accomplished by requiring them to attend the training offered by the RSO or RSOS and supplementing this training with laboratory-specific and hands on training. Responsible users who elect to do their own training shall submit a statement to the RSO listing the individuals trained and the topics covered.

"Radiation users" are required to have more extensive training than are *"potentially exposed"* personnel.

ISU-general training for radiation users includes:

- Safe handling of radioactive materials.
- Characteristics of ionizing radiation.
- Units of radiation dose and quantities.
- Radiation detection instrumentation.
- Risks of exposure to ionizing radiation.
- Mathematics pertaining to the use and measurement of radioactivity.
- Individual dose limits including special limits for declared pregnant workers.
- Classification of facilities and posting.
- The ALARA principle.
- External exposure limitation (time/distance/shielding)
- Internal exposure limitation (contamination control/bioassay)

ISU-specific training for radiation users includes:

- ISU broad scope license conditions.
- ISU radiation protection organization.
- ISU Radiation Safety Manual.
- Areas where radionuclides are used at ISU.
- The obligation to report unsafe conditions to the Radiation Safety Officer and/or applicable authorities.
- Operating and emergency procedures.

- Workers right to be informed of occupational radiation exposure and bioassay results.
- A hands-on simulation that reinforces selected topics covered above, as they pertain to the specific radionuclide used by the individual.

Radiation users will be given documented 10 CFR Part 19.12 instruction and documented instruction on local requirements by the RSOS or RSO, and on-the-job training by responsible users.

Regulatory Guide 8.29 will be used as a guide to provide information on risks from occupational radiation exposure.

Successful completion of a written examination is required for both responsible users and radiation users upon the completion of their respective training as outlined above. Satisfactory performance is defined as a score of 70% or greater. Any potential radiation user that fails to pass the radiation safety exam will be retrained and a new test will be administered to the individual.

The "*minimally exposed personnel*" (e.g. students who use small, non-dispersible radiation sources shall receive appropriate training by the laboratory instructor provided:

1. The use of the source is a part of a scheduled laboratory course under the supervision of an instructor who is either a qualified "Responsible User" or designated by the Responsible User for use of the source, AND;
2. The student will not receive more than 10% of the public dose limit of 100 mrem from the use of the source.

A lesson plan or outline and attendance records for the class period during which the radiation safety training was given will constitute the training record.

Annual refresher training will be given to responsible users and to radiation users. This training will consist of new local and NRC requirements, any problems over the last year, status of ISU radiological safety, discussion of interpretation of exposure reports, and a brief overview of radiation safety basics.

The "*potentially exposed personnel*" (including janitorial, shipping and receiving, and security personnel) will be provided with annual training by RSOS. This will include training on:

- The health risks associated with exposure to radiation or radioactive materials.
- Procedures to maintain exposure As Low As Reasonably Achievable (ALARA).
- Purposes and functions of warning signs and protective devices employed at ISU to reduce exposure to radiation or radioactive materials.

- Observation of Nuclear Regulatory Commission regulations for the protection of personnel from exposure to radiation or radioactive materials (NRC Form 3 material).
- Areas where radionuclides are used at ISU.
- The obligation to report unsafe conditions to the Radiation Safety Officer and/or applicable authorities.
- Emergency procedures.
- Workers right to be informed of occupational radiation exposure and bioassay results.

Completion of training will be documented as follows:

- 1) For responsible users and radiation users, the test cover sheet will be kept in the individual's personal file located in the TSO. This cover sheet includes the name and department of the person, test score, and a signature for review of the test with RSOS.
- 2) For potentially exposed personnel (including janitorial, shipping and receiving, and security personnel) documentation of training will be on a "Radiation Safety Training Attendance Record." This will include the name and workplace of the person. The "Radiation Safety Training Attendance Records" will be filed in the TSO.

6.0 CONTROL AND MONITORING OF EXPOSURES TO EXTERNAL RADIATION SOURCES

Sources that emit penetrating radiations (gamma and x rays, energetic beta particles, neutrons, etc.) can cause radiation exposures from outside the body. These external exposures must be controlled by appropriate shielding and by limiting the time spent in close proximity to the source. Radiation generating machines and radioactive materials shall be controlled by responsible users to prevent unauthorized use.

6.1 Radiation Machines

X-ray machines and particle accelerators shall be surveyed to verify adequacy of shielding, alarms, interlocks, and other safety-related apparatus or equipment. During the survey, the potential exposure rates to operators are evaluated to assure that they are ALARA and that operators are monitored appropriately.

Even a little shielding is effective against the low-energy radiation scattered from the patient. If an individual must stay near the patient, a lead apron should be worn.

6.2 Radioactive Materials

The intensity of radiation exposure decreases rapidly with distance from the source. Radionuclide sources that emit penetrating radiations should be stored away from regular work areas; they should be handled, when necessary, with tongs or forceps to eliminate direct contact and to increase the distance from the source.

Radionuclide sources that emit penetrating radiations should be stored and handled within appropriate shielding whenever physically possible. For gamma and x rays, high-density materials, e.g. lead, provide the most effective shielding. For energetic beta-particle emitters, e.g. P-32, low-atomic-number materials, e.g. plastics, should be used as the primary shielding to minimize bremsstrahlung production. Radioactive materials should be stored in designated containers and locations when not in actual use.

6.3 Exposure Evaluation and Monitoring

External exposures are detectable with portable instruments and personal monitoring devices (dosimeters). Radioisotope work and storage areas should be surveyed for external exposure rates whenever changes are made in the quantities, locations or shielding of radiation sources. The results of such surveys must be provided to all individuals working in the area to help them to control their own exposures.

Potential radiation exposures from any source, or within any facility, are evaluated by the RSO to determine protection and monitoring requirements. In some cases, exposures are evaluated for groups of individuals engaged in similar activities and exposed to comparable sources. In other situations, monitoring of individual exposures may be necessary.

6.4 Personal Dosimeters (Badges)

ISU uses a NVLAP accredited dosimetry service for external radiation monitoring. Dosimeters are exchanged on a quarterly basis and exposure results are reviewed during the quarterly RSC meetings to ensure proper oversight of the University's ALARA program. ISU uses two types of whole body dosimeters that measure: (1) photons, electrons, and neutrons and (2) photons and electrons. ISU uses one type of dosimeter to measure dose to extremities. ISU currently uses TLD 760 for the type one whole body dosimeter and TLD 100 for the type 2 whole body dosimeter. The type 1 dosimeters provide shallow, lens of eye and deep (photon and neutron separately) dose equivalents. The type 2 dosimeters provide shallow, lens of eye, and deep dose equivalents. The extremity dosimeter provides local shallow dose equivalent.

A radiation dosimeter does not provide protection; it merely verifies, after the fact, the adequacy of the radiation control program. Also, radiation dosimetry data are not, of

themselves, appropriate to determine risk to any individual; however, they can sometimes help an individual to develop safe work habits.

The primary purposes for performing individual monitoring are:

1. to monitor the individual's radiation environment and to evaluate the adequacy of the radiation control program and ALARA policy,
2. to promote safe radiation working habits by individuals,
3. to document radiation accidents,
4. to satisfy medical and legal requirements as are necessary to protect the employee and the employer, and
5. to comply with pertinent federal, state and local regulations.

All radiation users who are classified as badged personnel by the Technical Safety Office are required to wear one or more personal dosimeters. Users subject to general whole-body exposures are issued "body badges", which are to be worn on the front of the torso at all times while working with radiation sources, or on the collar if a lead apron is worn. Pregnant females subject to significant radiation exposures may be issued a second badge to be worn on the front of the abdomen under the lead apron. The purpose of the second badge is to monitor the potential dose to the embryo-fetus in the event of pregnancy. In order to declare herself pregnant, a female radiation worker must notify the RSO in writing. The TSO will work with the employee's supervisor to ensure that the dose to a declared pregnant woman will be maintained within 500 mrem for the gestation period (10 CFR 20.1208).

Extremity dosimeters (finger or ring badges) are required when significant quantities of radioisotopes that emit penetrating radiation must be directly handled routinely, or when the hands or fingers could be accidentally exposed to a high intensity source such as an x-ray diffraction unit.

When not being worn, dosimeters must be stored away from heat and radiation sources but they should not be taken home or worn away from work. All dosimeters must be returned promptly at the end of the monitoring period.

7.0 CONTROL AND MONITORING OF INTAKE OF RADIOISOTOPES

In research facilities, application of the ALARA principle dictates that no removable contamination shall be tolerated indefinitely. Whenever contamination is detected, it must be removed promptly to prevent its spread and the possible exposure of other

individuals. Refer to "CONTAMINATION LIMITS AND ACTION LEVELS" (RPR 10) for specific limits required responses.

Each person who works with unsealed or dispersal radioactive materials is responsible for:

1. knowing the basic properties of the radioactive materials to be used, e.g. the half-life of the nuclide(s), the type(s) of radiation emitted, the annual limit on intake (ALI) and any shielding that may be required.
2. being aware of actual or potential radiation exposures and keeping all exposures to levels that are As Low As Reasonably Achievable (ALARA).
3. following safe work practices and the instructions or procedures provided by the responsible user and the RSO.
4. the control and containment of radioactivity and for performing regular surveys of personnel, personal effects, equipment and work areas using methods that will assure the detection of contamination before significant exposures occur.
5. providing a urine sample, obtaining a thyroid count, or wearing a personal dosimeter as specified by the RSO.
6. recording the results of all radiation surveys and screening bioassays promptly, completely and accurately.

The responsible user must assure that the necessary monitoring is performed, recorded and reported. Routine evaluations of all radioisotope laboratories, including surveys for contamination, are also performed by the RSO.

7.1 Handling Precautions

Ingestion was adopted as the most probable pathway for internal exposure at ISU research laboratories. Thus, ingestion of radioactivity must be prevented by avoiding mouth contact with any items handled in a radioisotope laboratory (pipettes, pencils, etc.), by prohibiting eating, drinking, smoking, and chewing in radioisotope handling areas and by careful attention to personal hygiene. Gloves and other protective apparel should be used to prevent contamination of skin and personal clothing.

7.2 Contamination Surveys

ISU has an established plan for survey frequencies based upon ALIs. In this plan surveys performed by the users and those performed by the TSO are distinguished. The plan also includes a frequency for sealed source only users. The survey frequency plan is given in Table 7.2.

Table 7.2 Contamination survey frequencies

Laboratory Classification	TSO-performed surveys	Users Personal surveys	Users Laboratory surveys
<1 ALI	Semi-annually	Daily when radionuclides are in use.	Monthly when radionuclides are in use
1-30 ALIs	Quarterly	Daily when radionuclides are in use.	Weekly when radionuclides are in use.
>30 ALIs	Monthly	Daily when radionuclides are in use.	Daily when radionuclides are in use.
Sealed sources only	Semi-annually (leak tests)	N/A	N/A

External radiation surveys of restricted areas will be performed where gamma or neutron producing radionuclides and sources are used that are greater than 10 times the quantities listed in appendix C of §20.1001-20.2401 of 10 CFR, Part 20. External radiation surveys will also be performed by the TSO in accordance with the frequency in Table 8.3 or whenever unusual conditions or large changes in radiation levels are expected. Examples of these are new source acquisitions or new experimental configurations. Unrestricted areas adjacent to restricted areas will also be surveyed.

Surveys for contamination on the hands and clothing must be performed immediately after working with significant quantities of radioisotopes to assure detection and removal before any radioactive material enters the body. Any radioactive material on the skin must be removed promptly by normal washing. If it cannot be removed easily, the RSO should be contacted to assist with decontamination. Follow the instructions in "RADIOISOTOPE LABORATORY SAFETY PROCEDURES" (RPR 11) for performing and reporting contamination surveys.

7.3 Airborne Activity

Airborne activity will be measured in laboratories where the airborne radioactive material exists in concentrations exceeding the derived air concentrations (DACs) or in which any individual could be exposed to more than 0.5% of the ALI in one calendar week. Because the levels of dispersible radionuclide used at ISU are relatively small, ISU does not currently monitor routinely for airborne radionuclides. There may arise a situation, such as during a large spill of dispersible radioactive material when sampling for airborne radionuclides will be required.

Inhalation of radioactive materials must be prevented by performing all operations that release or generate gases, vapors or dusts in fume hoods. In emergency situations, filtered or supplied-air respirators may be required to prevent inhalation of contaminants. Whenever the probability of airborne contamination is significant, the RSO should be notified and air sampling may be required.

7.4 Bioassays

Although the emphasis of radiation protection is primarily on prevention of exposures, measurement and evaluation of exposures is also necessary. Bioassay is the determination of the kind and amount (and possibly the location) of radioactive material in the human body by direct (*in vivo*) measurement or by analysis *in vitro* of materials excreted or removed from the body. Bioassay is an important tool for evaluating actual or suspected internal contamination with radioactive materials.

Bioassay measurements used for demonstrating compliance with the occupational dose limits will be conducted often enough to identify and quantify potential exposures and resultant intakes that, during any year, are likely to collectively exceed 0.1 times the ALI. A system of levels (defined as ALI fractions) and assays are employed to estimate the intakes. Routine measurements are conducted to confirm that appropriate controls exist and to assess doses to radioactive material users (if intakes occur). Routine measurements include: baseline measurements, periodic measurement and termination measurements.

The "BIOASSAYS FOR INTERNAL EXPOSURE" procedure (RPR 12) specifies conditions, frequencies and methods for performing bioassays for all internally potential exposed personnel. Any radiation user who handles a cumulative quantity of radioactive materials in dispersible form of more than 1 ALI per month, averaged over the bioassay interval, is considered to be potentially exposed to an annual intake of more than 0.1 ALI and must perform or obtain bioassays routinely. For an occupationally exposed minor or declared pregnant woman the above values are considered to be ten times lower (0.1 ALI per month - the handled activity and 0.01 ALI the potential annually intake).

Individuals who handle dispersible radioiodine compounds may be required to obtain in vivo measurements, arranged by the Technical Safety Office, of radioiodine in the thyroid. Individuals who handle other radioisotopes in dispersible form may be required to perform assays of radioactivity in urine on a routine basis to verify the absence of radioactivity in the body or to determine the magnitude of any exposure. Other types of assays may be utilized if, in the judgement of the RSO, such assays will meet the intent of this policy more effectively.

A bioassay is required whenever personal contamination or injury caused by a contaminated object occurs, or if airborne radioactivity may have been inhaled. Routine bioassays, at intervals determined by the nuclides used, are required from each user who handles more than minimal quantities (RPR 12) of soluble radionuclides. A routine bioassay may be waived when appropriate surveys for contamination, conducted during and after each use of radioactive material according to recommended procedures, demonstrate that there was essentially no exposure to unconfined, dispersible radioactive material.

8.0 LABORATORY CLASSIFICATION, EVALUATION, SURVEY AND AUDIT

8.1 Description of the laboratories

The licensed material programs currently operating at ISU include sealed source programs, nuclear gauge programs, and dispersible radionuclide research laboratories. These programs are located in several buildings on the ISU Pocatello and Idaho Falls Campuses. Additionally, ISU temporarily stores waste in a basement room of the Physical Sciences Building (Building 3) and at an on-campus waste storage facility at 1540 South Seventh Avenue (Building 16).

ISU has several, small-use laboratories, using less than 10 mCi of dispersible radionuclides at any one time. These are located in the Gale Life Sciences, Pharmacy (Leonard Hall) and the Physical Sciences buildings. The laboratories consist of locking rooms where the radionuclides are used primarily on controlled area bench tops or in hoods. ISU also has several laboratories using less than 10 mCi of I-125 and I-131 in the Biological Sciences and Pharmacy buildings, primarily in hoods. Sealed sources are used at several locations on the Pocatello campus, the ISU Research Park and the Idaho Falls facilities. Tritium accelerator targets are used in the basement of the Physical Sciences Building.

Portable gauges are used on the ISU campus and at temporary job sites throughout the state of Idaho. These portable gauges are used at temporary job sites within states that are subject to NRC's regulatory authority. ISU will package and transport portable gauges in accordance with subpart E of 49 CFR Part 172 and subpart I of 49 CFR Part 173.

ISU maintains portable gauges in locked storage on the ISU Pocatello Campus and/or the Experimental Field Station at the Idaho National Engineering and Environmental Laboratory when not in use. At other times these portable gauges are under direct surveillance of a Responsible User.

ISU has animal care facilities located in the basement of the Biological Sciences building. The animal care facilities have positive controls, restricted access, separate rooms, isolation facilities and bio-containment cages. At present, the facilities are not being used for radioactively contaminated animals.

New facilities and equipment for licensed material use at ISU are evaluated by the RSO and approved by the RSC prior to commissioning. The criteria used to determine the acceptability of a proposed facility for radioactive materials depends on the classification of the proposed use of the facility. New facilities at ISU must successfully satisfy the requirements associated with the specific classification scheme(s) for the use of a facility as a dispersible, sealed-source only, or a combination of dispersible and sealed source facility. Facilities that classify as combination facilities must satisfy the requirements associated with both dispersible and sealed source classification schemes.

8.2 Laboratory Classification Scheme

ISU currently classifies facilities (laboratories) as "sealed sources only" or whether they use dispersible radionuclides. Laboratories that use dispersible radionuclides are further sub-classified according to the average amount of material that they have in stock over a one month period expressed in multiples of the most restrictive annual limit of intake, ALI (ingestion or inhalation). The number of ALIs is calculated by dividing the average amount of a dispersible radionuclide stored and used in a lab over the month by the ALI for that nuclide. This classification scheme is used to guide the frequency of surveys by the users and the TSO and to determine the need for routine bioassay (see Table 8.2).

Table 8.2 Example of how the ALI system of laboratory classification can be used to guide laboratory contamination surveys and bioassay.

Laboratory Classification	TSO performed contamination surveys	User's Personal contamination surveys	User's Laboratory contamination surveys	Bioassay required?
<1 ALI	Semi-annually	Daily when radionuclides are in use	Monthly when radionuclides are in use	No
1-30 ALIs	Quarterly	Daily when radionuclides are in use	Weekly when radionuclides are in use	Yes
>30 ALIs	Monthly	Daily when radionuclides are in use	Daily when radionuclides are in use	Yes

The scheme in Table 8.2 is employed for classifying laboratories and identifying the minimum requirements and desirable considerations for equipment and facilities.

8.3 Laboratory Evaluation and Survey

The RSO shall ensure that all areas where radiation sources of any kind are stored or used are evaluated at appropriate intervals with respect to potential radiological exposures and risks, and that appropriate exposure control and monitoring measures are used. Radiation surveys shall be performed, when necessary, by technically qualified personnel using instruments appropriate to the nature of the radioactive materials to be detected or radiation exposures to be measured. A pre-start evaluation is required before radioisotopes may be initially introduced into a laboratory, or before a radiation-generating machine may be installed.

A routine evaluation may consist of only a survey for contamination or it may be a complete audit of all radiation protection devices, procedures and records. A special evaluation may be required as a result of an accident or unusual incident. When use of a room or facility for radiation work is terminated, a close-out evaluation is required to assure that all conditions for an unrestricted area are met, with particular emphasis on removable contamination. In addition to surveys conducted by responsible users, laboratory evaluations shall be performed by Technical Safety Office personnel using instruments appropriate to the nature of the radioactive materials to be detected or radiation exposures to be measured.

For radioisotope laboratories, i.e. those where dispersible radioisotopes are used, the frequency of routine evaluations by the RSO or designee is based on the total number of ALI's present in the designee's laboratory. The routine evaluation frequencies for various average monthly inventories are shown in the table 8.3.

Table 8.3 Frequency of Laboratory Audits and Evaluations Performed by the TSO

Laboratory Classification	Routine audits including radiation/contamination surveys	Routine evaluation Radiation/contamination surveys
<1 ALI	Semi-annually	Semi-annually
1-30 ALIs	Semi-annually	Quarterly
30-300 ALIs	Quarterly	Monthly
> 300 ALIs	Monthly	Weekly
Sealed sources only	Semi-annually	Semi-annually

If no work with radioisotopes is being done, and all radionuclides are stored in a locked location conspicuously labeled with a sign that requires notification of the RSO prior to any further use of radionuclides, the laboratory may be considered to be inactive and need be inspected only annually.

The nominal survey frequencies given in the table 8.3 are to be interpreted as guidelines. In cases where continuing contamination problems are found, the interval between surveys will be shortened. If survey results obtained over a period of a year indicate no contamination or exposure problems, the routine survey interval may be increased. In no case, however, will the interval be more than double the nominal interval. To assure a realistic and independent evaluation of typical conditions, the schedule for surveys may be varied randomly.

8.4 Management and RSC Audits

The ISU Radiation Safety Program will be formally audited annually by the RSO and by the chairman and/or members of the RSC acting on behalf of management. The model audit program outlined in Appendix M of NUREG 1556, Volume 11, "Program-Specific Guidance About Licenses of Broad Scope" will be used as a guide for management audits. The RSO and the Chair of the RSC will brief executive management on the compliance status of the ISU radiation safety program, new NRC regulations, audits, and license provisions at least annually. Copies of these audits and management briefings will be kept on file in the TSO.

9.0 INSTRUMENTS (SURVEY/MONITORING EQUIPMENT)

Contamination and exposure rate instruments will be approved by the RSO prior to use in radioactive material facilities at ISU. The ISU program has a full complement of

commercially manufactured instruments suitable for performing surveys for alpha, beta, photon and neutron radiation.

Radiation and Contamination survey instruments will be calibrated on an annual basis, after maintenance has been performed (excluding maintenance which does not effect the accuracy of the instrument, i.e. battery replacement, glass meter face replacement), and upon receipt if the manufacturer has not performed a calibration. The calibration of radiation detection equipment used for radiation safety at ISU is performed by the RSOS under the direction of the RSO. 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 various nuclides, as well as for linearity of response. The detection efficiency will be recorded on the instrument probe.

10.0 SEALED SOURCE LEAK TESTS

Sealed sources of radioactive material shall be tested for leakage at regular intervals to verify the integrity of the source containment and, in the unlikely event of failure, to detect the escape of radioactive material before serious contamination of facilities, equipment or personnel occurs. Source leak checks will be performed as follows; β, γ sources $>100 \mu\text{Ci}$ will leak tested every six months, α sources $>10 \mu\text{Ci}$ will leak tested every three months. The maximum acceptable leakage will be $0.005 \mu\text{Ci}$. Leak tests are to be performed using procedures approved by the Radiation Safety Officer. Records of sealed source leak tests are maintained by the Radiation Safety Division of the TSO.

11.0 MATERIAL RECEIPT AND ACCOUNTABILITY

Acquisitions of radioactive materials including those materials that are obtained from other ISU licensed programs (e.g. the reactor program) must be initiated on a "Radioactive Material Purchase Permit" and submitted to the TSO. If the order is for an authorized radionuclide and quantity, it will be processed promptly. If the user is not authorized to possess the radionuclide type or quantity ordered, the request will be held by the TSO until proper authorization is obtained. The requisition shall contain the name of the responsible user and an accurate description of the radioactive material, including the radionuclide and the total activity, e.g. milliCuries, not just a catalog number.

A serialized, multi-part form is used by the TSO for tracking radioactive material from the time it arrives at the University until it is transferred or disposed of as radioactive waste. For radioactive materials acquired from external sources or from the ISU reactor program, the forms for reporting the contamination survey of a package, verification of its contents, and for reporting the disposition of the material will be initiated by the TSO.

In accordance with 10 CFR, Part 20.1906.c, a radioactive material package shall be surveyed by the TSO no later than three hours after receipt at the ISU campus. Any discrepancies in the package contents are to be noted on the form. The survey data and verification of the package contents are to be retained by the TSO in the "Isotope Inventory Book."

When radioactive material is received, the TSO will initiate the record by entering the identification of the user, the material, and the results of the external survey of the package on forms RPR 13A, B, and C. Form RPR 13A, when completed, will be placed in section 1 of the "Radioactive Waste Log." RPR 13B will be placed in the "Radioactive Material Inventory Book." Form RPR 13C, which contains the same serial number and identification data as 13A and 13B, is forwarded with the package to the responsible user.

When the radioactive material is returned to the TSO as radioactive waste, forms RPR 13A, 13B, and 13C are joined together and placed in the appropriate section of the "Radioactive Waste Log".

Radioactive material, in the form of sealed sources, having an activity greater than or equal to that of 10 CFR, Part 33.100 schedule A, will be inventoried by the RSOS once every six months. This will be a physical (hands on) inventory. Since radioactive materials acquired by ISU are procured through the Radiation Safety Officer (RSO), new sealed sources will be immediately added to the Sealed Source Inventory log upon arrival and documented on Radioisotope Package Arrival Form RPR13A.

12.0 RADIOACTIVE WASTE MANAGEMENT

Radioactive wastes shall be collected, stored, packaged, shipped and disposed of in accordance with pertinent regulations. Containers in which radioactive wastes are collected must be labeled "Caution-Radioactive Material" or "Caution Radioactive Waste". Packages in which radioactive wastes are stored or transported are to be labeled with a "Radioactive Waste" tag. Radioactive wastes shall be disposed of as follows: (1) Radionuclides with half-lives less than or equal to 120 days will be held for at least ten half-lives after being transferred to the TSO as waste. They will then be disposed of as solid waste after meeting the requirements of 10 CFR, Part 35.92; (2) Liquid radioactive wastes will be disposed of into the sanitary sewer in accordance with 10 CFR, Part 20.2003 and; (3) Radionuclides with half-lives greater than 120 days will be transferred to a licensed disposal company. ISU will not incinerate any radioactive wastes.

When responsible users have no further use for radionuclides, they will contact the TSO and arrange for a waste pick-up. The TSO will verify that the appropriate forms are filled out and that the waste conforms with packaging restrictions before accepting custody of the waste.

Radioactive waste will be segregated by nuclide and category, i.e., sharps, liquids, solids. Radionuclides will not be mixed with hazardous materials as this creates a "mixed waste". This special class of waste represents a problem for all generators, because there are extremely limited options for disposal of mixed wastes. ISU has no storage capability for such waste. **DO NOT GENERATE ANY MIXED WASTE.**

Wastes are stored pending disposal in a basement room of the Physical Sciences Building (Building 3) and at an on-campus waste storage facility at 1540 South Seventh Avenue (Building 16). Solid waste in storage will be double bagged in plastic bags. Liquid waste will be in a liquid-tight container and stored in a secondary container, i.e., plastic tub, garbage can, etc.

Disposals to the sanitary sewer will be performed by the TSO in sinks specifically designated for this purpose. Prior to each disposal of radioactive liquid waste to the sanitary sewer, the total activity of the nuclides to be discarded, the monthly average concentration, the cumulative annual activity and the solubility will be checked or calculated. The average monthly water flow through the building in which the designated disposal sink resides will be calculated by averaging the water flow for the previous 12 months and dividing the average by 10 to ensure an adequate safety margin.

Wastes containing transuranics will be segregated for special packaging.

Biological waste containing nuclides with a half-life <120 days (10 CFR, Part 35.92) will be held in one of the radioactive waste storage rooms for 10 half-lives and then transferred to the Biological Science Animal Care Facility for disposal. Biological waste with nuclide half-life >120 days will be packaged for shipment to a licensed disposal facility.

Any radioactive wastes not included in the above categories, or exhibiting unusual hazards, or requiring special precautions of any kind, are handled under special arrangements with the TSO.

13.0 TRANSPORTATION AND SHIPMENT OF RADIOACTIVE MATERIALS

Radioactive materials of any kind may be transported on public roads on or off University property only if packaged and labeled in compliance with U.S. Department of Transportation (DOT) regulations. Radioactive materials may be shipped from the University to another organization or individual only after verification by the RSO that all transfer, packaging, labeling and transportation requirements have been met.

To assure that all requirements for shipment are met, and that appropriate records are maintained, a written authorization form and one or more check lists must be prepared

by the individual responsible for the shipment and approved by the RSO before the shipment is made.

14.0 SERVICE FEES

Routine radiation protection services are provided by the University to all radiation users. However, services that are not routine and that involve extraordinary costs are charged to the user incurring the costs. Optional services, not recommended or required for radiation protection, but provided upon request, will be charged to the requesting user. For non-routine and optional services, the fees are intended to reimburse the actual service costs and to remove these items from the University's base budget.

14.1 Extraordinary Costs

Any major cost item incurred unexpectedly by a single radiation user may fall into this category. One example would be the disposal of exceptionally large volumes or activities of radioactive wastes involving special handling or disposal surcharges. Another example would be a fine levied against the University as a result of gross negligence or willful violation of procedures by a user. The method of reimbursement will depend upon the circumstances.

14.2 Optional Services

Any supplies or services that are not recommended or required for radiation protection, or that are normally the responsibility of the user but are provided by the Radiation Safety Division of the TSO as a convenience to the user, will be billed to the user at cost plus handling expenses. One example of an optional service is furnishing personal dosimeters to individuals who do not require personal monitoring under the criteria contained in this Manual. Protective clothing, equipment, instrument repairs, etc. are other examples of services or supplies that may be provided for the convenience of users.

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GLOSSARY

ACRONYMS AND ABBREVIATIONS

ALARA: The basic premise of radiation protection, i.e. that all radiation doses should be kept As Low As Reasonably Achievable, taking into account social and economic considerations, through the application of sound radiation protection practices, procedures and engineering controls.

ALI: The Annual Limit on Intake is the quantity of any radionuclide which, if taken into the body, produces an effective dose to internal organs that is equivalent in risk to the annual whole body dose limit of 5 rem. Because of differences in physiological transport mechanisms, the ALIs vary depending on the route of intake. For purposes of contamination control and bioassay procedures, the ALI for ingestion is used, since that is the most common route of accidental intake in research laboratories.

CFR: The Code of Federal Regulations

ISU: The Idaho State University

RSO: The Radiation Safety Officer is the individual specifically appointed and named on the radioactive materials licenses, to establish and enforce such procedures 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 Radiation Safety Committee. Depending on the context, "RSO" may also refer to any individual designated to act on behalf of the RSO.

RSOS: The Radiation Safety Office Staff (Radiation Safety Division Staff) of ISU Technical Safety Office (TSO).

TSO: The Technical Safety Office, Campus Box 8106, ISU, Pocatello ID 83209.

AREAS

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. X-ray rooms and accelerator rooms are controlled administratively by the personnel who operate the equipment. Radioisotope laboratories are controlled by posting and locking for the purpose of preventing unauthorized removal of radioactive materials. Exposure to radioactive materials is prevented by controlling the materials, not by limiting normal access to the laboratory when it is open and attended.

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.

Radiation Area: Any accessible area in which an individual could receive a dose equivalent exceeding 5 mrem in 1 hour at 30 cm (1 ft) from the source or from any surface the radiation penetrates.

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. Areas containing sources with the potential for producing significant exposures require specific authorizations and procedures or posting for access control and are designated as restricted areas (10CFR20, Idaho State Regulations). An area must be posted as a Restricted Area if the dose rate is >2 mrem/hr or it contains >0.02 ALI of dispersible contamination. A Restricted Area will have some type of marked or physical boundary so that untrained personnel will be prevented from accessing the area.

MONITORING AND SURVEYING

Bioassay Interval: The bioassay interval for a particular radioisotope is the maximum time that may elapse between bioassays that will assure detection of the verification level for a given assay method. The bioassay interval for a particular radioisotope is determined by its physical and metabolic characteristics, and by the instrumentation used for the measurement.

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.

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

Nonpenetrating Radiation: Ionizing radiation from external sources that is not likely to deliver significant doses to organs or tissues more than 1 cm deep in the body, e.g. beta particles and low energy photons.

Penetrating Radiation: Ionizing radiation from external sources capable of delivering significant doses to organs or tissues more than 1 cm deep, e.g. x or gamma rays and neutrons.

Wipe 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.

QUANTITIES AND UNITS

Absorbed dose is the mean energy per unit mass imparted to any matter by ionizing radiation. The common unit of absorbed dose is the rad, defined as an absorbed energy of 100 ergs per gram of material. The international standard unit is the Gray (Gy), defined as an absorbed energy of 1 joule per kilogram of material; 1 Gy = 100 rads.

Activity: A quantity of a radionuclide specified by the mean rate of spontaneous nuclear transformations which it undergoes. The common unit of activity is the Curie (Ci), defined as the quantity of radioactivity which decays at the rate of 37 billion transformations per second.

Quantities of radioactivity of biological or environmental interest are commonly expressed in submultiples of the curie:

$$1 \text{ millicurie (mCi)} = 3.7 \times 10^7 \text{ s}^{-1} \quad 1 \text{ microcurie (\mu Ci)} = 3.7 \times 10^4 \text{ s}^{-1} =$$

$$2.2 \times 10^6 \text{ min}^{-1} \text{ (dpm)}$$

$$1 \text{ nanocurie (nCi)} = 37 \text{ s}^{-1} = 2,220 \text{ dpm}$$

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

The international standard unit for activity is the Becquerel (Bq).

$$1 \text{ Bq} = 1 \text{ transformation per second.}$$

Committed dose equivalent (H_{T50}) means the dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

Committed effective dose equivalent ($H_{E,50}$) is the sum of the products of the weighing factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues.

Deep dose equivalent (H_d), is the dose equivalent at a tissue depth of 1 cm (1000 mg/cm^2).

Dose: used in this Manual 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).

Effective dose equivalent (H_E) is the sum of the products of the dose equivalent to the organ or tissue (H_T) and the weighing factors (w_T) applicable to each of the body organs or tissues that are irradiated.

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). Submultiples of the Roentgen are normally combined with time units to express exposure rates, e.g., milliRoentgen per hour (mR/hr), etc.

Extremity means hand, elbow, arm below the elbow, foot, knee, and leg below the 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^2).

Interval Inventory: The total quantity of radioisotopes introduced into the lab each month, averaged over the bioassay interval, expressed in ALIs.

Radiation Machine: Any device capable of producing ionizing radiation except those which produce radiation only from radioactive material.

Radioactive Material: Any material having a specific activity greater than 70 Bq/g (0.002 mCi/g), in accordance with 49 CFR 173.403. Also, any non-radioactive material (activity less than 70 Bq/gm) with surface contamination (both fixed and non-fixed/removable) that, when averaged over each 300 cm^2 (46.5 in^2) of all surfaces, is equal to or greater than $.4 \text{ Bq/cm}^2$ (10^{-5} mCi/cm^2) for Beta and Gamma emitters and low-toxicity Alpha emitters; and equal to or greater than $.04 \text{ Bq/cm}^2$ (10^{-6} mCi/cm^2) for all other Alpha emitters.

Radiation Source: Any "Radiation Machine" or "Radioactive Material" emitting or capable of producing ionizing radiation.

Radioisotope: As used in this Manual and related procedures, a "radioisotope" is 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.

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 (H_S), which 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^2) averaged over an area of 1 square centimeter.

Weighing factor (w_T), for an organ or tissue (T) is the proportion of the risk of stochastic effects resulting from irradiation of that organ or tissue to the total risk of stochastic effects when the whole body is irradiated uniformly. For calculating the effective dose equivalent, the values of w_T are:

<u>Organ or Tissue</u>	<u>w_T</u>
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone surfaces	0.03
Remainder	0.30 ^a
Whole Body	1.00 ^b

Footnotes:

a 0.30 results from 0.06 for each of 5 "remainder" organs (excluding the skin and the lens of the eye) that receives the highest doses.

b for the purpose of weighing the external whole body dose (for adding it to the internal dose), a single weighing factor, $w_T = 1.0$, has been specified.

USERS

Radiation user: A "radiation user" is any individual whose official duties or authorized activities include handling, operating, or working in the presence of, any type of radiation source, whether or not such use is confined to a restricted area. Radiation user includes all the *badged personnel* as well as the *minimally exposed personnel*.

Badged personnel are individuals who could receive more than one tenth (10%) of the ISU occupational radiation dose limit. This category includes those personnel who rarely receive more than 100 mrem/year, but who work with radiation sources that could produce a significant dose accidentally. Radiation doses to these individuals are individually monitored.

Minimally exposed personnel are individuals who are unlikely to receive one-tenth (10%) of the ISU occupational radiation dose limit. This category includes individuals who routinely handle only small quantities of radioactive materials (e.g. students that use small, non-dispersible radiation sources as part of a scheduled laboratory course under the supervision of an instructor).

Potentially exposed personnel are individuals who have a need to enter the Controlled or even the Restricted Areas as part of their job description or have a potential of exposure to a radiation source but do not normally work in the presence of a radiation field. This category includes janitorial, receiving and security personnel. The potentially exposed personnel should not enter in a High Radiation Area. A potential exposed individual is very unlikely to receive one-tenth (10%) of the ISU occupational radiation dose limit.

Responsible user: An individual authorized by the Radiation Safety Committee to acquire and use specific radiation sources, and to supervise their use by others, in compliance with pertinent regulations and under conditions approved by the Committee. Responsible users must demonstrate, to the satisfaction of the Committee, competence in the safe use of radiation sources by virtue of appropriate training and experience. Responsible users must assume full responsibility for all radiation sources under their control.

Alternate responsible user: An individual authorized by the RSC (or temporarily authorized by the RSO) to assume the duties of the responsible user in the absence of the later. The alternate responsible user will normally be required to possess the same qualifications as the responsible user.

ACKNOWLEDGMENT

This Manual was prepared initially by Morris Hall under the direction of the Radiation Safety Officer, Thomas Gesell and reviewed by the ISU Radiation Safety Committee. Catalin Frujinoiu, Donald Wamer, and Rebecca Backstrom have contributed to this revision. It is based in part on the radiation policy manual of the University of Utah.

RADIATION SAFETY PROCEDURES

- RPR 1 RADIATION USER PERSONAL DATA**
- RPR 2 RADIATION USE APPLICATION**
- RPR 10 RADIONUCLIDE DATA**
- RPR 11 RADIOISOTOPE LABORATORY SAFETY PROCEDURE**
- RPR 12 BIOASSAYS FOR INTERNAL EXPOSURE**
- RPR 13 RADIOISOTOPE ACQUISITION AND DISPOSITION**
- RPR 14 SHIPMENT OF EXCEPTED QUANTITIES OF RADIOISOTOPES**
- RPR 30 X-RAY MACHINES**
- RPR 32 PARTICLE ACCELERATORS**
- RPR 44 RADIATION SAFETY TRAINING**
- RPR 50 RADIOISOTOPE LABORATORY EVALUATION**
- RPR 51 LEAK TESTING OF SEALED SOURCES**
- RPR 54 RADIOACTIVE WASTE MANAGEMENT**
- RPR 55 TRANSPORTATION OF RADIOACTIVE MATERIALS**
- RPR 61 CALIBRATION OF THE RADIATION MONITORING INSTRUMENTS**

RPR 1 RADIATION USER PERSONAL DATA

PURPOSE

This procedure specifies the personal data that must be provided by each radiation user. The user shall provide a summary of training and experience with radiation sources (RPR 1A) and, if necessary, a form (RPR 1B) to request radiation exposure or radiation safety training records from previous employers. The confidentiality of personal data, and the right of individuals to review their own records and to obtain written summaries of radiation exposures are also specified.

DEFINITIONS

"Radiation user". A "radiation user" is any individual whose official duties or authorized activities include handling, operating, or working in the presence of, any type of radiation source, whether or not such use is confined to a restricted area. Radiation user includes all the *badged personnel* as well as the *minimally exposed personnel*.

"Badged personnel" are individuals who could receive more than one tenth (10%) of the ISU occupational radiation dose limit. This category includes those personnel who rarely receive more than 100 mrem/year, but who work with radiation sources that could produce a significant dose accidentally. Radiation doses to these individuals are individually monitored.

"Minimally exposed personnel" are individuals who are unlikely to receive one-tenth (10%) of the ISU occupational radiation dose limit. This category includes individuals who routinely handle only small quantities of radioactive materials (e.g. students that use small, non-dispersible radiation sources as part of a scheduled laboratory course under the supervision of an instructor).

"Potentially exposed personnel" are individuals who have a need to enter Controlled or even Restricted Areas as part of their job description or have a potential of exposure to a radiation source but do not normally work in the presence of a radiation field. This category includes janitorial, receiving and security personnel. The potentially exposed personnel should not enter in a High Radiation Area. A potential exposed individual is very unlikely to receive one-tenth (10%) of ISU occupational radiation dose limit.

"Responsible user". An individual authorized by the Radiation Safety Committee to acquire and use specific radiation sources, and to supervise their use by others, in compliance with pertinent regulations and under conditions approved by the Committee. Responsible users must demonstrate, to the satisfaction of the Committee, competence in the safe use of radiation sources by virtue of appropriate training and experience.

Responsible users must assume full responsibility for all radiation sources under their control.

POLICY

Before a radiation user is allowed to use radiation sources or radiation producing machines, they must participate in radiation safety training, or provide documentation stating they have received radiation safety training (RPR 1B), as specified by the RSO.

Radiation users that will be individually monitored for radiation exposure are required to provide certain personal information (RPR 1A) to the TSO.

The required information includes:

- (1) primary identification data, e.g. full name, birth date, sex, and social security number.
- (2) previous training and experience with radiation sources.
- (3) current employment status, including job title or description, department, supervisor, and work location.

Personal records of radiation users will also contain the scores obtained on tests taken to demonstrate knowledge of radiation safety procedures, data obtained from monitoring of external and internal radiation exposures, and reports on any injuries or abnormal incidents related to the use of radiation sources.

Individual radiation user records are treated as confidential and are available only to individuals with a legitimate need for the information. An individual may review the contents of his or her personal radiation user file at any time. All personnel will receive a copy their radiation monitoring record for each monitoring year.

PROCEDURE

Each radiation user shall submit a completed "RADIATION USER TRAINING & PERSONAL DATA" form (RPR 1A) to the TSO before starting work with any radiation sources. If any previous employment involved potential exposure to ionizing radiation, a "REQUEST FOR RADIATION EXPOSURE HISTORY AND/OR TRAINING VERIFICATION" form (RPR 1B) shall also be completed for each previous employer.

RPR 1A. RADIATION USER TRAINING & PERSONAL DATA

(Please type or print legibly)

Last name: _____ First name: _____

Middle Initial: _____ Previous (maiden) or other surnames known by: _____

Permanent Address: _____

Soc. Sec. No.: _____ Sex: Male _____ Female _____

Birth date: Month _____ Day _____ Year _____

Job Title or Duties: _____

Department: _____ Room Number: _____ Phone: _____

Responsible User: _____ or Instructor: _____

Program Number: _____

Date of first radiation use at Idaho State University: _____

Required radiation safety training includes the following topics:

- (1) nature of radiation sources,
 - (2) biological effects and risk estimates,
 - (3) risks to the unborn and control of prenatal exposure,
 - (4) ALARA principle and minimizing exposure,
 - (5) correct use of protective devices,
 - (6) provisions of regulations and licenses,
 - (7) response to radiation emergencies,
 - (8) responsibilities and rights of radiation users,
 - (9) availability of monitoring and inspection reports,
- and, for radioisotope users only:
- (10) safe handling and storage of radioactive materials.

1) Have you received the handouts on "Radiation Introduction Training Study Guide".

Yes ___ No ___

2) Have you had previous work experience involving occupational radiation exposure?

Yes ___ No ___

3) Have you received training on ALL of the topics listed above at another institution?

Yes No

If you checked "Yes" for items 2 or 3, complete a "REQUEST FOR RADIATION EXPOSURE HISTORY AND/OR TRAINING VERIFICATION" (RPR 1B) for each such institution or employer.

The information above is accurate and complete. I understand that I may communicate directly, in confidence and without prejudice, with the Radiation Safety Officer or the U.S. Nuclear Regulatory Commission on any matter concerning radiation protection.

Signature: _____ Date: _____

**RPR 1B. REQUEST FOR RADIATION EXPOSURE HISTORY
and/or TRAINING VERIFICATION**
(Please type or print legibly)

Organization: _____

Address: _____

Attention: _____
Radiation Safety Officer (if known) or Supervisor (indicate which).

To whom it may concern:

Please send the following to the address indicated below:

- My radiation exposure history.
- Verification that I received radiation safety training appropriate for independent work with radioactive materials and/or radiation sources.

Last name: _____ First names: _____

Soc. Sec. #: _____ Birth date: Mo: _____ Day: _____ Yr: _____

Inclusive dates of work with radiation (m/yr to m/yr): _____ to _____

Please send the requested information to:

Idaho State University
Technical Safety Office
Box 8106
Pocatello, ID. 83209

Signature: _____ Date: _____

RPR 2 RADIATION USE APPLICATION

PURPOSE

This procedure specifies the requirements that must be met and the information that must be provided to the Radiation Safety Committee in support of an application to use regulated ionizing radiation sources of any kind at Idaho State University.

DEFINITIONS

Responsible user: An individual authorized by the Radiation Safety Committee to acquire and use specific radiation sources, and to supervise their use by others, in compliance with pertinent regulations and under conditions approved by the Committee. Responsible users must demonstrate, to the satisfaction of the Committee, competence in the safe use of radiation sources by virtue of appropriate training and experience. Responsible users must assume full responsibility for all radiation sources under their control.

RSO: The Radiation Safety Officer is the individual specifically appointed and named on the radioactive materials licenses, to establish and enforce such procedures 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 Radiation Safety Committee. Depending on the context, "RSO" may also refer to any individual designated to act on behalf of the RSO.

POLICY

The Radiation Safety Committee is the governing body for all aspects of radiation protection within the University, including all affiliated research, clinical, instructional and service units utilizing radiation sources in facilities owned or controlled by the University. Each proposed use of radioactive materials, X-ray or other radiation generating machines must be submitted to the Committee, via the Radiation Safety Officer (RSO), for review before implementation. Specific forms and data to be submitted are prescribed in the attachments to this procedure. The descriptions of facilities and equipment, the training and experience of the user, and the operating or handling procedures shall be provided in sufficient detail to permit the Committee to evaluate the safety of the proposed use.

Upon the RSC approval, a permit to use radioactive material will be issued by the RSO. The permit will be valid for two (2) years and will be review on a two year basis. The permit will be mail to the responsible user and a copy will be kept in the TSO files. The permit will generally contain:

- the responsible user information,

- expiration date,
- permitted use locations,
- permitted radionuclides (permitted machines),
- permitted uses and restrictions,
- conditions for all users,
- additional conditions for users of dispersible sources.

INITIAL APPLICATIONS

A first-time applicant to become a responsible user should obtain a copy of the Radiation Safety Policy Manual from the Technical Safety Office. The index to all current Radiation Procedures and Records included in the Manual should be reviewed to identify any that may be applicable to the planned radiation use; these should also be obtained from the Technical Safety Office.

After becoming thoroughly familiar with the pertinent requirements, the applicant should complete the appropriate checklists and forms attached to this procedure and submit them to the RSO.

INFORMATION TO BE SUBMITTED

All applicants for authorization to be a responsible user must submit:

- 1 RADIATION USER PERSONAL DATA (RPR 1)
- 2 RESPONSIBLE USER'S TRAINING & EXPERIENCE (RPR 2A)

Applicants for unsealed, dispersible radioactive materials not to be used in or on humans must submit:

- 3 RADIOACTIVE MATERIAL USE APPLICATION (RPR 2B)

Applicants for radiation generating machines or self-shielded irradiators not to be used on humans must submit:

- 4 RADIATION MACHINE USE APPLICATION (RPR 2C)

Applicants for use of any source of radiation on or in humans must submit:

- 5 CLINICAL RADIATION USE APPLICATION (RPR 2D)

An applicant for research use of any radiation machines or radioactive materials applied to humans must first be approved as a Responsible User by the Radiation Safety Committee; use whichever application form is most appropriate. The use of radiation for human research is not currently authorized at Idaho State University.

REVISIONS TO AUTHORIZATIONS

Any desired revisions to an authorization should be discussed with the RSO via the Technical Safety Office. If the RSO determines that the proposed revision does not involve any change from the initial safety evaluation, and is within the intent of the initial authorization, the revision may be approved by the RSO without further Committee action. The RSO may, however, require additional information before granting approval. The RSO is required to brief the RSC of all program changes at the next Radiation Safety Committee meeting.

If a proposed revision to an initial authorization involves significant changes, in the opinion of the RSO, in sources or conditions of use from those specified initially, the proposal must be resubmitted to the Committee for authorization.

To assure that all records related to radiation sources, users and conditions of use are accurate and up-to-date, the RSO may require that parts or all of the application be verified or resubmitted periodically. If the updated information includes changes that are significant to safety, the application will be submitted to the Committee for reauthorization.

RPR 2A. RESPONSIBLE USER'S TRAINING & EXPERIENCE

(Please type or print legibly)

Last name: _____ Initials: _____ Soc. Sec. No: _____

Training in Basic Radiation Sciences:

<u>Subjects</u>	<u>Location & Dates</u>	<u>Type & Hours of Training</u>	
		<u>Formal Courses (hours)</u>	<u>Supervised On-the Job (hours)</u>
Nature of radiation sources	_____	_____	_____
Biological effects & risk estimates	_____	_____	_____
ALARA principle & minimizing exposure	_____	_____	_____
Correct use of protective devices	_____	_____	_____
Provisions of regulations & licenses	_____	_____	_____
Response to radiation emergencies	_____	_____	_____
Responsibilities & rights of Radiation users	_____	_____	_____

Experience in Using Radiation: List radiation sources used personally; list nuclides and quantities, description of machines, dates and nature of each use. (Attach supplemental sheets if necessary.) For each location where experience was obtained, complete one "REQUEST FOR ... TRAINING VERIFICATION" form (RPR 1B).

The information above is accurate and complete.

Signature _____ Date _____

RPR 2B. RADIOACTIVE MATERIAL USE APPLICATION

(FOR UNSEALED OR DISPERSIBLE MATERIALS NOT USED IN OR ON HUMANS)

<u>Nuclide</u>	<u>Physical/Chemical Form</u>	<u>Maximum Order</u>		<u>Nuclide ALI</u>	<u>Monthly Use</u>
		<u>mCi</u>	<u>How Often?</u>	<u>(mCi)*</u>	<u>(No. of ALIs)</u>
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

* See "RADIONUCLIDE CATEGORIES AND DATA" (RPR 10A)

In addition to the RESPONSIBLE USER'S TRAINING & EXPERIENCE (RPR 2A), the PERSONAL DATA form (RPR 1A), submit the following:

- "RADIATION USER TRAINING & PERSONAL DATA" forms (RPR 1A) for all other individuals who will work in the same location (faculty, staff).
- Brief description of experimental objectives and methods, with justification for the specific radionuclides and quantities.
- Description of facilities where radiation sources will be used and stored, including building, rooms, fume hoods, shielding, security arrangements; include diagram of layout if appropriate.
- Description of radiation survey instruments that will be readily available for contamination and exposure control, and analytical instruments that will be used for determination of radioactivity in wipe test papers or urine samples.
- Animals to be used, if any, including number, individual doses, holding facilities and handling methods.
- Brand names of liquid scintillation fluor(s) and tissue solubilizers, if any, that will be used. Written justification must be provided for any fluors other than "NHNT" and vials larger than "minis". See "LIQUID SCINTILLATION MEDIA" on next page.
- Description and estimated quantities of radioactive wastes to be generated. If any radioactive wastes will also contain any hazardous materials, as defined by the EPA, provide written justification for producing them.

I have read the University's Radiation Safety Policy Manual and understand the conditions and regulations contained in it. With respect to the requested radiation sources and proposed uses, I acknowledge and accept the responsibility for:

- (a) radiation protection instruction for all involved personnel;
- (b) acquisition of the equipment, supplies and/or services necessary for radiation protection;
- (c) security to prevent misuse or theft of radioactive materials;
- (d) maintaining accurate records of acquisitions and dispositions;
- (e) regular contamination and/or exposure surveys and records;
- (f) notification of the RSO of any accident or abnormal incident;
- (g) arranging for authorization of another individual to assume the preceding responsibilities, or to suspend or terminate all radiation uses, prior to any extended absence.

Signature of Responsible User: _____ Date: _____

LIQUID SCINTILLATION MEDIA

Fluors containing non-hazardous, non-toxic (NHNT) solvents are required unless a specific exception is obtained from the RSO or the Radiation Safety Committee. Examples of such fluors are:

Fluor (Mfgr.)	³ H Efficiency* Mean ± SD (N)	Flow* (sec)	Fluor (Mfgr.)	³ H Efficiency* Mean ± SD (N)	Flow* (sec)
BCS (AMER)			Betamax-ES (ICN)	45.1 ± 7.9 (6) ¹	2.6
Bio-Safe II (RPI)	38.1 ± 5.2 (24) ²	4.1	Bio-safe NA (RPI)	43.9 ± 9.8 (6) ¹	2.5
Cytoscint-ES (ICN)	43.7 ± 4.0 (24) ²	3.7	Ecolite(+) (ICN)	32.1 ± 5.1 (24) ²	5.3
Ecolume (ICN)	36.6 ± 6.0 (24) ²	4.9	Ecoscint A (NAT)	40.2 ± 4.5 (24) ²	3.7
Ecoscint H (NAT)	45.8 ± 5.0 (24) ²	2.7	Ecoscint O (NAT)	45.1 ± 6.7 (6) ¹	2.8
Envirosafe (ANOR)	35.4 ± 4.6 (24) ²	4.2	Mono Flow S (NAT)	35.6 ± 3.7 (24) ²	2.7
Opti-Fluor** (PACK)	39.7 ± 5.5 (24) ²	3.2			
OrganicSolv 3 (ANOR)	42.2 ± 9.7 (6) ¹	2.5			
Ready Safe (BECK)	40.6 ± 4.2 (24) ²	7.2			
Ultima Gold (PACK)	43.1 ± 2.1 (24) ²	5.5			

Fluors containing toxic or flammable solvents may not be purchased without prior approval from the RSO. Examples are:

CP, HP, HP/b, EP, MP, NA, Ready Micro, Ready Solv, Ready Protein, Ready Gel, Ready Value, Ready Organic, Ready Flow II, Ready Flow III (BECK)

Universall (ICN)

Betafluor, Hydrofluor, Liquiscint, Monoflow 4, Ultraflow (NAT)

Aquasol, Aquasol-2, Econofluor, Econofluor-2, Formula 963, Liquifluor, Omnifluor, Atomlight, Aquasure, Biofluor, Riafluor, and all "NEF" numbers (NEN)

Insta-Gel XF, Scint-A XF, Pico-Aqua, Pico-Fluor 15, Pico-Fluor 40, Hionic Fluor, Filter-Count, Pico-Fluor LLT, Insta-Fluor, Permafluor V, Monophase S, Flo-Scint I, II, III, IV, and V (PACK)

* Tritium counting efficiencies are based on 0.1 mL sample in 4.0 mL fluor; "Flow" represents the time for a fixed volume to flow from a pipette and is inversely proportional to viscosity; data from Klein, RC and Gershey, EL, 'Biodegradable' liquid scintillation counting cocktails, Health Physics 59:461-470, 1990.

1 Non-aqueous cocktail

2 Multipurpose cocktail

AMER = Amersham Corp., Arlington Heights, IL 800-323-9750

ANOR = Anorak Scientific, South Hackensack, NJ

BECK = Beckman Instruments, Fullerton, CA 800-742-2345

ICN = ICN Radiochemicals, Irvine, CA 800-854-0530

ISO = Isolab, Inc., Akron, OH 800-321-9632

NEN = DuPont-NEN Products, Boston, MA 800-551-2121

NAT = National Diagnostics, Manville, NJ 800-526-3867

PACK = Packard Instrument Co., Downers Grove, IL 800-323-1891

RPI = Research Products International Corp., Mount Prospect, IL 800-323-9814

RPR 2C-2. ANALYTICAL X-RAY MACHINE APPLICATION CHECKLIST (cont'd)

PERSONNEL REQUIREMENTS

Have all persons operating x-ray equipment received both Institutional Analytical X-Ray and on-the-job instruction and demonstrated adequate knowledge of:

radiation hazards associated with use of equipment;	Yes	No
significance of radiation warning and safety devices;	Yes	No
operating procedures;	Yes	No
symptoms of acute localized exposure; and	Yes	No
procedure for reporting actual or suspected exposure?	Yes	No

Personnel Monitoring

For open-beam systems, have personal monitoring devices (ring badges) been issued? Yes No

If "Yes", are they used in compliance with University requirements? Yes No

RADIATION SURVEY EQUIPMENT

Radiation survey meter(s) available at facility:

Make/Model: _____ Ser. No.: _____ Calibration Date: _____

Make/Model: _____ Ser. No.: _____ Calibration Date: _____

Upon completion, send this application checklist to:

Technical Safety Office
Box 8106

RPR 10 RADIONUCLIDE DATA

PURPOSE

This procedure provides a ready reference to radiation protection data for commonly used radionuclides. Data for nuclides not listed herein may be obtained from the RSO.

POLICY

Radionuclide data used for radiation protection calculations shall be obtained from regulatory authorities or reputable scientific advisory organizations.

In research facilities, application of the ALARA principle dictates that no removable contamination shall be tolerated indefinitely. Whenever contamination is detected, it must be removed promptly to prevent its spread and the possible exposure of other individuals. The responsible user must assure that the necessary monitoring is performed, recorded and reported.

DEFINITIONS

Annual Limit on Intake (ALI): The quantity of a radionuclide which, if taken into the body, produces an effective dose equivalent in risk to the annual whole body dose limit of 5 rem. Because of differences in physiological transport mechanisms, the ALIs vary depending on the route of intake. For purposes of contamination control and bioassay procedures, the ALI for ingestion is used, since that is the most common route of accidental intake in research laboratories.

Reference Quantity (RQ): A quantity of a radionuclide (expressed in microcuries) related to its relative hazard potential and used to prescribe requirements for handling, monitoring, labeling and disposal. Reference quantities are obtained from 10CFR20, Appendix C.

Removable Contamination Limit: A basic limit for removable surface contamination, specified in "CONTAMINATION LIMITS AND ACTION LEVELS" (RPR 10B).

Dose Equivalent Rates (mrem/hour) as given:

Penetrating - the dose rate from photons at 1 meter from a point source of 1 millicurie, assumed to be proportional to the inverse of the square of the distance between the point source and the receptor.

Skin dose - dose rate to the basal epidermal cells from contamination on the skin, expressed in microcuries per unit area of skin ($\mu\text{Ci}/\text{cm}^2$) over an area of at least 1 cm^2 .

REFERENCES

International Commission on Radiological Protection, *Recommendations of the ICRP*, Publ. No. 26, 1977.

Ibid., *Limits for Intakes of Radionuclides by Workers*, Publ. No. 30, in 4 parts with supplements, 1979-88.

US Environmental Protection Agency, *Limiting of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, Federal Guidance Report No. 11, EPA-520/1-88-020, September 1988.

Health Physics Journal, Volume 53, Number 2, August 1987. D.C. Kocher and K.F. Eckerman, *Electron Dose-Rate Conversion Factors For External Exposure Of The Skin From Uniformly Deposited Activity On The Body Surface*.

U.S. Nuclear Regulatory Commission, Code of Federal Regulations, Title 10, Part 20. *Standards For Protection Against Radiation*.

RPR 10A. RADIONUCLIDE CATEGORIES AND DATA

(For data on radionuclides not listed below, contact the RSO. Half-lives in bold indicate radionuclides that are stored for decay for waste disposal purposes).

<u>Nuclide</u>	<u>Half-life</u>	<u>Reference Quantity (μCi)</u>	<u>Ingestion ALI (mCi)</u>	<u>Dose rates (mrem/hour):</u>	
				<u>Penetrating At 1 meter from 1 mCi</u>	<u>Skin dose at 0.07 mm per μCi/cm²</u>

"LO-BETAS" - low-energy beta or electron emitters with negligible external exposure potential and ALI's \geq 1 millicurie.

H-3	12 yrs	1000.	80.	0.	
C-14	5730 yrs	1000.	2.	0.	1200
S-35	87 days	100.	6.	0.	1300
Cl-36	3x10⁵ yrs	10.	2.	0.	7200
Ca-45	165 days	100.	2.	0.	
Cr-51	28 days	1000.	40.*	0.02	
Fe-55	2.7 yrs	100.	9.	0.	
Ni-63	100 yrs	100.	9.	0.	
Tc-99	2x10⁵ yrs	100.	4.	0.	
Pm-147	2.6 yrs	10.	4.	0.	

"HI-BETAS" - high-energy beta emitters with negligible gamma emission but capable of significant *bremsstrahlung* production if not properly shielded. Emphasis is on control of doses to extremities and prevention of intake.

P-32	14.3 days	10.	0.6	0.	8900
Rb-86	18.7 days	100.	0.5	0.05	
Sr-90	28.6 yrs	0.1	0.03	0.	

"IODINES" - radioiodines are treated as a separate category for exposure evaluation. Emphasis is on prevention of intake by ingestion or inhalation.

I-125	60 days	1.	0.04	0.07	
I-129	6x10⁹ yrs	1.	0.005	0.13	
I-131	8 days	1.	0.03	0.22	6300

"GASES" - noble gases present minimal exposure potential or waste disposal problems.

Kr-85	10.7 yrs	1000.	NA	0.	
Xe-133	5.2 days	1000.	NA	0.1	

"NATURAL" - naturally occurring nuclides, primarily alpha emitters. Emphasis is on prevention of intake by ingestion or inhalation.

Th-232 (nat)	14x10⁹ yrs	100.	0.0007	0.	
U-238 (nat)	4.5x10⁹ yrs	100.	0.2	0.	

* The ALI is not applicable to microspheres, which are highly insoluble particles, typically greater than 0.01 mm diameter. They require external exposure control and monitoring, but are not readily absorbed from the gastrointestinal tract. If inhaled, because of their size, they are most likely to be deposited in the upper respiratory tract, from which they would be cleared by the mucous transport and swallowed.

<u>Nuclide</u>	<u>Half-life</u>	<u>Reference</u>		<u>Dose rates (mrem/hour):</u>	
		<u>Quantity</u> <u>(μCi)</u>	<u>Ingestion</u> <u>ALI (mCi)</u>	<u>PenetratingSkin dose</u> <u>At 1 meter at 0.07 mm</u> <u>from 1 mCiper μCi/cm²</u>	

"GAMMAS" - gamma emitters with ALI \geq 1 millicurie; emphasis is on external exposure control and monitoring.

Na-24	0.625 days	100.	4.	1.89	
Mn-54	312 days	100.	2.	0.51	
Co-57	271 days	100.	4.*	0.15	290
Ga-67	3.3 days	1000.	7.	0.11	1100
Ga-68	68 min	1000.	20.	0.54	
Ge-68	288 days	10.	5.	0.06	
Sr-85	64.8 days	100.	3.*	0.75	55
Nb-95	35 days	100.	2.*	0.48	970
Mo-99	2.8 days	100.	1.	0.11	
Tc-99m	0.25 days	100.	80.	0.12	890
Ru-103m	39 days	1000.	2.*	0.33	2400
In-111	2.8 days	100.	4.*	0.5	1400
Sn-113	115 days	100.	2.*	0.18	
I-123	0.542 days	100.	3.	0.28	
Gd-153	242 days	10.	5.*	0.17	460
Au-195	183 days	10.	5.	0.09	
Hg-195m	1.7 days	100.	2.	0.1	
Hg-197	2.7 days	1000.	3.	0.07	
Au-198	2.7 days	100.	1.	0.29	
Tl-201	3 days	1000.	20.	0.09	970
Pb-203	2.2 days	1000.	5.	0.68	

ALL OTHER NUCLIDES not included in one of the above groups are assumed to have significant potentials for both external and internal exposures and must be evaluated individually.

Na-22	2.6 yrs	10.	0.4	1.33	7200
Sc-46	84 days	10.	0.9*	1.17	5100
Fe-59	44.6 days	10.	0.8	0.66	4600
Co-60	5.27 yrs	1.	0.2	1.37	
Zn-65	244 days	10.	0.4	0.33	
Se-75	118 days	100.	0.5	0.86	360
Ru-106	367 days	1.	0.2	0.	
Cd-109	453 days	1.	0.3*	0.18	
Ir-192	74 days	1.	0.9	0.59	
Hg-203	47 days	100.	0.5	0.25	

* The ALI is not applicable to microspheres, which are highly insoluble particles, typically greater than 0.01 mm diameter. They require external exposure control and monitoring, but are not readily absorbed from the gastrointestinal tract. If inhaled, because of their size, they are most likely to be deposited in the upper respiratory tract, from which they would be cleared by the mucous transport and swallowed.

RPR 10B. CONTAMINATION LIMITS AND ACTION LEVELS¹

NUCLIDE CATEGORY

REMOVABLE CONTAMINATION LIMIT (RCL)²

Electron and/or photon emitters:

with ingestion ALI ≥ 1 mCi

1. nCi (2,000 dpm; 40. dps) per 100 cm²

with ingestion ALI < 1 mCi

0.1 nCi (200 dpm; 4. dps) per 100 cm²

Alpha-particle emitters:

0.01 nCi (20 dpm; 0.4 dps) per 100 cm²

<u>LOCATION</u>	<u>QUANTITY</u>	<u>REQUIRED ACTION</u>
Skin or hair	Any	Immediate removal by gentle washing
	>1 RCL	Immediate removal and bioassay ³ within normal interval
	>10 RCL	Immediate removal and bioassay ³ within 5 days
Clothing, personal or protective	>1 RCL	Do not remove clothing from the lab; wash in the lab or store for decay of activity
Skin contact likely	>10 RCL	Bioassay ³ within five (5) days
Skin contact unlikely	>10 RCL	Bioassay ³ within normal interval
Surfaces or objects that are readily accessible or normally touched, e.g. bench tops, handles, etc.	>1 RCL	Until decontaminated, isolate, cover, label, etc. to prevent personnel contact; indicate location and activity in survey record.
	>10 RCL	Decontaminate immediately; bioassay ³ required within normal interval for potentially exposed individuals
	>100 RCL	Decontaminate immediately; bioassay ³ required within 5 days for potentially exposed individuals
Equipment or facilities to be released for unrestricted use	>1 RCL removable; >10 RCL fixed	Do not release until criteria are satisfied
Other surfaces or objects (not readily accessible or normally touched).	>1 RCL	Label the contaminated area or object; indicate location and activity on survey record
	>10 RCL	Decontaminate within one week

¹ Based on NRC Regulatory Guide 8.23, Radiation Safety Surveys at Medical Institutions, Rev. 1, Jan. 1981.

² All contamination is presumed to be removable until proven otherwise. The limits are expressed as activity per 100 square centimeters, rounded to one significant figure. For all surfaces except skin, the contamination may be averaged over no more than 300 cm² for determining the appropriate action. ³ All requirements for bioassays in this table are for screening bioassays.

RPR 11 RADIOISOTOPE LABORATORY SAFETY PROCEDURE

PURPOSE

This procedure provides criteria, reference data, and specific instructions for safe handling of radioisotopes in unsealed or dispersible forms, including contamination control and monitoring of exposures. It also specifies the requirements for monitoring records to be maintained by the users.

POLICY

It is the responsibility of each radiation user to follow safe work practices, to be aware of actual or potential radiation exposures, and to keep all exposures to levels that are As Low As Reasonably Achievable (ALARA). Each person who handles unsealed radioisotopes is responsible for the control and containment of radioactivity and for performing regular surveys of personnel, personal effects, equipment and work areas using methods that will assure the detection of contamination before significant exposures occur.

In research facilities, application of the ALARA principle dictates that no removable contamination shall be tolerated indefinitely. Whenever contamination is detected, it must be removed promptly to prevent its spread and the possible exposure of other individuals. The responsible user must assure that the necessary monitoring is performed, recorded and reported. Routine evaluations of all radioisotope laboratories, including surveys for contamination, are also performed by Technical Safety Office personnel.

RESPONSIBILITIES

Each radiation user is responsible for:

- 1 knowing the basic properties of the radioactive materials to be used, e.g. the half-life of the nuclide(s), the type(s) of radiation emitted, the annual limit on intake (ALI) and any shielding that may be required. See "RADIONUCLIDE CATEGORIES AND DATA" (RPR 10A).
- 2 following the instructions or procedures provided by the responsible user and the RSO, or provided in the Radiation Safety Policy Manual.
- 3 surveying of gloves, clothing, equipment and work area frequently during procedures in which more than 1 ALI is manipulated, and surveying of hands and personal clothing before leaving the laboratory.

- 4 providing a urine sample, or obtaining a thyroid count, at intervals specified by the RSO. Refer to "BIOASSAYS FOR INTERNAL RADIOACTIVITY" (RPR 12).
- 5 recording the results of all radiation surveys and screening bioassays promptly, completely and accurately.

The responsible user must ensure that:

- 1 all radiation users have received the required radiation safety instruction.
- 2 the equipment, supplies and services necessary for radiation protection are provided.
- 3 radioactive materials are secured against theft, misuse and access by unauthorized personnel.
- 4 radioactive wastes are segregated properly and placed in appropriate containers. The containers are to be provided by the user; labels and clear plastic bags are available from the RSO. Follow the instructions in "RADIOISOTOPE ACQUISITION AND DISPOSITION" (RPR 13).
- 5 accurate records of acquisitions and dispositions of radioactive materials are maintained. Refer to "RADIOISOTOPE ACQUISITION AND DISPOSITION" (RPR 13).
- 6 regular exposure and contamination surveys are performed and recorded (see table 1).
- 7 the RSO is notified promptly of any accident or abnormal incident involving radioactive materials.
- 8 prior to any extended absence, another individual is authorized by the Radiation Safety Committee (or temporarily authorized by the Radiation Safety Officer) to assume the preceding responsibilities, or the use of radioactive materials is suspended or terminated.

POSTING OF RADIOISOTOPE LABORATORIES

Each room containing more than 10 reference quantities (RPR 10 or 10CFR20 Appendix C) of all radioisotopes combined must be labeled with a "CAUTION RADIOACTIVE MATERIALS" label. This label should indicate the isotopes present, and the name and phone numbers (home and office) of the responsible user.

A "NOTICE TO EMPLOYEES", available from the RSO, must be posted where anyone entering the lab can see it.

If any dose rate exceeds 2 mrem/hour at 30 cm (1 ft.) from an accessible source or surface, the room is a "Restricted Area" and must be posted to prevent entry of unauthorized individuals. If any dose rate exceeds 5 mrem/hour at 30 cm (1 ft.) from an accessible source or a surface, the room must be labeled with a "CAUTION RADIATION AREA" sign. If either of these dose rates is exceeded, notify the RSO.

SURVEY INSTRUMENTS

The responsible user shall ensure that instruments used for determining exposure rates or for direct detection of contamination are capable of responding appropriately to the kinds of radiation anticipated and have been calibrated within the past six months. For most radioisotope laboratories, a thin-window Geiger-Mueller (GM) survey meter with an audible response is the best. For low-energy photon emitters, (I-125, Cr-51, etc.) a thin-crystal scintillation detector, also with audible response, is preferred.

The user must know the detection efficiency (e.g. % efficiency, cpm/dpm) for each survey instrument and record it with all survey results. The reporting forms attached to this procedure include provisions for recording all pertinent instrument data.

In laboratories where only tritium (H-3) or less than 1 ALI of low-energy beta emitters are used, direct surveys are not necessary and all contamination surveys must be made by means of wipe tests.

If an analytical instrument is to be used for counting urine samples or contamination wipe tests, the user must know the counting efficiency for each sample type and for each anticipated nuclide. The RSO will help the user to determine appropriate sample sizes and counting times for urine samples, and the results that would require verification.

TROUBLE SHOOTING RADIATION SURVEY METERS

Instruments used for contamination surveys are not required to provide extremely accurate results. However, they should provide consistent indications of the presence or absence of contamination. If a meter gives inconsistent or questionable results, check the following conditions before sending it for repair or recalibration.

- 1 Check the battery!** Turn the selector to the "Battery" position for a minimum of 30 seconds to verify that the battery is in good condition. If the battery is low, replace it.

- 2 If the meter reads higher than its normal background, check for external contamination with a reliable meter. Contamination becomes a problem when users have neglected to monitor their hands during the radiolabeling process. Meters should be included when performing both personal and area surveys.
- 3 If the meter is contaminated, clean it carefully to remove the contamination. If the contamination cannot be removed down to background, remove the batteries, label the meter with "CAUTION RADIOACTIVE MATERIAL" tape, place it in a labeled plastic bag, and set it aside for decay. When the contamination has decayed down to background, the meter should be recalibrated.
- 4 If discrepancies are observed between the readings from two meters, first check the efficiencies indicated on the calibration label. Small discrepancies may represent actual differences in the sensitivities of the instruments. If the discrepancies are not due to differences in efficiencies, the problem may be in the electronics or in the calibration of one or both meters. First ask the Technical Safety Office to verify the calibration; then obtain repairs, if necessary.
- 5 Before removing a meter from the lab, survey it to assure that no contamination is present.
- 6 If a meter has been sent in for repair, the meter must be recalibrated by Technical Safety Office personnel before being put back into use.

EXTERNAL EXPOSURE CONTROL

Careful planning of work, good handling techniques and thorough monitoring are all necessary to minimize exposure. Adequate shielding and distance from sources are also important factors in reducing exposure. Iodine-125 should be shielded with at least 3 mm (1/8") of lead. Other nuclides that emit higher energy gamma rays may require 5 cm (2") or more of lead. The shielding must extend entirely around the source; verify by making measurements of exposure rates above, below, in back and at the sides of storage locations.

The potential quarterly gamma dose from each unshielded radionuclide used may be estimated as:

$D = A \cdot X \cdot T(1/d^2)$, where:

- D** = estimated dose (millirem/quarter)
A = activity handled (millicuries)
X = external dose-rate constant (mrem/hr-mCi at 1 m). Values for X are given in RPR 10.
T = exposure time (hours/quarter)

- 1/d² = distance correction**
- = 10,000 for contact hand dose (d = 1 cm)**
- = 100 for hand dose using tongs (d = 10 cm)**
- = 10 for body dose during entire handling time (d = 30 cm).**

SPECIAL INSTRUCTIONS FOR P-32 USERS

For high energy beta-particle emitters, e.g. P-32, the dose rate to the hands (1 cm distance) from a point source with no shielding is approximately 200 mrem/hour per millicurie. Multiply activity handled at one time (mCi) by the hand contact time (hours/quarter) by 200 to estimate the quarterly hand dose.

For P-32 or other high-energy beta emitters, a shield made of any plastic material 1 cm (3/8 inch) thick will absorb the beta particles while generating little secondary radiation. For millicurie quantities of P-32, lead shielding approximately 3 mm (1/8 inch) thick should be added to the exterior of the plastic to absorb the more penetrating secondary radiation.

The requirement for personnel monitoring is based on the nuclide(s) used, and the activity (mCi) handled monthly by the individual. **An individual who has been issued a badge is required to wear it whenever handling radioactive materials.** The badge itself offers no protection; however, it provides valuable information that is necessary to ensure that exposures are kept As Low As Reasonably Achievable (ALARA).

The ring badge should be worn so that the name label faces the source, i.e. toward the palm of the hand. For example, when pipetting P-32 from a vial, the ring badge should be worn on the little finger of the hand holding the pipette with the name label facing the mouth of the vial. The dose rate at the mouth of an open combi-vial containing 1 mCi of P-32 in 1 ml of liquid may be as high as 400 mrem/minute. **Exposure can be markedly reduced by not picking up tubes when radiolabeling.**

To avoid contamination of the ring badge, always wear it under gloves. Verify that it has not become contaminated by including it in your routine personal and area surveys. Always store your badge away from heat, as well as radiation sources.

EXPOSURE RATE SURVEYS

A survey of exposure rates must be performed whenever sources of penetrating radiation are first acquired, when the quantities of these radionuclides are increased and when physical arrangements for handling or storage are modified. Additional surveys should be performed occasionally to assure that inadvertent changes in exposure rates have not occurred.

PREVENTION OF INTAKE OF RADIOACTIVE MATERIAL

Ingestion of radioactivity must be prevented by avoiding mouth contact with any items handled in a radioisotope laboratory (pipettes, pencils, etc.), by prohibiting eating, drinking and smoking in radionuclide handling areas and by careful attention to personal hygiene.

Gloves, lab coats, or other protective clothing, should be available and worn to prevent contamination of skin and personal clothing. Lab coats and gloves should not be worn to the cafeteria, library, classrooms or home. Sandals or other open-toed shoes are not appropriate for work with radionuclides.

Work, storage and waste areas should be provided with secondary containers and covered with absorbent paper. Plastic trays and dish pans are suitable for use as secondary containers. The protective covering should be replaced when it becomes excessively dirty or contaminated.

Inhalation of radioactive materials must be prevented by performing all operations that release gases, vapors or dusts in fume hoods. The sash of a fume hood is intended to serve as a shield to protect the face from spatters, as well as to control air flow. To provide the proper protection, the hood must be free of major obstructions to the flow of air and the sash should be set at the optimal height. It is the users responsibility to ensure fume hoods provide adequate air velocity.

In emergency situations, filtered or supplied-air respirators are used to prevent inhalation of contaminants. Whenever the probability of airborne contamination is significant, the RSO should be notified and air sampling may be required.

CONTAMINATION SURVEYS

Surveys for contamination on the hands and clothing must be performed immediately after working with radioisotopes to allow detection and removal before the material enters the body. Any radioactive material on the skin must be removed promptly by normal washing. If it cannot be removed easily, request advice from the RSO.

A thorough survey of the entire laboratory must be performed and recorded by the user in each radioisotope laboratory on a regular basis according to the level of use, as indicated below. An evaluation of the radiation protection status of each radioisotope laboratory, including a contamination survey, will also be performed by TSO personnel at the frequencies given in "RADIOISOTOPE LABORATORY EVALUATIONS" (RPR 50).

The appropriate frequency for performing routine laboratory surveys is determined by the nature and quantities of radionuclides, and the conditions of use. The frequency of routine contamination surveys is based on the total number of ALIs in the Responsible Users possession at any one time. The survey frequency plan is given in Table 1.

Table 1 Contamination survey frequencies

Laboratory Classification	TSO-performed surveys	Users Personal surveys	Users Laboratory surveys
<1 ALI	Semi-annually	Daily when radionuclides are in use.	Monthly when radionuclides are in use
1-30 ALIs	Quarterly	Daily when radionuclides are in use.	Weekly when radionuclides are in use.
>30 ALIs	Monthly	Daily when radionuclides are in use.	Daily when radionuclides are in use.
Sealed sources only	Semi-annually (leak tests)	N/A	N/A

The total number of ALIs are determined by Technical Safety Office personnel when radioisotopes are received.

The nominal survey frequencies shown in the Table 1 are to be interpreted as guidelines. In cases where contamination occurs regularly, the interval between surveys should be shortened.

Measurements of contamination by direct detection, wipe tests, or both, should be made of representative surfaces. An audible instrument response should be used during direct surveys because of the faster and more sensitive response and because it eliminates the need to watch the meter constantly.

To determine quantities of removable contamination, or to survey areas that are inaccessible to a survey instrument, wipe tests should be taken. An area of 100 -300 cm² should be wiped with absorbent paper for each test. If energetic beta emitters are involved, the activity on the filter may be measured directly with a thin-window GM survey meter. If tritium, carbon-14, sulfur-35 or other low-energy beta emitters are involved, the wipe filter should be analyzed with a liquid scintillation counter.

CONTAMINATION SURVEY DATA

- 1** Unless the only nuclides used are tritium or small quantities (<1 ALI) of other low-energy beta emitters, a direct survey should be made with a portable instrument. For each portable survey instrument used, record the make, model and serial number(s) of survey meter(s) used for the survey on the " form RPR 11 (map). Determine the Removable Contamination Limit (RCL) from RPR 10.
- 2** With the audible response turned on, move the detector slowly over all surfaces that might be contaminated, holding the detector 1-2 cm from the surface. Record the response for each object or location surveyed. Direct contamination survey results are recorded on RPR 11(map) using the symbol "#" and the units will be dpm/frisk.

- 3 At locations with positive survey results, first ascertain whether the reading could be penetrating radiation coming through the surface, rather than from contamination on the surface. If significant penetrating radiation is detected, i.e. more than 0.2 mrem/hr (approximately 10 times background), an exposure rate survey should be made as previously described.
- 4 At locations with positive results from contamination, or surfaces that are not accessible for a direct measurement, use a dry filter paper to take a wipe of 100 cm². (A 100 cm² area is any equivalent of a 4-inch square or a strip 1 cm wide and 1 meter long.) Measurement by wipe will be recorded using a circle on the RPR 11 map. Units will be dpm/100cm².
- 5 Using the portable survey instrument in a low-background location, make a direct measurement of the contamination on the filter paper. Record the results according to the directions on the survey form.
- 6 In laboratories using low energy beta emitters e.g. C-14 , H-3 or S-35 wipes will be used for determination of removable surface contamination.

SPECIFIC INSTRUCTIONS FOR SURVEY MAP (FORM RPR 11)

- 1 Radiation levels will be in mrem/hr and will be annotated on the survey map as a box (γ) or triangle (n). The radiation levels will be written inside this box or triangle without units. Note: the type of radiation monitored for should be recorded outside the box or triangle (e.g. α , β , γ or n).
- 2 All smears will be located on the survey map as a circle with a number written inside the circle. This number will be in chronological order and will reference the associated smear, recorded in the table below the map.
- 3 Contamination measurements using a meter directly (direct frisk) will be annotated on the survey map using the symbol "#". A number (in chronological order) will follow the "#" symbol and will reference the associated meter reading in the table below the map.

- 4 Fill out the required information including a signature upon completion of the survey. File the survey map in the appropriate program record.

RECORDS

All radioisotope disposition records must be kept up to date and returned to the TSO when the waste is picked up. Refer to "RADIOISOTOPE ACQUISITION AND DISPOSITION" (RPR 13) for instructions.

The results of radiation surveys are to be recorded and retained for a minimum of three years. They are to be made available for review and evaluation by the RSO and the appropriate licensing agency. A suitable form for recording survey results is attached to this procedure; however, other formats that provide comparable information may be used.

Personnel surveys should indicate the name of the individual surveyed and, if any contamination was found, the location on the body or on the clothing.

RPR 12 BIOASSAYS FOR INTERNAL EXPOSURE

PURPOSE

This procedure specifies the requirements, responsibilities and methods for performing and reporting measurements for detecting and verifying the presence or absence of radioactivity in the body.

POLICY

Bioassay measurements used for demonstrating compliance with the occupational dose limits will be conducted often enough to identify and quantify potential exposures and resultant intakes that, during any year, are likely to collectively exceed 0.1 times the ALI. Because the above level is specified as a potential exposure (risk), operational quantities were defined in terms of yearly handled activity (see definitions). A system of action levels (defined as ALI fractions) and assays are employed to estimate the intakes. Routine measurements are conducted to confirm that appropriate controls exist and to assess doses to radioactive material users (if intakes occur). Routine measurements include: baseline measurements, periodic measurement and termination measurements.

Individuals who handle dispersible radioiodine compounds may be required to obtain in vivo measurements of radioiodine in the thyroid, performed by the user, at specified intervals. Individuals who handle other radionuclides in dispersible forms may be required to perform assays of radioactivity in urine on a routine basis to document the absence of radioactivity in the body or to determine the magnitude of any exposure. Other types of assays may be utilized if, in the judgement of the RSO, such assays will meet the intent of this policy more effectively.

A bioassay is required whenever personal contamination or injury caused by a contaminated object occurs, or if airborne radioactivity may have been inhaled. Periodic bioassays, at intervals determined by the nuclides used, are required from each user who handles more than minimal quantities of dispersible radionuclides. A periodic bioassay may be waived when appropriate surveys for contamination, conducted during and after each use of radioactive material according to recommended procedures, demonstrate that there was essentially no exposure from unconfined, dispersible radioactive material.

The RSO will notify the responsible users when a routine bioassay is due, i.e. the expiration of the bioassay interval, but it is the responsibility of the user to complete the bioassay promptly. Routine bioassays may be waived at the discretion of the RSO if the records of contamination surveys of both the user and the RSO verify that there was no exposure to unconfined radioactive materials exceeding the levels specified above and no incidents of personal contamination since the last bioassay.

CONCEPTS

ALI: The Annual Limit on Intake is the quantity of any radionuclide which, if taken into the body, produces an effective dose to internal organs that is equivalent in risk to the annual whole body dose limit of 5 rem. Because of differences in physiological transport mechanisms, the ALIs vary depending on the route of intake. For purposes of contamination control and bioassay procedures, the most restrictive ALI (ingestion or inhalation) is used if the intake exceeds the verification levels. For screening assay the ALI for ingestion was adopted as the most probable pathway in research labs.

Baseline measurements: Measurements conducted prior to initial work activities that involve exposure to radiation or radioactive materials.

Bioassay interval: The bioassay interval is the maximum time that may elapse between bioassays that will assure detection of the verification level for a given nuclide and assay method. The bioassay interval for a particular nuclide is determined by its physical and metabolic characteristics, and by the instrumentation used for the measurement. For most commonly used nuclides and typical analytical systems, the bioassay interval is 13 weeks (one calendar quarter); for P-32, and a few other very short-lived nuclides, however, the bioassay interval is only one month.

Dosimetric assay: A quantitative bioassay performed by an independent reputable laboratory to provide data for annual dose determination is called a dosimetric assay. The need for a dosimetric assay will be determined by the RSO, but it is generally required for any individual whose cumulative annual intake is likely to exceed the NRC investigation level (0.1 ALI) .

Elapsed interval: The elapsed interval is the time since an assumed intake of radioactive materials or, if the time of intake is unknown, since the last bioassay without a positive result. The elapsed interval is used to calculate the intake and the effective dose from a positive bioassay result.

IRF: The Intake Retention Fraction is the fraction of intake that is retained in the body at time (t) following the intake.

ISU investigation level: An assay result that indicates a possible intake of 0.05 ALI or more will be investigated by the RSO to determine the cause of the exposure and corrective measures to prevent or reduce exposures in the future.

ISU verification level: The verification level is a result of a screening bioassay that indicates a possible intake exceeding 0.002 ALI. A screening assay result that exceeds the verification level must be verified.

Minimally exposed: A radiation user who handles a cumulative quantity of radioactive materials in dispersible form of less than 1 ALI per month, averaged over the bioassay interval, is very unlikely to experience an annual intake of 0.1 ALI and does not require routine bioassays. If exposed to contamination exceeding the levels specified under "Conditions Requiring Bioassays", however, a non-routine bioassay will be required.

NRC investigation level: The level at which an intake should be investigated (a dosimetric assay should be a part of the investigation). The investigation level is any intake greater than or equal to 0.1 times the annual limit on intake (ALI).

NRC verification level: The level at which an intake should be evaluated beyond the initial bioassay measurement. The evaluation level is 0.02 times the annual limit on intake (ALI).

Periodic measurements: Measurements performed with a defined frequency considering the likely exposure of the individual.

Potentially internal exposed: A radiation user who handles a cumulative quantity of radioactive materials in dispersible form of more than 1 ALI per month, averaged over the bioassay interval, is considered to be potentially exposed to an annual intake of more than 0.1 ALI and must perform or obtain bioassays routinely. For an occupationally exposed minor or declared pregnant woman the above values are considered to be ten times lower (0.1 ALI per month - the handled activity and 0.01 ALI the potential annually intake).

RCL (Removable Contamination Limit) A basic limit for removable surface contamination, specified in "CONTAMINATION LIMITS AND ACTION LEVELS" (RPR 10B).

Screening assay: A screening assay is one that is performed simply to determine whether radioactivity may be present in the body, but without precise quantification of activity or dose.

Termination measurements: Measurements made when an individual is no longer subject to the bioassay program, because of termination of employment or change in employment status.

Verification assay: A verification assay is one that is performed to obtain a reasonable estimate of the actual quantity of radioactivity taken into or present in the body. The verification assay is performed by or under the direction of the RSO.

CONDITIONS REQUIRING BIOASSAYS

- 1 A bioassay is required within 5 days for each individual having contamination of the skin or hair exceeding 10 RCL.
- 2 A bioassay is required within the normal bioassay interval for any individual having skin or hair contamination exceeding 1 RCL.
- 3 A bioassay is required within 5 days for each individual involved in a spill, or other uncontrolled release, of > 0.5 ALI of radioactive material outside of a properly functioning fume hood or > 5 ALI inside a hood.
- 4 A bioassay is required within 5 days for each individual who was present in an area during a time when removable contamination exceeding 100 RCL was present on any readily accessible surface.
- 5 A bioassay is required within the normal bioassay interval for each individual who was present in an area during a time when removable contamination exceeding 10 RCL was present on any readily accessible surface.
- 6 A bioassay is required within the normal bioassay interval for personnel who work in laboratories that have > 1 ALI's of cumulative quantity handled, averaged over the bioassay intervals. The determination of the cumulative quantity handled will be based primarily on records of receipts and disposals of radioactive materials, with adjustments for individual work assignments as defined by the responsible user. Routine bioassays may be waived at the discretion of the RSO if the records of contamination surveys of both the user and the RSO verify that there was no exposure to unconfined radioactive materials exceeding the levels specified above and no incidents of personal contamination since the last bioassay.

THE OPTIMUM TIME FOR A BIOASSAY

The optimum time for performing a bioassay is within a few days after a potential exposure. Each user should perform a screening assay within a few days after handling any unusually large quantities, or after performing any procedure involving a greater than usual opportunity for intake. Subsequent routine bioassays would not be required again until the end of another full bioassay interval unless another unusual exposure situation occurred.

SCREENING URINALYSIS

A screening assay is one performed simply to determine whether radioactivity is present in the body, but without precise quantification of activity or dose. For radionuclides other

than iodines, routine bioassays are most easily performed by in vitro analysis of urine. The same instruments that are used to measure radioactivity in research samples may be used to detect the same radionuclides in urine samples. Routine screening assays are to be performed by or for each potentially exposed individual.

For the nuclides used recently, RSO will determine the ISU and NRC verification levels (dpm/ml of urine) for the elapsed interval using a specific procedure. This procedure uses IRFs through a method implied in NUREG/CR 4884. For several commonly-used nuclides, the "BIOASSAY GUIDELINES" lists the ISU and NRC verification levels (both in case chronic intake and bolus intake) for various elapsed times up to the maximum elapsed interval. For other nuclides, or for elapsed times not listed, the verification levels must be obtained from the RSO.

For urinalysis by gamma counting, as well as by liquid scintillation counting:

- 1 To assure adequate sensitivity of the measurement, use the largest vial and sample volume that the counting system can accommodate.
- 2 Prepare urine and distilled water samples of equal volumes (the verification levels from the "BIOASSAY GUIDELINES" were computed for 9 ml sample). Count both the urine and the distilled water samples for the same times.
- 3 Record the sample data and results on the "URINALYSIS SCREENING ASSAY" form (RPR 12A). Calculate the activity concentration (dpm/ml) in the urine sample, using a nominal counting efficiency (as provided by the vendor) for the nuclide of greatest concern.
- 4 Select the type of intake: chronic intake or acute intake (bolus intake)
- 5 Compare the assay result with the appropriate ISU verification level (chronic or bolus intake) for the nuclide(s) of interest, based on the elapsed interval since last use (or last negative bioassay). If the assay result is less than the ISU verification level, send the signed form to the RSO. If the assay result exceeds the ISU verification level, perform a "Verification Assay".

VERIFICATION ASSAYS

If the result of a screening assay indicates the possible presence of radioactive material in the body, at least one additional assay must be performed to verify the result. A verification assay for a urine sample involves spiking the urine and distilled water samples with a known amount of activity to obtain the true efficiency of the counting system for the samples. Follow the steps on the "URINALYSIS VERIFICATION ASSAY" form (RPR 12B). If the bioassay result exceeds the ISU investigation level or indicates a potential annual

intake exceeding 0.1 ALI (NRC investigation level), the RSO will determine appropriate corrective measures.

RADIOIODINE ASSAYS

The preferred bioassay method for gamma-emitting radioiodines is by in vivo measurement of the thyroid gland. The guidelines are provided in the "BIOASSAY GUIDELINES". A screening assay is performed and the result will be compared to the appropriate ISU verification level (defined in case of a chronic or a bolus intake). If the appropriate verification level is exceeded at least one additional assay must be performed to verify the result. If the bioassay result exceeds the ISU investigation level or indicates a potential annual intake exceeding 0.1 ALI (the NRC investigation level), the RSO will determine appropriate corrective measures. These assays are usually performed by the RSO or RSOS at locations agreed upon with the responsible user. In some cases, the responsible user may perform these measurements. It is the responsibility of the user to obtain the thyroid assay whenever appropriate. Records of the results of these assays are maintained by the RSOS, but are available to the monitored individuals upon request.

The ISU bioassay guidelines are based on recommendations of the following publications:

International Commission on Radiological Protection:

General Principles of Monitoring for Radiation Protection of Workers, ICRP Publ. 35, 1982.

Limits for Intakes of Radionuclides by Workers, ICRP Publ. 30, Parts 1, 2 and 3 with Supplements, 1979-82.

Evaluation of Radiation Doses to Body Tissues from Internal Contamination Due to Occupational Exposure, ICRP Publ. 10, 1968.

An Assessment of Internal Contamination Resulting from Recurrent or Prolonged Uptakes, ICRP Publ. 10A, 1971.

National Council on Radiation Protection and Measurements:

General Concepts for the Dosimetry of Internally Deposited Radionuclides, Report No. 84, 1984.

Use of Bioassay Procedures for Assessment of Internal Radionuclide Deposition, NCRP Report No. 87, 1987.

U.S. Nuclear Regulatory Commission:

Acceptable Concepts, Models, Equations and Assumptions for a Bioassay Program, Reg. Guide 8.9, 1993.

NUREG/CR 4884; BNL-NUREG-52063; "Interpretation of Bioassay Measurements", Prepared for NRC, 1988.

Applications of Bioassay for I-125 and I-131, Reg. Guide 8.20, Rev. 1, 1979.

Information for Establishing Bioassay Measurements and Evaluations of Tritium Exposure, NUREG-0938, 1983.

U.S. Environmental Protection Agency:

Limiting Values of Radionuclide and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion, EPA, Federal Guidance Report No. 11, 1988.

U.S. Department of Energy:

Primer on Tritium Safe Handling Practices, DOE-HDBK-1079-94

MINIMUM COUNTING TIME CALCULATION

The lower limit of detection (LLD) for which the risks of false negative results and of false positive results are each 5% is defined as follows:

$$\text{LLD} = 4.66(\text{SD}_b)/\text{Eff}$$

where:

LLD = disintegrations in sample in time T = VL x Vol x T

4.66 = the product of the distribution parameters needed to establish the 5% error limits

SD_b = standard deviation of the background (distilled water) count

$$= N_b^{0.5} = (R_b \times T)^{0.5}$$

N_b = total background counts in time T

R_b = background count rate, in cpm

Eff = detection efficiency, in counts/dis

(a nominal efficiency may be used for screening assays, whereas it should be determined experimentally for verification assays)

VL = verification level for elapsed interval since last bioassay, in dpm/mL

Vol = volume of urine in sample, in mL

T = minimum counting time required, in minutes

$$= R_b(4.66/(\text{VL} \times \text{Vol} \times \text{Eff}))^2$$

BIOASSAY GUIDELINES

For Urinalyses for Selected Radionuclides ⁽¹⁾

Nuclide	Elapsed interval (weeks)	ISU Action Levels (dpm/ml)			NRC Action Levels (dpm/ml)		Assumed Efficiency (%)	Min. counting time ⁽⁴⁾ (min)
		ISU Verif. Chronic Intake	ISU Verif. Bolus Intake	ISU Invest. Bolus Intake	NRC Verif. Bolus Intake	NRC Invest. Bolus Intake		
H-3	1	5 800	6 800	170 000	68 000	340 000	> 25	1
	8	1 500	250	6 400	2 500	12 800	> 25	1
	max. 13	220	21	530	210	1 060	> 25	1
C-14 ^(2,3)	1	1	2	56	20	112	> 30	12
	max. 8	6	1	25	10	50	> 30	60
P-32	1	16	15	380	150	760	> 80	1
	2	13	6.5	180	65	320	> 80	1
	3	10	3.5	86	35	172	> 80	1
	max. 4	7	1.5	37	15	74	> 80	4
S-35	1	64	48	1 200	480	2 400	> 40	1
	4	100	18	450	180	900	> 40	1
	max. 8	65	6	160	60	320	> 40	1
Cl-36 ⁽³⁾	1	270	100	2 500	1 000	5 000	> 50	1
	4	250	20	520	200	1 040	> 50	1
	max. 8	71	4	100	40	200	50	2
Cr-51 ⁽³⁾	1	130	100	2 800	1 000	5 600	> 50	1
	4	48	50	1 200	500	2 400	> 50	1
	8	19	15	360	150	720	> 50	1
	max. 13	9	5	120	50	240	> 50	1
Co-60 ⁽³⁾	max. 1	-	0.4	9	3	18	> 50	150

For Thyroid Monitoring for Radioiodines

Nuclide	Elapsed interval (weeks)	ISU Action Levels (nCi)			NRC Action Levels (nCi)	
		ISU Verif. Chronic Intake	ISU Verif. Bolus Intake	ISU Invest. Bolus Intake	NRC Verif. Bolus Intake	NRC Invest. Bolus Intake
I-125 ⁽⁵⁾	1	21	NA	530	NA	NA
	2	38	NA	470	NA	NA
	4	59	NA	370	NA	NA
	8	72	NA	230	NA	NA
	13	64	NA	120	NA	NA
I-131	1	9.4	8	200	80	400
	2	9.9	4	110	40	220
	4	5.4	1	24	10	48
	8	0.8	0.1	2.7	1	5.4
	13	0.05	0.004	0.1	0.04	0.2

- (1) If the nuclide(s) you work with are not listed, or if your counting instrument has a significantly different background count rate (> 20 cpm) or counting efficiency from that listed above, contact the RSO for appropriate maximum intervals, sample volume and counting time.
- (2) CO₂ gas
- (3) A IRF value for urine is not defined in NUREG 4884. The radionuclide goes preferentially in systemic organs or in the whole body and probably other bioassay method (e.g. feces analysis) will be more reliable to assign the dose. This would be the practice in case of important intakes and will be decided by the RSO.
- (4) a 9 ml sample was assumed.
- (5) IRFs values are not defined in NUREG 4884.
- NA Not Available.

RPR 12A. URINALYSIS SCREENING ASSAY

Name: _____

Soc. Sec. No. _____

Department: _____

Work Location: _____

Radionuclides used since last bioassay:

Action Levels

<u>Nuclide</u>	<u>How Much?</u>	<u>How Long Ago?</u>	<u>Verification</u>	<u>Investigation</u>
_____	___ mCi	___ weeks	___ dpm/mL	___ dpm/mL
_____	___ mCi	___ weeks	___ dpm/mL	___ dpm/mL

Check here if all records of contamination surveys, both by the user and the RSO, indicate no personal contamination and no exposure to unconfined radioactive materials exceeding the levels specified under "Conditions Requiring Bioassays" in the procedure.

Check here if you have used no dispersible radioactive materials since your last bioassay.

If you have checked either of the above exemption statements, provide the signatures and return the form to the RSO.

Assay Data: Sample collection date: _____

Date counted: _____

Instrument used (make, model, S.N.): _____

Sample: _____ mL Fluor: _____ mL

Count time: _____ minutes

Total counts from samples - Urine: _____ Distilled water: _____

Nominal counting efficiency for the assay = _____ counts/dis

Concentration in dpm/mL:

$$\frac{\text{(Urine sample counts)} - \text{(Distilled water sample counts)}}{\text{(Sample volume, mL)} \times \text{(Count time, min)} \times \text{(Efficiency, counts/dis)}}$$

= _____ dpm/mL Less than the appropriate verification level? Yes No

If less than the verification level, sign the form and obtain the signature of the authorized user; then send the form promptly to the RSO.

If the result exceeds the verification level, proceed with a verification assay, using the following form (RPR 12B) for reporting.

Signatures:

Counted by: _____

Responsible User: _____

RSO verification of survey data: _____ (Analyst or RSO)

RPR 12B. URINALYSIS VERIFICATION ASSAY

Name: _____

Soc. Sec. No. _____

Sample collection date: _____

Date counted: _____

Instructions:

1. Complete the "Screening Assay" procedure.
2. Add a known activity of the nuclide of greatest concern to each sample (urine and distilled water) and count again to determine the true efficiency. (NOTE: The volume of the spike must be small enough so that it does not change the original counting characteristics of the sample.) If the appropriate nuclide is not available in a solution of known concentration from which a spike can be obtained, discuss the requirement with the RSO.
3. Calculate the counting efficiency and convert the final results to disintegrations per minute per milliliter of sample (dpm/mL).

Assay Data: Instrument used: _____

Sample: _____ mL Fluor: _____ mL Count time: _____ minutes

Activity added to sample for efficiency determination:

Source: Inventory No. _____ Concentration: _____ dpm/mL

Volume added: _____ mL Activity: _____ dpm

Total counts obtained from samples: Untreated Spiked

Urine samples: _____

Distilled water samples: _____

Efficiency In counts/dis:

$$\frac{(\text{Spiked urine sample counts}) - (\text{Untreated urine sample counts})}{(\text{Count time, min}) \times (\text{Spike activity, dpm})}$$

= _____ counts/dis

Concentration In dpm/mL:

$$\frac{(\text{Untreated urine sample counts}) - (\text{Untreated distilled water sample counts})}{(\text{Sample volume, mL}) \times (\text{Count time, min}) \times (\text{Efficiency, counts/dis})}$$

= _____ dpm/mL

Less than investigation level? Yes No

If less than the investigation level, complete the signatures and mail the form to the RSO. If the result exceeds the investigation level, confer with the RSO to determine appropriate follow-up assays.

Signatures:

Counted by: _____

Responsible User: _____

RPR 12C. THYROID MONITORING REPORT

Name: _____

Soc. Sec. No.: _____

Instructions:

1. Record successive counts for one individual until the sheet is filled, or until a verification assay is required, as long as the same instrument is used and the calibration is still valid.
2. Use the same counting time for all counts.
3. Convert to thyroid activity if counts exceed an action level.

Instrument and calibration data:

Scaler - model: _____

Ser. No. _____

Detector - model: _____

Ser. No. _____

Calibration date: _____

Count time: _____ min or sec

Efficiency (net counts/nCi): _____

I-125: _____ I-131: _____

I-129 check source ID: _____

Net counts in phantom: _____

Screening assay data:

<u>Date</u>	<u>Nuclide Used</u>	<u>Elapsed Interval (weeks)</u>	<u>Verif. Level (nCi)</u>	<u>Phantom Counts</u>		<u>Thyroid Data</u>			<u>By</u>
				<u>Bkad.</u>	<u>I-129</u>	<u>Gross (cts)</u>	<u>Net (cts)</u>	<u>(nCi)</u>	
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

Submit the form for filing after the above spaces have been filled, or after one verification assay has been recorded, whichever comes first.

Verification assay data:

If screening assay exceeds the verification level, make a measurement on the thigh to determine contribution from blood pool. Use the thigh measurement as the background to determine net activity in thyroid:

$$\frac{\text{(Total counts from thyroid)} - \text{(Total counts from thigh)}}{\text{(Efficiency, net counts per nCi)}} = \text{_____ nCi}$$

If the verification assay result does not exceed the investigation level, submit the form although no further action is required. If the investigation level is exceeded, report to the RSO and initiate an investigation.

Reviewed by: _____

Date: _____

RPR 13 RADIOISOTOPE ACQUISITION AND DISPOSITION

1.0 PURPOSE

This procedure specifies measures for the control of radioactive materials from initial acquisition to final disposition by the Responsible User. It describes the prerequisites for acquiring radioactive materials. It specifies the procedures and forms for surveying and reporting the receipt of radioactive materials, for maintaining radioactive inventory records, and for reporting all transfers and disposals of radioactive materials. Radioactive waste categories are described, along with acceptable methods for segregation, packaging, labeling and reporting the disposal of such wastes. A separate procedure, RPR 54 covers waste management by the Technical Safety Office (TSO) and the Responsible Users.

2.0 POLICY

Radioactive materials may be used for any legitimate educational, clinical or research purpose. However, they shall be purchased, or obtained, by individuals specifically authorized by the Radiation Safety Committee (RSC). The use of radioactive materials is conditional upon compliance with specific procedures established by the RSC. Radioactive Material (RAM) purchases can be made on a University Purchase Orders only. The use of a 250 purchase order for RAM requests is not allowed and the TSO will return the request to the responsible user for resubmittal.

2.1 Radioactive Material Purchases

The permission of the Radiation Safety Officer (RSO) or a designated alternate, shall be obtained, before any radioactive materials can be obtained by a Responsible User. The receipt of any radioactive material that is not obtained through the RSO, should be reported promptly to the TSO.

2.2 Radioactive Material Obtained from College of Engineering's Reactor

The College of Engineering's reactor program is allowed, under its reactor license, to produce radioactive materials. Subsequently, all requests for radioactive material, from the reactor program, shall be treated as a normal purchase of radioactive material. All requests for radioactive material from the reactor program shall be submitted to the TSO on a "Radioactive Material Request Form" (RPR 13F).

If the request is for an authorized material it will be processed promptly; However, if the request is for an unauthorized material it will be returned to the user until proper authorization is obtained.

2.3 RAM obtained from Physics Departments Accelerators

The Physics department has accelerators that are capable of producing radioactive isotopes. Any requests for radioactive material from the Physics Department shall also be treated as a normal purchase of radioactive material. All request must be submitted to the TSO on Form RPR 13F.

2.4 Radioactive Material Accountability

Each user of radioactive materials (RAM) shall maintain a complete record of all acquisitions, uses, transfers and disposals of such materials and provide this data to the TSO in a timely manner. Before any radioactive materials can be transferred to another responsible user, or to another organization, authorization shall be obtained from the TSO.

2.5 Radioactive Waste Handling

Radioactive waste materials must be segregated by nuclide and all radioactive material labels removed by the responsible user prior to collection for disposal by the TSO. For the safety of all personnel involved in radioactive waste disposal, responsible users must take all reasonable precautions to deactivate, detoxify, and neutralize biological waste materials. When chemical agents are involved with radioactive wastes, consideration must be given with storage so as to not mix incompatible chemicals. Mixed wastes are not allowed at ISU (see ISU Radiation Safety Policy Manual pg xxxi).

3.0 DEFINITIONS

"Animal" waste means carcasses or parts of animals administered radioactive materials; it also includes collected excreta and combustible bedding materials, e.g. shavings or sawdust.

"Assay Date" is the date that the manufacture certifies the activity of the isotope.

"Aqueous" means a liquid that is soluble or readily dispersible in water and which contains no chemicals classified as toxic or hazardous; except for limits on radioactivity, aqueous liquid wastes are those which may be discarded to the sewer.

"Decay Date" the date radioactive material can be disposed of as normal non-radioactive material. This period shall not be less than 10 half-lives from the materials "Assay Date."

"Dry" waste means any solid, non-putrescible, dry waste, e.g., paper, plastics, glassware and metals, that does not contain any compressed gases, pyrophoric or other hazardous materials, including lead.

"LS media" means any mixture of solvents and fluors used for liquid scintillation counting.

"Mixed waste" means any mixture of a radionuclide with a regulated hazardous chemical.

"NHNT" means nonhazardous, nontoxic, non-flammable aqueous liquid.

"Pathogenic" means any material potentially containing pathogenic organisms, toxins, infectious agents, etc.

4.0 PURCHASING PROCEDURES

All purchases of radioactive materials and those materials that are obtained from the reactor or accelerator programs must be initiated on a **"Radioactive Material Purchase Permit"** (RPR 13F) and submitted to the TSO. If the order is for an authorized isotope and quantity, it will be processed promptly. If the user is not authorized to possess the isotope type or quantity ordered, the request will be held, by the TSO, until proper authorization is obtained. The requisition shall contain the name of the responsible user and an accurate description of the radioactive material, including the isotope and the total activity, e.g. millicuries, not just a catalog number.

4.1 Radioactive Material Control Records

A serialized, multi-part form (RPR 13A,B & C) is used for tracking of all radioactive material, from the time it arrives at the University until it is transferred or disposed of as radioactive waste. For radioactive materials acquired through normal purchasing channels, the reactor program, or the accelerator program, the forms for reporting the contamination survey of a package, verification of its contents, and for reporting the disposition of the material will be initiated by the TSO. For materials acquired by any other means, the user is responsible for promptly notifying the TSO and providing the information necessary to initiate the form.

4.2 Package Arrival Report (RPR 13A)

When radioactive material is received, the TSO will initiate the record by entering the identification of the user, the material, and the results of the external survey of the package on forms RPR 13A, B, and C. Form RPR 13A, when completed, will be placed in section 1 of the **"Radioactive Waste Log."** RPR 13B will be placed in the **"Radioactive Material**

Inventory Book." And, form RPR 13C, which contains the same serial number and identification data as 13A and 13B, is forwarded with the package to the Responsible User.

A fourth form RPR 54D DISPOSAL LOG is available to the user as a supplement to RPR 13C. When the radioactive material is returned to the TSO as radioactive waste, forms RPR 13A, 13B, and 13C are joined together and placed in the appropriate section of the "Radioactive Waste Log" (see RPR 54).

4.3 Receipt and Verification (RPR 13B)

Each new acquisition of radioactive material is reported on the "RADIOISOTOPE RECEIPT AND VERIFICATION" form (RPR 13B). In accordance with 10 CFR 20.1906.c, all radioactive material shall be surveyed by the TSO not later than three hours of its arrival on the ISU Campus, if the package was received during normal working hours. If the package arrives at the ISU campus after normal working hours, then the package shall be surveyed not later than three hours from the beginning of the next working day. Any discrepancies in the package contents are to be noted on the form. The survey data and verification of the package contents are to be retained by the Technical Safety Office in the "Isotope Inventory Book." When the material is returned to the TSO as waste, RPR 13B will be attached to RPR 13A and placed in the appropriate section of the "Radioactive Waste Log."

Additionally, the TSO will recalculate a new "Bioassay Interval" (RPR 12) and a new "Laboratory Evaluation Interval" (RPR 50) for each new isotope shipment.

4.4 Disposition Record (RPR 13C)

All dispositions of radioactive materials are to be recorded, by the user, on the "RADIOISOTOPE DISPOSITION RECORD" (RPR 13C). To avoid incomplete records and possible oversights, the disposition of material should be recorded either directly on the disposition form (RPR 13C) or on a "DISPOSAL LOG" sheet (RPR 54D) at the time it is placed in a waste container. However, the material will not be removed from the Isotope Inventory Book until the disposition form is returned to the TSO. When the material is returned to the TSO as radioactive waste, RPR 13C will be attached to forms 13A and 13B and placed in the appropriate section of the "Radioactive Waste Log" (see RPR 54)

To minimize errors in calculation of the activity used or disposed of at various times, dispositions should be reported, on RPR 13C, as percentages of the original quantity without regard to the radioactive decay or subsequent dilutions. Quantities may be reported as actual activities, e.g. microcuries or millicuries, but care must be taken to avoid errors. The reported dispositions must account for the original quantity within a reasonable degree of accuracy or the form may be returned to the user for correction.

4.5 Disposal Log (RPR 54D)

The "DISPOSAL LOG" (RPR 54D) is an optional form to aid radiation users in accounting for frequent disposals of small quantities of radioisotopes. Each "DISPOSAL LOG" sheet should be used for only one disposal method or waste container. When frequent disposals are made to the same waste container, the quantities may be summed for periods of up to a week for entry on the "RADIOISOTOPE DISPOSITION RECORD" (RPR 13C). The total activity placed in each waste container must be recorded on its "RADIOACTIVE WASTE TAG" (RPR 13E). This form should remain with the Radioisotope Disposition Record.

5.0 TRANSFERS TO OTHER UNIVERSITY USERS

Radioactive materials may be transferred between responsible users provided that the user possessing the material has checked with the TSO to verify the receiving user is allowed to possess the isotope and that the transfer is reported properly. The first user must record the transfer on the original "RADIOISOTOPE DISPOSITION RECORD" (RPR 13C) and the receiving user must request a new form from the Technical Safety Office on which to record the disposition of the material.

Radioactive materials transferred by vehicle between buildings must be packaged and labeled in accordance with US Department of Transportation regulations. Follow the instructions in RPR 14, "LOCAL TRANSPORT OR SHIPMENT OF SMALL QUANTITIES OF RADIOISOTOPES."

6.0 TRANSFER TO NON-UNIVERSITY USERS

The user who wishes to send radioactive material to another institution must notify the TSO of the intended transfer. **The user will not transfer any material until specific approval is received from the TSO.** In accordance with 10 CFR 30.31.c, the TSO must obtain confirmation of the other institution's license before the transfer is made. Additionally, the TSO must verify that the material is shipped in accordance with the regulations of the US Dept. of Transportation. A user planning on shipping material to another institution, should refer to "LOCAL TRANSPORT OR SHIPMENT OF SMALL QUANTITIES OF RADIOISOTOPES" (RPR 14) or "TRANSPORTATION OR SHIPMENT OF RADIOACTIVE MATERIALS" (RPR 55) for instructions.

7.0 EMPTY CONTAINERS

If an empty radioisotope container is not contaminated, it should be disposed of as nonradioactive trash. All radiation symbols and warning labels must be obliterated before an empty container is discarded. Discarded lead containers must be kept separate, but will be picked up, by the TSO, for recycling or disposal.

8.0 UNCONTAMINATED DRY WASTES

Whenever possible, potentially contaminated waste materials, e.g. gloves, absorbent paper, etc., should be surveyed before disposal. If the absence of radioactive contamination can be verified by direct survey, remove or obliterate all radiation labels and discard the material as ordinary trash.

Since tritium (H-3) cannot be detected by direct survey, materials potentially contaminated with tritium must be assumed to be contaminated. For other low-energy beta emitters, e.g. C-14, S-35, etc., direct surveys can detect contamination only on directly accessible surfaces. For high-energy beta (e.g. P-32), x ray (e.g. I-125) or gamma (e.g. Na-24) emitters, direct surveys with appropriate instruments can detect contamination beneath surface layers.

9.0 DRY RADIOACTIVE WASTES

Solid wastes that do not contain putrescible or pyrophoric materials, compressed gases or free liquids are collected and handled as dry radioactive waste. Wastes containing only short-lived nuclides (half-lives of less than <120 days), will be packaged separately and disposed of by radioactive decay. Radioactive waste that contains long-lived nuclides (half-lives >120 days) will be packaged by the TSO for disposal to a licensed disposal facility.

Syringes, needles, pipettes, etc. must be placed in standard "sharps" or other puncture-proof containers. The user shall provide a covered garbage can of an appropriate size (no larger than 25 gallons); the RSO provides labels and plastic bag liners. As materials are added to the container, the isotopes and quantities should be recorded on a "DISPOSAL LOG" (RPR 54D) or the "RADIOISOTOPE DISPOSITION RECORD" (RPR 13C).

Labels shall be removed from all radioactive material that is placed inside a radioactive waste container.

10.0 DISPOSAL TO THE SANITARY SEWER SYSTEM

Only the TSO is allowed to dispose of liquid radioactive wastes to the sanitary sewers. This is contingent upon if it will meet one of the following criteria:

- 1** Small quantities of radionuclides that are readily soluble or dispersible in water, and contain no toxic or hazardous substances;
- 2** Waste water from washing of contaminated persons or equipment and that the total activity to be released is verified with reasonable accuracy and recorded in the responsible users program file.

All disposals to the sanitary sewers is contingent upon the TSO knowing the chemical solubility of the liquid or if it is a biological waste. If you know that your liquids are not soluble in water, inform the TSO by noting this on the "waste tags" (RPR 13 D).

11.0 LIQUID WASTE COLLECTION AND SEGREGATION

All radioactive liquid wastes are to be segregated and collected by the waste generator for disposal by the TSO. Separate containers are to be obtained for materials which would be incompatible if placed in the same container, e.g. aqueous solutions and organic solvents, as well as for different nuclides.

Liquid waste containers are to be unbreakable, e.g., plastic jugs or metal cans, and are to be placed in a secondary container of sufficient volume to collect all of the liquid in the event of a leak in the primary container.

Aqueous wastes must be neutralized to prevent violent chemical reactions when the wastes are transferred. Organic solvents and other hazardous materials must be clearly and completely identified to permit safe handling and disposal. No solid objects are to be placed in any liquid waste container and the materials must be sufficiently fluid to be poured from the container, even after storage for decay.

Biologically active materials are to be deactivated or detoxified at the time they are placed in the waste containers. A chlorine disinfectant (e.g. Chlorox brand liquid bleach) should be added to putrescible liquid wastes to retard putrefaction; the quantity depends on the concentration of organic material in the waste.

Frequent disposals to liquid waste containers may be recorded and summed on a "DISPOSAL LOG" (RPR 54D). Transfer the totals to the "RADIOISOTOPE DISPOSITION RECORD" (RPR 13C) at least weekly and to the "RADIOACTIVE WASTE TAG" (RPR 13E) before final disposal.

12.0 LIQUID SCINTILLATION MEDIA AND VIALS

Users are required to use "NHNT" LS media and to minimize the quantities of LS media used, to the maximum extent that is compatible with research requirements. The use of flammable LS media or standard vials should be justified in writing and approved by the Radiation Safety Committee.

Used vials are to be segregated, according to the LS medium and the radionuclides they contain, into one of the following categories:

- 1** Vials containing only "NHNT" media, H-3, C-14 and/or short-lived nuclides, (half-lives of less than 120 days).
- 2** "NHNT" media containing long-lived nuclides (half-lives >120 days) other than H-3 or C-14.
- 3** Any flammable solvent containing only H-3 and/or C-14.
- 4** Any flammable solvent containing only H-3, C-14 and/or short-lived nuclides, (half-lives <120 days) should be further segregated by nuclides.
- 5** Any flammable solvent containing long-lived nuclides other than H-3 or C-14.

Used vials containing LS media should be placed in their original containers for collection. Standard vials should be returned to their cardboard trays and cartons; mini-vials should be placed in plastic bags of approximately the same capacity as the original bags.

"RADIOACTIVE MATERIAL" labels should be removed from all vials, trays, bags and boxes of vials before they are transferred to the Technical Safety Office for disposal. The "RADIOACTIVE WASTE TAG" (RPR 13E) should be the only label indicating that the package contains radioactive material.

Vials are to be securely capped; cartons are to be securely taped and labeled to indicate the top, e.g., "this side up".

13.0 SPECIAL WASTES

Any radioactive wastes not included in the above categories, or exhibiting unusual hazards, or requiring special precautions of any kind, are handled under special arrangements with the TSO. Costs associated with handling, packaging, and/or disposal of abnormal radioactive wastes may be charged to the Responsible User. Whenever

unusual wastes are anticipated, the user should contact the TSO to plan for disposal before the wastes are generated.

14.0 LABELING OF RADIOACTIVE WASTES

All containers in which radioactive wastes are collected must be labeled "CAUTION - RADIOACTIVE MATERIAL" or "CAUTION RADIOACTIVE WASTE". Packages in which radioactive wastes are stored or transported must be labeled with a "RADIOACTIVE WASTE TAG" (RPR 13E). The radioactive waste tag shall be filled out by the responsible user prior to pickup by the TSO.

- 1** Each package should contain only one material category of waste and must be labeled with its own tag.
- 2** Check one material category and one nuclide category contained in the package.
- 3** List the isotope and its activity in the spaces provided. Enter the chemical or trade name of any scintillation fluor, tissue solubilizer, or and chemical that may be classified as flammable, hazardous or toxic in the space provided. For such materials, attach a "Chain of Custody Record Sheet" (available from the TSO) to the waste tag.
- 4** For liquid wastes, enter the volume (gallons) in a bulk container or the size of L.S. vials.
- 5** Verify whether the package contains any "RADIOACTIVE MATERIAL" labels or tape; circle "YES" or "NO" (all labels should be removed prior to placing any material in a radioactive material waste container).
- 6** Enter the name of the Responsible User; date and sign the tag to indicate compliance with the waste generator's certification.
- 7** The TSO will tie or tape the tag securely to the waste packages.

15.0 WASTE COLLECTION

Responsible users should contact the Technical Safety Office (282-2311) at least two days before a desired waste pick-up. All appropriate forms shall be filled out before the Technical Safety Office will accept custody of any waste.

The notice on the following page (RADIOACTIVE WASTE INSTRUCTIONS) will be posted at radwaste collection locations to remind users of the requirements.

When the isotope is no longer of use to the responsible user, the user should contact the TSO and schedule a waste pick-up. **The Responsible Users should not accumulate waste in their laboratories.**

RADIOACTIVE WASTE INSTRUCTIONS POST NEAR THE RADWASTE COLLECTION AREA

ALL USE OF RADIOACTIVE MATERIALS IS CONDITIONAL UPON COMPLIANCE WITH THE FOLLOWING REQUIREMENTS FOR PACKAGING AND LABELING RADIOACTIVE WASTES. NONCOMPLIANCE WILL NOT BE TOLERATED, SINCE IT JEOPARDIZES ALL LEGITIMATE USES. WASTE PACKAGES ARE BEING INSPECTED; IMPROPERLY PACKAGED OR LABELED WASTES MAY RESULT IN IMMEDIATE CURTAILMENT OF THE USE OF RADIOACTIVE MATERIAL.

- 1. ALL RADIOACTIVE WASTES MUST BE PROPERLY SEGREGATED - BY MATERIALS AND BY NUCLIDES.**
- 2. ALL SHARP OBJECTS MUST BE PLACED IN SEPARATE "SHARPS CONTAINERS".**
- 3. LEAD MUST BE KEPT SEPARATE, BUT WILL BE PICKED UP.**
- 4. THE RADIOACTIVE WASTE TAG MUST BE FILLED OUT COMPLETELY AND ACCURATELY, SIGNED AND DATED, BEFORE THE WASTE WILL BE ACCEPTED.**
- 5. THE ACTIVITY OF EACH NUCLIDE MUST BE ESTIMATED AS ACCURATELY AS POSSIBLE AND MUST BE CLEARLY SPECIFIED AS MILLICURIES OR MICROCURIES.**
- 6. IN ADDITION TO CHECKING THE APPROPRIATE CATEGORIES, THE WASTE TAG MUST INCLUDE A DESCRIPTION OF THE WASTES.**
- 7. CHEMICAL CONSTITUENTS OF THE WASTE MUST BE IDENTIFIED BY NAME. SCINTILLATION FLUORS MUST BE IDENTIFIED BY BRAND NAME OR BY COMPLETE CHEMICAL COMPOSITION.**
- 8. IF ALL THE NUCLIDES IN A WASTE PACKAGE HAVE HALF-LIVES OF LESS THAN <120 DAYS, AND IF ALL "RADIOACTIVE MATERIAL" TAPE OR LABELS HAVE BEEN REMOVED OR OBLITERATED, ANSWER "NO" TO THE QUESTION ABOUT "RADIOACTIVE MATERIAL" LABELS; OTHERWISE, ANSWER "YES".**
- 9. CALL FOR WASTE PICKUP (282-2311) AT LEAST 2 DAYS BEFORE IT BECOMES URGENT.**

If you have any questions or problems, call the Technical Safety Office at 282-2311.

RPR 13A RADIOISOTOPE PACKAGE ARRIVAL REPORT

00529 Program # _____ Responsible User: _____
 _____ Location: _____
 PO/Ref # _____ Nuclide _____ Initial activity _____ millicuries
 Date _____ Description _____

This package contains _____ other items: Nos. _____
 Verify every item and return all RECEIPT & VERIFICATION forms,
 but ONLY ONE PACKAGE SURVEY is required.

This inventory item is in _____ packages.
 Return all attached RECEIPT & VERIFICATION forms.
 Only one DISPOSITION form (attached) is to be completed.

Exposure Rate Survey Results:

<0.5 mrem/hr at surface
 or: _____ mrem/hr at surface
 _____ mrem/hr at 1 meter
 If >50 at surface or
 if >1 at 1 meter, label
 should be Yellow II or III

Contamination Survey Results:

<2000 net dpm/100 cm² direct
 or: _____ net dpm/100 cm² on wipe
 Above results by survey meter.
 Recipient to be notified by phone
 if contamination is found on wipe
 by liquid scintillation count.

"RADIOACTIVE" vehicle placards required to transport packages with YELLOW III labels
 Instruments: Model Ser. No. Calib. Date Efficiency

Contamination

Exposure rate

Liquid Scint.: _____
 * (Instrument identification, calibration data and efficiency are on file in ISU Technical Safety Office.)

Wipe results:	Count time	Total count rate	Background	Net count rate
Survey meter	_____	_____ + _____ cpm	_____ + _____ cpm	_____ + _____ cpm
LS counting	min _____	_____ cpm	_____ cpm	_____ cpm

(all channels)

If incorrect labeling is suspected, or if any contamination is found on the package,
 notify the recipient promptly.

If personal or vehicle contamination is suspected, notify the Radiation Safety Officer
 immediately. Any required notifications to the carrier or regulatory agencies is to
 be made by the RSO.

Package survey by _____

Original - Initiated and retained by ISU Technical Safety Office
 Copies to send with the package(s):
 RADIOISOTOPE DISPOSITION (RPR 13C) for each package and/or item.

RPR 13 ISOTOPE ACQUISITION & DISPOSITION (2/92)

RPR 13B. RADIOISOTOPE RECEIPT AND VERIFICATION

Inv. # **00529** Program #: _____ Responsible User: _____
 Dept.: _____ Location: _____
 FO/Ref. #: _____ Nuclide: _____ Initial activity: _____ millicuries
 Date: _____ Description: _____

- This package contains _____ other items: NOS. _____
 Verify every item and return all RECEIPT & VERIFICATION forms,
 but ONLY ONE PACKAGE SURVEY is required.
- This inventory item is in _____ packages.
 Return all attached RECEIPT & VERIFICATION forms.
 Only one DISPOSITION form (attached) is to be completed.

Exposure Rate Survey Results:

<0.5 mrem/hr at surface
 or: _____ mrem/hr at surface
 _____ mrem/hr at 1 meter
 If >50 at surface or
 if >1 at 1 meter, label
 should be Yellow II or III.

Contamination Survey Results:

<2000 net dpm/100 cm² direct
 or: _____ net dpm/100 cm² on wipe
 Above results by survey meter.
 Recipient to be notified by phone
 if contamination is found on wipe
 by liquid scintillation count.

PACKAGE OPENING INSTRUCTIONS:

1. Assume that container and packaging materials may be contaminated.
2. Open in hood, if possible; wear gloves; work over absorbent paper.
3. Use shielding and tongs for energetic beta or gamma emitters.
4. Monitor thoroughly for contamination, including packaging materials, work area, clothing, hands, etc.
5. Survey the inner container for removable contamination:
 Wipe with a small piece of filter paper and check the paper for activity.
 Use liquid scintillation counter for low-energy betas such as H-3, gamma counter
 for Cr-51, I-125 etc. or portable survey meter for energetic beta emitters such
 as P-32. Report results below.
6. Verify that the material description, nuclide and activity listed above are
 correct, or make corrections as necessary.

WIPE TEST RESULT: net cpm, by Survey Meter or Sample Counter

PACKAGE RECEIVED IN GOOD CONDITION? Yes or describe: _____

DESCRIPTION ABOVE IS ACCURATE OR HAS BEEN CORRECTED

Opened, surveyed and verified by: _____ Date: _____

RPR 13. ISOTOPE ACQUISITION & DISPOSITION (2/92)

RPR 13F. RADIOACTIVE MATERIAL PURCHASE AUTHORIZATION

1. All Radioactive Materials purchases requests must be cleared by the Technical Safety Office.
2. Radioactive material purchases must be submitted at least three working days in advance.
3. All Radioactive Material Purchase Orders are to be addressed as follows;

Responsible User's Name
c/o Technical Safety Office
Idaho State University
Shipping & Receiving Dept.
638 E. Dunn St.
Pocatello, ID. 83209

4. Forward the purchase request and this form to:

Technical Safety Office
Box 8106

The attached requisition specifies the purchase of radioactive material under Idaho State Universities radioactive material license.

Responsible User: _____ Program #: _____

Dept: _____ Supplier: _____

Authorized Isotope	Chemical/ physical form	Isotope Possession limit	Isotope Amount Requested
_____	_____	_____	_____

I certify I am allowed to possess this material and that this purchase will not exceed my radioactive material possession limit.

Responsible User Signature: _____ Date: _____

To be completed by TSO staff - This purchase request has been reviewed and verified by the TSO

Users Limit: _____ Users Current Inventory: _____

ISU Limit: _____ ISU Current Inventory: _____

Lab ALI's: _____ Bioassay Frequency: _____

Lab Survey Frequency: _____ Verified by: _____

TSO STAFF

I approve/disapprove this radioactive material purchase:

Radiation Safety Officer: _____ Date: _____

RPR 14 SHIPMENT OF EXCEPTED QUANTITIES OF RADIOISOTOPES

PURPOSE

This procedure contains instructions and checklists to assure compliance with federal regulations for shipment of excepted quantities of radioisotopes to other licensees or for transporting radioactive materials between buildings within the University.

POLICY

Radioactive materials may be transported on public roads or shipped to another licensee only after verification that all licensing, transfer, packaging, labeling and transportation requirements have been met. To assure that all requirements are met, and that appropriate records are maintained, a checklist must be prepared by the Technical Safety Office (TSO) before the shipment is made.

PROCEDURES

1. The person planning to transport radioactive material between University buildings or to ship to another institution must first contact the TSO.
2. For transportation of any quantities of radioactive materials the individual desiring authorization to transport the material shall complete the "REQUEST FOR SHIPMENT OF RADIOACTIVE MATERIAL" (RPR 14ISU-1) and submit it to the TSO before the material is transported.
3. TSO will verify appropriate material and package limits, and record findings on "CLASSIFICATION OF SHIPMENT OF LIMITED QUANTITY OF RADIOACTIVE MATERIAL" (RPR 14ISU-2).
4. For intramural shipment, when the TSO determines that the person requesting the shipment is qualified to transport the material, permission will be given using "AUTHORIZATION TO TRANSPORT LIMITED QUANTITY OF RADIOACTIVE MATERIAL" (RPR 14ISU-3)
5. Prior to off-campus shipment, the TSO must verify the license status and shipping address of the consignee, and approve the packaging and contamination survey, then contact the shipping coordinator to prepare shipping papers, and arrange transport.

DEFINITIONS - USDOT [References to 49 CFR]

Radioactive Material: Any material having a specific activity greater than 70 Bq/g (0.002 mCi/g), in accordance with 49 CFR 173.403. Also, any material with surface contamination (both fixed and non-fixed/removable) that, when averaged over each 300 cm² (46.5 in²) of all surfaces, is equal to or greater than .4 Bq/cm² (10⁻⁵ mCi/cm²) for Beta and Gamma emitters and low-toxicity Alpha emitters; and equal to or greater than .04 Bq/cm² (10⁻⁶ mCi/cm²) for all other Alpha emitters.

Limited Quantities: Packages that are exempt from specific packaging and labeling requirements because they contain no more than the following:

Solids: 0.001 A₁ of special form or
0.001 A₂ of other solids

Liquids: 0.0001 A₂

Additional limits are provided in 49 CFR 173.423.

Contamination Limits: Removable contamination on the surfaces of any package or vehicle shall be determined by wiping an area of 300 cm²; the measured activity on the wipe shall not exceed 3 nCi (6600 dpm) of beta emitters, natural uranium or thorium, or 0.3 nCi (660 dpm) for other alpha emitters [173.443].

Shipping Paper: A shipping order, bill of lading, manifest or other shipping document serving a similar purpose and containing the information required by 49 CFR 172.202, 49 CFR 172.203 and 49 CFR 172.204.

REFERENCES

- U.S. Department of Transportation (DOT) regulations, 49 CFR, Parts 171 through 178.
- U.S. Nuclear Regulatory Commission (NRC) regulations, 10 CFR, Parts 61 and 71.
- U.S. Postal Service Publication #6, Radioactive Materials, December 1975.
- U.S. Environmental Protection Agency (EPA) regulations, 40 CFR, Parts 260-262.

RPR 14 ISU-1 REQUEST FOR SHIPMENT OF RADIOACTIVE MATERIAL

This form is to be completed for transportation of any quantities of radioactive materials. The individual desiring transportation of the material shall complete the form and submit it to the TSO for approval before the material is transported. For repetitive intramural transfers of the same material, a generic form may be used repetitively. **THIS REQUEST IS VALID ONLY FOR MATERIALS POSSESSED BY IDAHO STATE UNIVERSITY** [References are to Department of Transportation regulations, Title 49, Code of Federal Regulations.]

For Transportation Between (Consignor/Consignee):

Name (RU): _____ Name (RU): _____
Address: _____ Address: _____
Phone: _____ Phone: _____

Package Contents and Hazardous Material Classification:

Description of Material (Solid/Liquid, Serial Number, Type of Packaging, etc.): _____

	Item Activity (Bq/Ci)	Package Activity (Bq/Ci)
<u>Nuclide</u>	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Type of Request

_____ One Time, One Way
_____ One Time, Round Trip (Same Day)
_____ Routine Shipment from _____ (date) to _____ (date)

_____ (Signature) _____ (Date)

**RPR 14 ISU-2 CLASSIFICATION OF SHIPMENT OF LIMITED QUANTITY OF
RADIOACTIVE MATERIAL**

Package Category for Packaging and Labeling

Initials

- _____ Initial here and use check list below if the package qualifies as a Limited Quantity (less than 10^{-3} A₁ for special form material. i.e. sealed source; less than 10^{-3} A₂ for solid material; or less than 10^{-4} A₂ for liquid material.) [49 CFR 173.423].
- _____ Initial here and proceed to RPR 55 if package exceeds Limited Quantity.

For a Limited Quantity

- _____ DOT requires a strong, tight package that will not leak during conditions normally incident to transportation [49 CFR 173.24 and 49 CFR 173.421]. A metal or plastic file box or toolbox with latching lid is suggested for repeated use.
- _____ Names of consignee and consignor on outside of package.
- _____ This statement must be on the package, on the shipping paper, or otherwise accompany the shipment: "Idaho State University. This package conforms to the conditions and limitations specified in 49 CFR 173.421 for excepted radioactive material, limited quantity, n.o.s., UN2910." [49 CFR 173.421-1(a)]
- _____ The inner package or, if there is no inner packaging, the outside of the packaging itself bears the marking "Radioactive". [49 CFR 173.421(d)]

Radiation Survey

Dose rates measured with _____ (Model)

Ser. No.: _____ Calibration date: _____

_____ Maximum at surface = _____ mrem/hr (For Limited Quantity, maximum at surface must be less than or equal to 0.5 mrem/hr [173.421]).

Contamination measured with _____ (Model)

Ser. No.: _____ Efficiency: _____ Calibration date: _____

Count rates: Gross: _____ cpm Background: _____ cpm Net: _____ cpm

_____ Less than 0.3 nCi (660 dpm) alpha and less than 3 nCi (6600 dpm) beta-gamma removable contamination per wipe of 300 cm². [49 CFR 173.421, 49 CFR 173.443(a)]

Surveyed by (signature): _____

Date: _____

RSO approval (signature): _____

Date: _____

RPR 30 X-RAY MACHINES

PURPOSE

This procedure specifies requirements for x-ray machines, including registration, physical safety features, training and operational requirements for users, and regular safety inspections.

POLICY

All operable x-ray generating machines used in Idaho State University facilities must be authorized by the Radiation Safety Committee and must be registered by the Idaho Radiation Control Agency (Idaho Department of Health and Welfare). All authorizations and registrations shall be submitted to the Radiation Safety Officer (RSO) for review and processing. The RSO must also be notified before moving, transferring or disposing of any x-ray machine.

The responsible user for each x-ray machine shall assure that operating and emergency procedures are available and that each operator has received appropriate specific training and understands and follows the correct procedures. Each responsible user should obtain a copy of IDAPA 16, DOCKET No. 16-0227-9701, from the RSO and be familiar with its contents.

DEFINITIONS

"Analytical x-ray" refers broadly to machines or systems used for research, for example to determine the composition or microstructure of materials by means of diffraction or fluorescence analysis or to irradiate materials for testing. Specifically excluded are medical diagnostic or therapeutic units.

"Beam-blocking device" means any part of an analytical x-ray machine or accessory that may be struck by x-rays, such as radiation source housings, ports and shutter assemblies, collimators, sample holders, cameras, goniometers, detectors and shielding.

"Exposed beam" means the operation of a normally enclosed x-ray machine with any beam-blocking device removed and the x-ray beam on.

"Fail safe characteristics". A design feature which causes beam port shutters to close, or otherwise prevents emergence of the primary beam, upon the failure of a safety or warning device.

"Interlock". A device arranged or connected such that the occurrence of an event or condition is required before a second event or condition can occur or continue to occur.

"Open beam configuration". An x-ray system in which an individual could accidentally place some part of his body in the primary beam path during normal operation.

“Radiation user”. A “radiation user” is any individual whose official duties or authorized activities include handling, operating, or working in the presence of, any type of radiation source, whether or not such use is confined to a restricted area. Radiation user includes all the *badged personnel* as well as the *minimally exposed personnel*.

“Badged personnel” are individuals who could receive more than one tenth (10%) of the ISU occupational radiation dose limit. This category includes those personnel who rarely receive more than 100 mrem/year, but who work with radiation sources that could produce a significant dose accidentally. Radiation doses to these individuals are individually monitored.

“Minimally exposed personnel” are individuals who are unlikely to receive one-tenth (10%) of the ISU occupational radiation dose limit. This category includes individuals who routinely handle only small quantities of radioactive materials (e.g. students that use small, non-dispersible radiation sources as part of a scheduled laboratory course under the supervision of an instructor).

“Potentially exposed personnel” are individuals who have a need to enter Controlled or even Restricted Areas as part of their job description or have a potential of exposure to a radiation source but do not normally work in the presence of a radiation field. This category includes janitorial, receiving and security personnel. The potentially exposed personnel should not enter in a High Radiation Area. A potential exposed individual is very unlikely to receive one-tenth (10%) of ISU occupational radiation dose limit.

“Responsible user”. An individual authorized by the Radiation Safety Committee to acquire and use specific radiation sources, and to supervise their use by others, in compliance with pertinent regulations and under conditions approved by the Committee. Responsible users must demonstrate, to the satisfaction of the Committee, competence in the safe use of radiation sources by virtue of appropriate training and experience. Responsible users must assume full responsibility for all radiation sources under their control.

“Radiation machine”. Any device (industrial x ray system, analytical x ray system, diagnostic x ray system, particle accelerators, etc. - see the specific definitions in IDAPA 16) capable of producing radiation except devices which produce radiation only from radioactive material.

“Restricted Area”. Any area access to which is controlled by the licensee or registrant for purposes of protection of individuals from exposure to radiation/or radioactive material. Restricted area does not include any areas used for residential quarters, although a separate room or rooms in a residential building can be set apart as restricted area.

"Unrestricted Area". Any area access to which is not controlled by the licensee or registrant for purposes of protection of individuals from exposure to radiation and radioactive materials, and any area used for residential quarters.

"X ray machine". Any industrial x ray system, analytical x ray system, diagnostic x ray system, fluoroscopic x ray system, dental x ray system as defined in IDAPA 16, DOCKET No. 16-0227-9701.

EQUIPMENT REQUIREMENTS

The requirements specified in regulation IDAPA 16, DOCKET No. 16-0227-9701 apply to all of the University's x-ray machines as modified by the registration agreements between the State and University for each radiation machine. The important requirements are itemized in "X-RAY MACHINE SAFETY INSPECTION" (RPR 30A). This record is to be completed by the responsible user at the time the machine is first registered and submitted to the RSO. The inspection form is also to be used by the responsible user as a safety check list after any maintenance or modification that requires disassembly or for the verification of safety devices at time intervals required by the IDAPA 16, DOCKET No. 16-0227-9701 for each type of machine. The inspection form is also to be used by TSO for the annual evaluation of the safety systems of X ray machines.

OPERATING REQUIREMENTS

Each person who will operate or maintain x-ray equipment shall first receive appropriate instruction and demonstrate competence to the satisfaction of the Responsible User. Written covering both normal and abnormal (emergency) conditions shall be available to, and followed by, all users of x-ray equipment. The operating procedures shall include step-by step detailed instructions for sample insertion and manipulation, equipment alignment, routine maintenance by the user and recording of data related to radiation safety.

No person shall bypass a safety device without the written authorization of the RSO. Individuals who expect to perform maintenance that requires the presence of the primary beam when beam-blocking devices are removed must be authorized in advance by the Radiation Safety Committee and must notify the RSO that such work is expected.

RADIATION SURVEYS

The RSO will survey the radiation exposure rates in accessible areas near an x-ray machine at least once a year. The responsible user must request, or perform and record, a radiation survey:

- 1 following any change in the arrangement, number or type of components that effect radiation field,
- 2 any time a visual inspection reveals an abnormal condition,
- 3 during any maintenance or alignment procedure that requires the presence of a primary x-ray beam when a component is disassembled or removed.

EXPOSURE MONITORING

Users of open beam x-ray units, and users of enclosed units who are approved to perform maintenance procedures with an exposed beam, are classified as normally exposed radiation users. Each normally exposed radiation user of x-ray equipment must complete the "RADIATION USER PERSONAL DATA" form (RPR 1A). An appropriate dosimeter (TLD whole body and/or finger badges) will be issued within approximately two weeks after the data form is received by the RSO. The dosimeter must be worn whenever the x-ray machine is operating and must be kept in an unexposed location at all other times.

All dosimeters must be returned promptly at the end of the monitoring period.

Users of enclosed x-ray equipment who are not specifically approved to perform maintenance procedures with an exposed beam are classified as minimally exposed and are not issued personal dosimeters.

Any suspected exposure to the primary beam of an x-ray machine must be reported promptly to the RSO.

REFERENCE

IDAPA 16, DOCKET No. 16-0227-9701, *Idaho Radiation Control Rules*, Idaho Department of Health and Welfare.

"Structural Shielding design and Evaluation for Medical Use of X Rays and Gamma Rays of Energies up to 10 MeV", NCRP Report No. 49.

RPR 30A. X-RAY MACHINE SAFETY INSPECTION

Responsible user _____ Phone _____ Inspection date _____

Location (Bldg. & Room) _____ X-ray tube(s): _____

Type and use:

_____ Open beam _____ Medical _____ Fully enclosed _____ Industrial _____ Diffraction _____ Fluorescence

FACILITY REQUIREMENTS	
"CAUTION - X-RAY EQUIPMENT" (or equivalent) sign at entrance?	Yes No
"NOTICE TO EMPLOYEES" posted conspicuously?	Yes No
Was the last TSO evaluation performed no more than 12 months ago?	Yes No
Was the last user's inspection no more than 3 months ago (industrial X ray) (*)?	Yes No
Was the last user's safety check no more than 1 month ago (analytical X ray) (*)?	Yes No
Since the last radiation survey, have occurred the removal or the disassembly of any component that normally stops the primary beam?	No Yes
Control booth according to IDAPA 16/203.04 (*)	Yes No
Viewing system according to IDAPA 16/203.04.c	Yes No
Gloves and Aprons available	Yes No
Technical charts available	Yes No
Entry doors visible from X-ray booth	Yes No
EQUIPMENT REQUIREMENTS	
Filtration adequate (*)	Yes No
Filter permanently installed (*)	Yes No
Collimating functions (*)	Yes No
Tube housing and collimator meet leakage requirements (*)	Yes No
Focal point location indicator (*)	Yes No
Safety Devices	
Required on open beam units - a device that prevents any portion of the body from entering the primary beam, or a device that terminates the beam if obstructed.	Yes No
Signs and Labels	

"CAUTION: HIGH INTENSITY X-RAY BEAM" - adjacent to housing?	Yes	No
"CAUTION-RADIATION. This Equipment Produces Radiation When Energized"	Yes	No
Warning Lights or Devices		
"X-RAY ON" light - near any switch that energizes an x-ray tube.	Yes	No
Light must be illuminated only when the tube is energized.	Yes	No
Audible exposure signal	Yes	No
Control Panel Interlock		
If an interlock device turns off the primary x-ray beam, it must not be possible to resume operation without resetting the beam "ON" switch at the control panel.	Yes	No
Dead man switch	Yes	No
Ports and Shutters		
Unused ports on radiation source housing shall be secured in the "closed" position in a manner that will prevent casual opening, i.e. without the use of tools.	Yes	No
Beam Alignment Apparatus		
Any apparatus utilized in beam alignment procedures must be designed in such a way that excessive radiation will not strike the operator.	Yes	No
OPERATING REQUIREMENTS		
Are written emergency procedures for radiation safety posted in a conspicuous location?	Yes	No
Are written operating procedures available to all users of x-ray equipment?	Yes	No
PERSONNEL REQUIREMENTS		
Have all persons received general TSO Rad. Safety Training ?	Yes	No
Have all persons received specific Resp. Users' training ?	Yes	No
Personnel Monitoring		
Have personal monitoring devices been issued?	Yes	No
Have exposure reports been issued ?	Yes	No
RADIATION SURVEY DATA		
Radiation survey meter(s) available at facility:		
Make/Model: _____	Ser. No.: _____	Calibration Date: _____
Make/Model: _____	Ser. No.: _____	Calibration Date: _____

Radiation survey meter(s) used for this survey, if different:	
Make/Model: _____	Ser. No.: _____ Calibration Date: _____
Make/Model: _____	Ser. No.: _____ Calibration Date: _____
Survey results (with machine operating at usual maximum KVp and mA):	
Analytical machines:	
Maximum exposure rate within 5 cm from tube housing:	mR/hr
Is the exposure rate less than 2.5 mR/hr?	Yes No
Maximum exposure rate within 5 cm from protective cabinet:	mR/hr
Is the exposure rate less than 0.25 mR/hr?	Yes No
Medical machines:	
Maximum exposure rate at 1 m from the machine (in any direction):	mR/hr
Is the dose rate less than 100 mR/hr?	Yes No
All types of radiation machines	
Maximum exposure rate at operator's position:	mR/hr
Maximum exposure rate at the closest unrestricted area:	mR/hr
Other locations (description):	mR/hr
	mR/hr

(*) From the lighter to the darker cells: general provisions specific to all X-ray machines, provisions specific to industrial or analytical machines and provisions specific to medical machines, respectively.

(**) Not required to be filled by the TSO.

Surveyed By: _____

Upon completion, send this inspection report to:
 Technical Safety Office, Box 8106.

RPR 32 PARTICLE ACCELERATORS

PURPOSE

This procedure specifies requirements for particle accelerators used in research and education. Requirements include registration, physical safety features, training and operational requirements for users, and regular safety inspections. Accelerators used for the treatment of patients are excluded.

POLICY

All operable accelerators 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 authorizations and registrations shall be submitted to the Radiation Safety Officer (RSO) for review and processing.

The responsible user for each accelerator shall assure that operating and emergency procedures are available and that each operator has received appropriate training and understands and follows the operating protocol. Each responsible user should obtain a copy of IDAPA 16, DOCKET No. 16-0227-9701, from the RSO and be familiar with its contents.

DEFINITIONS

"Particle Accelerator". The term particle accelerator is very broad and covers many types of devices. It is generally defined as a device used to impart kinetic energy to electrically charged particles such as electrons, protons, deuterons, and helium ions, and is referred to herein to designate devices that accelerate particles to energies greater than approximately one (1) MeV. Accelerators used for treatment of patients are excluded.

"Radiation user". A "radiation user" is any individual whose official duties or authorized activities include handling, operating, or working in the presence of, any type of radiation source, whether or not such use is confined to a restricted area. Radiation user includes all the *badged personnel* as well as the *minimally exposed personnel*.

"Badged personnel" are individuals who could receive more than one tenth (10%) of the ISU occupational radiation dose limit. This category includes those personnel who rarely receive more than 100 mrem/year, but who work with radiation sources that could produce a significant dose accidentally. Radiation doses to these individuals are individually monitored.

"Minimally exposed personnel" are individuals who are unlikely to receive one-tenth (10%) of the ISU occupational radiation dose limit. This category includes individuals who

routinely handle only small quantities of radioactive materials (e.g. students that use small, non-dispersible radiation sources as part of a scheduled laboratory course under the supervision of an instructor).

"Potentially exposed personnel" are individuals who have a need to enter Controlled or even Restricted Areas as part of their job description or have a potential of exposure to a radiation source but do not normally work in the presence of a radiation field. This category includes janitorial, receiving and security personnel. The potentially exposed personnel should not enter in a High Radiation Area. A potential exposed individual is very unlikely to receive one-tenth (10%) of ISU occupational radiation dose limit.

"Responsible user". An individual authorized by the Radiation Safety Committee to acquire and use specific radiation sources, and to supervise their use by others, in compliance with pertinent regulations and under conditions approved by the Committee. Responsible users must demonstrate, to the satisfaction of the Committee, competence in the safe use of radiation sources by virtue of appropriate training and experience. Responsible users must assume full responsibility for all radiation sources under their control.

"Restricted Area". Any area access to which is controlled by the licensee or registrant for purposes of protection of individuals from exposure to radiation/or radioactive material. Restricted area does not include any areas used for residential quarters, although a separate room or rooms in a residential building can be set apart as restricted area.

"Unrestricted Area". Any area access to which is not controlled by the licensee or registrant for purposes of protection of individuals from exposure to radiation and radioactive materials, and any area used for residential quarters.

EQUIPMENT REQUIREMENTS

The requirements specified in regulation IDAPA 16, DOCKET No. 16-0227-9701 apply to all of the University's accelerators as modified by the registration agreements between the State and University for each accelerator. The important requirements are itemized in "PARTICLE ACCELERATOR SAFETY INSPECTION" (RPR 32A). This record is to be completed by the responsible user at the time the machine is first registered and submitted to the RSO. The inspection form is also to be used by the responsible user as a safety check list after any maintenance or modification that requires disassembly or for the quarterly verification of safety devices as required by the IDAPA 16, DOCKET No. 16-0227-9701. The inspection form is also to be used by TSO for the annual evaluation of the safety systems of particles accelerators.

OPERATING REQUIREMENTS

Each person who will operate or maintain an accelerator shall first receive appropriate instruction and demonstrate competence to the satisfaction of the responsible user.

Written procedures covering both normal and abnormal (emergency) conditions shall be available to, and followed by, all users of the particle accelerators.

Each accelerator user will receive a general Rad. Safety training from TSO and a specific training on IDAPA 16, operating protocol, emergency procedure, and other local rules.

No person shall bypass a safety device without the written authorization of the RSO. Individuals who expect to perform maintenance that requires the presence of the primary beam when beam-blocking devices are removed must be authorized in advance by the Radiation Safety Committee and must notify the RSO that such work is expected.

RADIATION SURVEYS

The RSO will survey the radiation exposure rates in accessible areas near an accelerator at least once a year. The responsible user must request, or perform and record, a radiation survey:

- 1 following any change in the arrangement, number or type of accelerator's components that affect radiation field,
- 2 any time a visual inspection reveals an abnormal condition.
- 3 during any maintenance or alignment procedure that requires the presence of a primary beam when a component is disassembled or removed.

EXPOSURE MONITORING

Users of accelerators are classified as normally exposed. Each normally exposed radiation user of accelerators must complete the "RADIATION USER PERSONAL DATA" form (RPR 1A). A whole body dosimeter (TLD badge) will be issued shortly after the data form is received by the RSO. The dosimeter must be worn whenever the accelerator is operating and must be kept in an unexposed location at all other times.

All dosimeters must be returned promptly at the end of the monitoring period.

Any suspected exposure to the primary beam of an accelerator must be reported promptly to the RSO.

REFERENCE

IDAPA 16, DOCKET No. 16-0227-9701, *Idaho Radiation Control Rules*, Idaho Department of Health and Welfare.

"Radiation Protection Design Guidelines for 0.1 - 100 MeV Particle Accelerator Facilities", NCRP Report No. 51.

"Radiation Alarms and Access Control Systems", NCRP Report No. 88.

"Accelerator Operations Safety Policy", Rev. 9 Sept 9, 1999, Accelerator Center Building.

RPR 32A. PARTICLE ACCELERATOR SAFETY INSPECTION

Responsible user _____ Phone _____ Inspection date _____
 Location (Bldg. & Room) _____ Accelerator identification _____

FACILITY REQUIREMENTS	
"CAUTION" or "DANGER HIGH RADIATION AREA" posted?	Yes No
Idaho Radiation Control Program's "NOTICE TO EMPLOYEES" posted ?	Yes No
NRC's "NOTICE TO EMPLOYEES" posted (wherever byproduct material is used) ?	Yes No
All radiation areas are conspicuously posted "CAUTION RADIATION AREA"?	Yes No
CONTROL AND INTERLOCK SYSTEMS	
Are all target areas and other High Radiation Areas interlocked as appropriate?	Yes No
Each safety interlock is on a circuit which will allow its operation independently of all other safety interlocks?	Yes No
All safety interlocks are designed so that any defect or component failure in the interlock system prevents operation of the accelerator?	Yes No
Scram or Emergency stop button located and easily identifiable in all High Radiation Areas; button must include a manual reset.	Yes No
WARNING DEVICES	
Rotating or flashing warning light at entrances to High Radiation Areas?	Yes No
Warning light is only operational when radiation is being produced?	Yes No
Audible indication of system activation (at least 15 sec prior to system activation) ?	Yes No
OPERATING PROCEDURES	
System secured from unauthorized use ?	Yes No
Copy of current operating procedures at the accelerator control panel?	Yes No
Copy of current emergency procedures at the accelerator control panel?	Yes No
Was the training program for operators implemented for all the machine's operators?	Yes No
Warning and safety devices are tested: - at least once every 3 months when in use ?	Yes No
- upon start up ?	Yes No
Circuit diagrams of the interlock system available ?	Yes No

RADIATION SURVEYS/MONITORING REQUIREMENTS	
Appropriate portable monitoring equipment available at facility ?	Yes No
Portable monitoring equipment tested for proper operation before use ?	Yes No
Biannual portable monitoring equipment calibration ?	Yes No
Is continuous monitoring of radiation levels in all High Radiation areas being performed ?	Yes No
Are the monitoring devices electrically independent of the accelerator control and interlock systems and capable of providing local readout at both the control panel and at entrances to high radiation areas ?	Yes No
Was the last radiation survey performed no more than 12 months ago ?	Yes No
When applicable, have periodic radioactive material contamination surveys been made to determine the degree of contamination in target and other pertinent areas?	Yes No
Are records of all radiation protection surveys, calibration results, instrumentation tests, and radioactive material contamination results on file and available for review?	Yes No
EQUIPMENT REQUIREMENTS	
Signs and Labels	
"CAUTION - RADIATION. THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED" - near switch used to turn on unit?	Yes No
Warning Lights or Devices - All Units	
"BEAM - ON" light - near any switch that energizes the system	Yes No
PERSONNEL REQUIREMENTS	
Have all persons received general TSO Rad. Safety Training ?	Yes No
Have all persons received specific Resp. Users' training ?	Yes No
Have all the operators received the adequate training program ?	Yes No
PERSONNEL MONITORING	
Have personal monitoring devices been issued?	Yes No
RADIATION SURVEY DATA	
Radiation survey meter(s) available at facility:	
Make/Model: _____	Ser. No.: _____ Calibration Date: _____
Make/Model: _____	Ser. No.: _____ Calibration Date: _____

Radiation survey meter(s) used for this survey, if different:	
Make/Model: _____	Ser. No.: _____ Calibration Date: _____
Make/Model: _____	Ser. No.: _____ Calibration Date: _____
Survey results (with machine operating at usual maximum parameters):	
Maximum exposure rate within 30 cm from the primary barrier:	mR/h
Is the dose equivalent rate less than 2.5 mrem/hr ?	Yes No
Maximum exposure rate at operator's position:	mR/h
Is the dose equivalent rate less than 2.5 mrem/hr ?	Yes No
Maximum exposure rate within 30 cm from the secondary barrier:	mR/h
Maximum exposure rate at the closest uncontrolled area:	mR/h
Is the dose equivalent rate less than 0.25 mrem/hr ?	Yes No
Maximum exposure rate at the closest public area:	mR/h
Other locations (description):	mR/h
	mR/h

Surveyed By: _____

Upon completion, send this inspection report to:
Technical Safety Office Box 8106.

RPR 44 RADIATION SAFETY TRAINING

PURPOSE

This procedure prescribes the training in radiation protection required for all individuals who may be exposed to ionizing radiation in the course of their official duties. The content and frequency of training sessions are specified for each category of radiation user.

POLICY

Each individual working with or in the presence of radioactive materials or other radiation sources is required to receive training or provide documentation showing they have received training in the applicable provisions of regulations and license conditions, in the potential health problems associated with exposure to radiation, in the precautions and procedures required for safe use of radiation, and in the proper use of protective and measurement devices. The extent of the training is to be commensurate with the potential risk of radiation exposure to the individual. Responsible users shall have their prior training evaluated by the RSO or RSOS or shall be trained by the RSOS. Responsible users shall ensure that subordinate employees or students working in their facilities are trained. This may be accomplished by requiring them to attend the training offered by the RSO or RSOS and supplementing this training with laboratory-specific and hands on training. Responsible users who elect to do their own training shall submit a statement to the RSO listing the individuals trained and the topics covered.

DEFINITIONS

Radiation user: A "radiation user" is any individual whose official duties or authorized activities include handling, operating, or working in the presence of, any type of radiation source, whether or not such use is confined to a restricted area. Radiation user includes all the *badged personnel* as well as the *minimally exposed personnel*.

Badged personnel are individuals who could receive more than one tenth (10%) of the ISU occupational radiation dose limit. This category includes those personnel who rarely receive more than 100 mrem/year, but who work with radiation sources that could produce a significant dose accidentally. Radiation doses to these individuals are individually monitored.

Minimally exposed personnel are individuals who are unlikely to receive one-tenth (10%) of the ISU occupational radiation dose limit. This category includes individuals who routinely handle only small quantities of radioactive materials (e.g. students that use small,

non-dispersible radiation sources as part of a scheduled laboratory course under the supervision of an instructor).

Potentially exposed personnel are individuals who have a need to enter the Controlled or even the Restricted Areas as part of their job description or have a potential of exposure to a radiation source but do not normally work in the presence of a radiation field. This category includes janitorial, receiving and security personnel. The potentially exposed personnel should not enter in a High Radiation Area. A potential exposed individual is very unlikely to receive one-tenth (10%) of the ISU occupational radiation dose limit.

Responsible user: An individual authorized by the Radiation Safety Committee to acquire and use specific radiation sources, and to supervise their use by others, in compliance with pertinent regulations and under conditions approved by the Committee. Responsible users must demonstrate, to the satisfaction of the Committee, competence in the safe use of radiation sources by virtue of appropriate training and experience. Responsible users must assume full responsibility for all radiation sources under their control.

TRAINING CONTENT - RADIATION USERS

"Radiation users" are required to have more extensive training than are *"potentially exposed"* personnel.

ISU-general training for radiation users includes:

- Safe handling of radioactive materials.
- Characteristics of ionizing radiation.
- Units of radiation dose and quantities.
- Radiation detection instrumentation.
- Risks of exposure to ionizing radiation.
- Mathematics pertaining to the use and measurement of radioactivity.
- Individual dose limits including special limits for declared pregnant workers.
- Classification of facilities and posting.
- The ALARA principle.
- External exposure limitation (time/distance/shielding)
- Internal exposure limitation (contamination control/bioassay)

ISU-specific training for radiation users includes:

- ISU broad scope license conditions.
- ISU radiation protection organization.
- ISU Radiation Safety Manual.
- Areas where radionuclides are used at ISU.
- The obligation to report unsafe conditions to the Radiation Safety Officer and/or applicable authorities.
- Operating and emergency procedures.

- Workers right to be informed of occupational radiation exposure and bioassay results.
- A hands-on simulation that reinforces selected topics covered above, as they pertain to the specific radionuclide used by the individual.

Radiation users will be given documented 10 CFR Part 19.12 instruction and documented instruction on local requirements by the RSOS or RSO, and on-the-job training by responsible users.

Regulatory Guide 8.29 will be used as a guide to provide information on risks from occupational radiation exposure.

Successful completion of a written examination is required for both responsible users and radiation users upon the completion of their respective training as outlined above. Satisfactory performance is defined as a score of 70% or greater. Any potential radiation user that fails to pass the radiation safety exam will be retrained and a new test will be administered to the individual.

The "*minimally exposed personnel*" (e.g. students who use small, non-dispersible radiation sources shall receive appropriate training by the laboratory instructor provided:

1. The use of the source is a part of a scheduled laboratory course under the supervision of an instructor who is either a qualified "Responsible User" or designated by the Responsible User for use of the source, AND;
2. The student will not receive more than 10% of the public dose limit of 100 mrem from the use of the source.

A lesson plan or outline and attendance records for the class period during which the radiation safety training was given will constitute the training record.

Annual refresher training will be given to responsible users and to radiation users. This training will consist of new local and NRC requirements, any problems over the last year, status of ISU radiological safety, discussion of interpretation of exposure reports, and a brief overview of radiation safety basics.

TRAINING CONTENT - POTENTIALLY EXPOSED PERSONNEL

The "*potentially exposed personnel*" (including janitorial, shipping and receiving, and security personnel) and will be provided with annual training by RSOS. This will include training on:

- The health risks associated with exposure to radiation or radioactive materials.
- Procedures to maintain exposure As Low As Reasonably Achievable (ALARA).
- Purposes and functions of warning signs and protective devices employed at ISU to reduce exposure to radiation or radioactive materials.
- Observation of Nuclear Regulatory Commission regulations for the protection of personnel from exposure to radiation or radioactive materials (NRC Form 3 material).
- Areas where radionuclides are used at ISU.
- The obligation to report unsafe conditions to the Radiation Safety Officer and/or applicable authorities.
- Emergency procedures.
- Workers right to be informed of occupational radiation exposure and bioassay results.

FREQUENCY

Radiation users are required to receive training prior to beginning work with radiation sources. An annual refresher covering specifics of radioisotope use at Idaho State University and any change to federal or state regulations will also be given to all radiation users. Training received at another institution may be acceptable if it fulfills current requirements, however training on ISU specific procedures will be given to all new personnel. The documentation of training is retained in the permanent radiation user file for the individual.

Potentially exposed personnel are offered radiation safety training on an annual basis. Groups in this category include janitorial, security and stores personnel. Training records for these personnel are retained in the form of attendance sheets listing the name of the group, the date, the instructor, any handout materials used and the attenders.

RECORDS

Completion of training will be documented as follows:

- 1) For responsible users and radiation users, the test cover sheet will be kept in the individual's personal file located in the TSO. This cover sheet includes the name and department of the person, test score, and a signature for review of the test with RSOS.

- 2) For potentially exposed personnel (including janitorial, shipping and receiving, and security personnel) documentation of training will be on a "Radiation Safety Training Attendance Record." This will include the name and workplace of the person. The "Radiation Safety Training Attendance Records" will be filed in the TSO.

REFERENCES

National Council on Radiation Protection and Measurements, *Operational Radiation Safety - Training*, NCRP Report No. 71, 1983.

**U.S. Nuclear Regulatory Commission:
Notices, Instructions, and Reports to Workers; Inspections, 10 CFR 19.**

***Instruction Concerning Risks from Occupational Radiation Exposure*, Regulatory Guide 8.29, July 1981.**

***Instruction Concerning Prenatal Radiation Exposure*, Regulatory Guide 8.13, Rev. 1, Nov. 1975.**

Idaho Department of Health and Welfare, *Idaho Department of Health and Welfare, Rules and Regulations*, Idaho Radiation Control Rules, IDAPA 16, Docket no. 16-0227-9701.

TRAINING HANDOUTS

Radiation Introduction Training Study Guide - Sealed Sources

Radiation Introduction Training Study Guide - Unsealed Sources

Radiation Introduction Training Study Guide - X-Ray Machines

Radiation Safety Training - Public Safety Officers

Radiation Safety Training - Custodial Personnel

Study Guide for Refresher Training - Radiation Users

Study Guide for Refresher Training - Shipping Personnel

Visitor Information

RPR 54 RADIOACTIVE WASTE MANAGEMENT

PURPOSE

This procedure specifies how radioactive waste will be collected, segregated, stored, processed and packaged, shipped, and disposed of by the Technical Safety Office.

POLICY

Radioactive wastes (radwastes) shall be collected, stored, packaged, shipped and disposed of in accordance with all pertinent State and Federal regulations. The RSO shall prepare and maintain procedures for handling radwastes that will ensure the protection of the employees involved in such duties and keep all radiation exposures ALARA. Specifications for segregation and packaging of radwastes shall be based on specific regulations or regulatory guidance, and include a record-keeping system that will allow complete tracking and accounting for all radwastes shipped to a disposal site or disposed of locally. Radioisotopes will not be mixed with hazardous materials. If there are any questions about a material contact the Technical Safety Office.

GENERAL RESPONSIBILITIES

Technical Safety Office will assure that:

- 1 The present procedure and all the new procedures are reviewed to ensure that waste is handled in a manner consistent with established measures.
- 2 All radioactivity labels were defaced or removed from containers and packages prior to disposal into ordinary "non-radioactive" waste streams.
- 3 The entire impact of various available disposal routes is considered. Occupational and public exposure to radiation, other hazards associated with the material and routes of disposal (e.g., toxicity, carcinogenicity, pathogenicity, flammability), and costs are considered.

Responsible Users will assure that:

- 1 Radioisotopes will not be mixed with hazardous materials.
- 2 Radioactive waste is not created unnecessarily.
- 3 All radioactivity labels are defaced or removed from containers and packages before it is placed in a radioactive waste container.
- 4 Each radiation user within their laboratories or assigned areas has specific training in handling the waste.
- 5 The housekeeping staff has sufficient information to avoid the possibility of unauthorized disposal or exposure of these individuals to radioactive materials or to radiation.

Radiation Users should:

Know the basic properties of radioactive substances and how to handle safe the radioactive substances.

DEFINITIONS

"Animal" waste means carcasses or parts of animals administered radioactive materials; it also includes collected excreta and combustible bedding materials, e.g. shavings or sawdust.

"Assay Date" is the date that the manufacture certifies the activity of the radioactive material.

"Aqueous" means a liquid that is soluble or readily dispersible in water and which contains no chemicals classified as toxic or hazardous; except for limits on radioactivity, aqueous liquid wastes are those which could be discarded to the sewer.

"Biological" waste means any biodegradable materials, including "animal" wastes.

"Dry" waste means any non-putrescible, dry waste, e.g. paper, plastics, glassware and metals, that does not contain any compressed gases, pyrophoric or other hazardous materials.

"LS media" means any mixture of solvents and fluors used for liquid scintillation counting. "LS media" must be segregated for disposal, based on the solvents and nuclides they contain:

- 1 **"NHNT"** refers to nonhazardous, nontoxic, nonflammable solvents.
- 2 Flammable or toxic solvents, e.g. toluene, xylene, dioxane, pseudocumene, etc. shall not be used except with special authorization from the Radiation Safety Officer.

SCHEDULING AND NOTIFICATION

Request for waste pickups should be made by phone to the Technical Safety Office; a waste pickup request form (RPR 54A) must be filled out and provided to the person collecting the wastes.

Waste pickups should be arranged, by the user at least two days in advance.

PROTECTIVE CLOTHING AND DEVICES

The minimum requirement for all phases of waste handling is the wearing of a lab coat and plastic or rubber gloves. Lab coats and gloves used for waste handling will not be worn to the cafeteria or other public areas on or off the campus.

During packaging or disposal of liquid wastes, a plastic-lined lab coat and face shield or safety glasses shall be worn. Check with the TSO if there are any questions regarding conditions that may require the use of additional protective devices.

PICKUP OF WASTE

The TSO will bring a thin-window GM survey meter on all waste pickups to survey waste containers for contamination or excessive exposure levels. The TSO will verify that a radioactive waste tag (RPR 13E) has been filled out properly and signed by the user before any waste will be accepted. The TSO will not take any waste until it has been properly labeled.

Packaging of Dry Waste

Responsible User:

All radioactive labels must be removed from laboratory material before it is placed in a radioactive waste container.

Technical Safety Office:

Remove the lid of the waste can and check the exposure rate. Visually check contents to ensure that only dry waste is in the container. Carefully J-seal the package and then remove the bag from the waste container; inspect for protruding hypodermics needles, pipettes or other objects that may rupture the bag or cause injuries; also, check for leakage. Take swipes on the interior surface of the waste container to determine if the waste container has been contaminated. Next, place the waste inside of a second bag, and remove gloves and place them inside of the second bag. Securely close the bag, with a J-seal, and place the bagged waste in the transfer drum or cart. Swipe the outside of the second bag and record the results on the waste tag. Before leaving the lab, put a new bag in the waste container with top folded over the rim and replace the container lid. Survey hands for contamination; survey the transfer drum to determine the exposure rate and record the results on the waste tag.

Packaging Liquid Waste

Technical Safety Office:

Check the exposure rate from the container. Lift the container out of its secondary containment and inspect for leakage and solid objects. **If solid objects are found return the container to secondary containment and inform lab personnel that the objects must be removed before waste will be picked up.** If no solids are observed, Insure the lid to the primary container is secure and then place the container in a plastic bag with some absorbent material to absorb potential leakage from the primary container. Carefully J-seal the bag and tape the user-prepared waste label on the bag. Next, place the waste in the transfer drum. Remove gloves and place them in a dry waste container, survey the waste in the transfer drum, and survey hands for contamination.

Liquid Scintillation Vials

Liquid scintillation vials may be picked up and transported in plastic bags or the original cardboard trays. Verify that they are properly segregated and labeled according to the nuclides and solvents present.

TRANSPORT OF RADIOACTIVE WASTE

The vehicle used for transporting wastes from on-site generators to the Radioactive Waste Storage room in the Physical Science Building or to the on-campus waste storage facility at 1540 South Seventh Avenue (Building 16) must be placarded on all four sides with "RADIOACTIVE" placards whenever radioactive materials are present in the vehicle. When radioactive materials are not in the transport vehicle, the "Radioactive" placards should be removed or switched to the "DRIVE SAFELY" position. A plastic cart or drum is used to transport waste packages of all types to the waste transport vehicle.

When unattended, the transport vehicle will be kept locked at all times if it contains radioactive waste. All radioactive materials will be removed from the vehicle at the end of each work day. If the transport vehicle is involved in an accident while transporting radioactive waste, the Campus Police Department (Ext: 2515) and the RSO (Ext. 2311) shall be notified as soon as possible. The RSO or his designee will determine if there is any contamination problem and supervise cleanup operations if necessary.

SORTING AND SEGREGATION OF RADWASTE

Dry Radioactive Waste:

All radioactive waste will be segregated by nuclide. Unless specifically noted, dry waste that contains nuclides with a short half-life (< 120 days) will be held for decay in the

radioactive waste storage room for 10 half-lives. Short-lived waste should be segregated from long-lived waste. Dry waste with a half-life of > 120 days will be packaged for transport to a licensed disposal facility.

Liquid Radioactive Waste:

All radioactive waste will be segregated by nuclide. The TSO will employ three methods to dispose of liquid radioactive waste as authorized by 10 CFR 20.2003. These disposal methods are: 1) Store for decay, 2) Disposal to the sanitary sewer, 3) Shipment to a licensed disposal facility. Aqueous liquid radioactive wastes with half-lives < 120 days will be held in the radioactive waste handling room for ten half-lives and then be disposed of as uncontaminated liquid waste. Aqueous liquid radioactive waste with half-lives > 120 days (excluding H-3 and C-14) will be held in the radioactive waste handling room for as long as practical (up to 10 half-lives) and then disposed of via the sanitary sewer. Radioactive waste storage time will be determined by the amount of space available in the waste handling room. Due to their long half-lives, aqueous liquid radioactive wastes that contain H-3 and C-14, will be disposed of to the sanitary sewer as soon as practical. There is no appreciable benefit gained from on site storage of these materials.

Biological Radioactive Waste:

Biological wastes containing radium or transuranics will be segregated for special packaging. Biological waste containing nuclides with a half-life < 120 days will be held in the radioactive waste handling room for 10 half-lives and then disposed of by incineration. Biological waste with nuclide half-life > 120 days will be packaged for shipment to a licensed disposal facilities.

Once the biological waste has been decayed, it will be transferred to the Biological Science Animal Care Facility (ext. 3895) for incineration.

Liquid Scintillation Vials:

Representative vials from each package will be retrieved and counted using procedures outlined in "RADIOACTIVITY MEASUREMENTS" (RPR 53). The results will be recorded on form RPR 54B. Any vials that contain toluene, xylene, dioxane, or pseudocumene will be set aside for packaging. Packages containing only H-3 and C-14 in an NHNT solvent at less than 0.05 microCi/g will be placed in a dumpster for disposal after completely obliterating or removing all radioactive material labels (10 CFR 20.2005). Vials containing short lived nuclides (half-life < 120 days) in NHNT fluors will be held for a period of ten half lives, then surveyed to assure that the external exposure rate is not above background; these packages may then be disposed of in a dumpster as ordinary trash. Vials containing long lived nuclides (half-life >120 days) in NHNT fluors will be segregated for packaging.

METHODS OF DISPOSAL

Decay in Storage:

The TSO will be the only facility on campus to dispose of radioactive wastes for decay in storage. TSO must design an adequate space and facilities for the storage of waste for decay in storage. Waste should be stored in suitable well-marked containers, and the containers should provide adequate shielding. Liquid and solid wastes must be stored separately. When the container is full, it should be sealed. The sealed container should be identified with a label affixed or attached to it. The identification label should include the date when the container was sealed, the longest-lived radioisotope in the container, total activity, date when ten half-lives of the longest-lived radioisotope will have transpired, and the initials of the individual who sealed the container. The container may be transferred to the decay in storage area. When large quantities are held for decay in storage, sufficient quantities may be present even after 10 half-lives that persons performing surveys should be aware of the potential for measurable radiation. The contents of the container should be allowed to decay for at least ten half-lives of the longest-lived radioisotope in the container.

Prior to disposal as ordinary trash, TSO staff should monitor each container as follows:

- check the radiation detection survey meter for proper operation.
- survey the contents of each container in a low background area.
- remove any shielding from around the container.
- monitor all surfaces of the container.
- discard the contents as ordinary trash only if the surveys of the contents indicate no residual radioactivity, i.e. surface readings are indistinguishable from background.
- if the surveys indicate residual radioactivity, return the container to decay in storage area and contact the RSO for further instructions.

If the surveys indicate no residual radioactivity TSO staff will record the date when the container was sealed, the disposal date, type of waste (used or unused material, gloves, etc.), survey instrument used, and the initials of the individual performing surveys and disposing of the waste.

All radiation labels must be defaced or removed from containers and packages prior to disposal as ordinary trash. Syringes/needles placed into sealed waste containers for decay do not need the labels removed, provided that the following is done: waste barrels are sealed prior to delivery to the waste disposal firm and delivered directly from the licensee's facility; labels are removed from the waste barrels/containers; and that the waste is incinerated, not placed in a landfill; and the waste disposal firm is cautioned not to open the container prior to incineration.

Sewage Disposal:

The TSO will be the only facility on campus to dispose of radioactive wastes to the sanitary sewer. For each disposal of radioactive liquid waste to the sanitary sewer, the TSO will proceed as follows:

- check that the waste being discharged is soluble (or is biological material that is readily dispersible) in water.
- determine the activity of all nuclides that can be discharged by using the information from prior, similar discharges and the information in 10 CFR 20, Appendix B.
- determine the activity of all nuclides to be discarded, their monthly average concentration, and the cumulative annual activity.
- if more than one radioisotope is released, the sum of the ratios of the average monthly discharge of a radioisotope to the corresponding limit in 10 CFR Part 20, Appendix B, Table 3 must not exceed unity.
- total quantity of licensed material released into the sanitary sewerage system in a year does not exceed 185 GBq (5 Ci) of H-3 (tritium), 37 GBq (1 Ci) of C-14, and 37 GBq (1 Ci) of all other radioisotopes combined.
- calculate the average monthly water flow through the Physical Science Building or the Garrison Building. The average water flow is calculated by averaging the water flow for the previous 12 months and dividing the average by 10 to insure an adequate safety margin.
- record all the information on RPR 54I.
- discharge liquid waste slowly to minimize splashing with water running, to be sure that the material moves out of the sink and into the sewer system.
- survey the sink and surrounding work surfaces to confirm that no residual material or contamination remained in the sink or on work surfaces. Decontaminate as appropriate.
- decontaminate all areas or surfaces if found to be contaminated.
- log RPR 54I and maintain records of each radioisotope and its quantity and concentration that is released into the sewer system that demonstrate compliance with the regulatory limits for total quantity released and concentrations released by the licensed facility.

All disposals to the sanitary sewer will be performed by the TSO. The sewer disposals will be performed in a sink that is a part of the public system specifically designated for this purpose. The sink used for sewage disposal is located in the Physical Science Building Rm-330 or in the Garrison Building Rm B -10A.

PACKAGING OF RADWASTES

Liquid Radwastes for Burial:

Biological liquid waste to be sent to the U.S. DOE Hanford Reservation for disposal will be

packaged in compliance with requirements found in the Hanford Radioactive Waste Packaging manual. Liquids wastes to be sent directly to the commercial burial site will be solidified in accordance with instructions in the US Ecology license. Before absorbing, solidifying or packaging liquids for burial, check the latest revisions of license conditions or regulations to determine approved materials for absorption or solidification.

If nonreclaimable liquid wastes are sent to another broker for solidification, they should be packaged for transportation the same as reclaimable liquids.

STORAGE OF PACKAGED RADWASTE

Sealed drums are to be placed on wooden slats and remain covered at all times. The radioactive waste handling room in the basement of the Physical Science Building or in the on-campus waste storage facility at 1540 South Seventh Avenue (Building 16) must be posted with signs "CAUTION - RADIOACTIVE MATERIALS" and kept locked when not attended. Waste shipments should be scheduled to prevent excessive accumulation of filled drums. If material is stored for decay and subsequent local disposal, waste drums only need to be marked with the container number. If the materials are in storage awaiting shipment to a disposal facility, RPR 54C should be completed and the drums should be marked with all labels and markings required for shipment.

RECORDS

Radioactive Waste Log:

The Radioactive Waste Log Consists of five sections. Each section is described below.

Section 1-Active File:

Section 1 contains form RPR 54D and the completed form RPR 13A. RPR 54D allows the TSO to track the location of all radioactive material that is received by the TSO. When isotope is returned to the TSO as waste RPR 13A will be removed from section 1, attached to RPR 13B & C and placed in the appropriate section of the waste log (See Section Categories Below).

Section 2-Decay Storage:

Section 2 contains a list of all material that is currently held in the Physical Science Building Radioactive waste storage room or in the on-campus waste storage facility at 1540 South Seventh Avenue (Building 16) for disposal by decay. RPR 54E is used to keep a record of all material awaiting disposal by this method.

Section 3-Shipment:

Section 3 contains a record of all material that is awaiting shipment to an off site radioactive waste disposal facility. RPR 54F is used to trace all material in this section.

Section 4-Sewage Disposal:

Section 4 contains a listing of all material that is being held for disposal by dumping into the sanitary sewer. RPR 54G has a listing of all material in this section.

Section 5-Dead File:

Section 5 contains a record of all radioactive waste that has been processed by the TSO. Records will be held for three years on material that has been decayed on site or dumped into the sewer. Records will be maintained in this section for the life of the radiation safety program at ISU on all material that has been shipped to a licensed disposal facility. RPR 54H has a listing of all the material in this section.

Upon receipt of any radioactive material the TSO will fill out a "Radioisotope Package Arrival Report" (RPR 13 A,B,&C) and assign three "Radioactive Waste Tags" (RPR 13E) to the responsible user. RPR 13A will be filled out and placed in Section 1 (active file) of the radioactive waste log. RPR 13B will be filled out and placed in the Isotope Inventory Book. RPR 13C and three RPR 54Es will be delivered to the user along with the isotope.

When responsible users are done with the isotope, they will contact the TSO and arrange for a waste pick-up. The TSO will verify all the appropriate forms are filled out and the waste conforms to all packaging restrictions before accepting custody of the waste. The completed waste tags will be distributed as follows:

- 1 White copy: will be left with the responsible user for their records.
- 2 Yellow copy: will be attached to the completed RPR 13C and placed in the appropriate section of the "Radioactive Waste Log."
- 3 Hard Tag: will be attached to the waste container and remain with the container until it is disposed of into the sewer or by decay. After the waste has been disposed of, the hard tag will be attached to RPR 13A and placed in section 5 of the waste log. The hard tag will remain with the waste if it is shipped to a disposal facility.

Records will be kept that verify the exempt concentration of H-3 and C-14 vials (RPR 54B). Radiation surveys of packages of vials containing short-lived nuclides, e.g. P-32 and Cr-51, will also be recorded on RPR 54B.

Summaries of all radioactive waste disposals shall be generated at least annually by the Radiation Safety Officer. These summaries will be filed with the annual reports prepared

for the records of the Radiation Safety Committee. The radwaste disposal log will be used to summarize information required for waste shipment manifests, as described in "TRANSPORTATION OF RADIOACTIVE MATERIALS" (RPR 56).

REFERENCES

U.S. Nuclear Regulatory Commission: *10 CFR 20 and 10 CFR 61; 10 CFR 71.*

Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements, WHC-EP-0063, Westinghouse Hanford Company, 1988.

State of Washington, Radioactive Materials License issued to US Ecology, Inc.

U.S. Nuclear Regulatory Commission: (NUREG 1556v11), *Consolidated Guidance About Materials Licenses Program-Specific Guidance About Licenses of Broad Scope*, April 1999.

LIQUID SCINTILLATION MEDIA

Fluors containing non-hazardous, non-toxic (NHNT) solvents are required unless a specific exception is obtained from the RSO or the Radiation Safety Committee. Examples of such fluors are:

<u>Fluor (Mfgr.)</u>	<u>³H Efficiency* Mean ± SD (N)</u>	<u>Flow* (sec)</u>	<u>Fluor (Mfgr.)</u>	<u>³H Efficiency* Mean ± SD (N)</u>	<u>Flow* (sec)</u>
BCS(AMER)		Betamax-ES(ICN)		45.1 ± 7.9 (6) ¹	2.6
Bio-Safe II(RPI)	38.1 ± 5.2 (24) ²	4.1 Bio-safe NA(RPI)		43.9 ± 9.8 (6) ¹	2.5
Cytoscint-ES(ICN)	43.7 ± 4.0 (24) ²	3.7 Ecolite(+)(ICN)		32.1 ± 5.1 (24) ²	5.3
Ecolume(ICN)	36.6 ± 6.0 (24) ²	4.9 Ecoscint A(NAT)		40.2 ± 4.5 (24) ²	3.7
Ecoscint H(NAT)	45.8 ± 5.0 (24) ²	2.7 Ecoscint O(NAT)		45.1 ± 6.7 (6) ¹	2.8
Envirosafe(ANOR)	35.4 ± 4.6 (24) ²	4.2 Mono Flow 5(NAT)		35.6 ± 3.7 (24) ²	2.7
Opti-Fluor**(PACK)	39.7 ± 5.5 (24) ²	3.2			
OrganicSolv 3(ANOR)	42.2 ± 9.7 (6) ¹	2.5			
Ready Safe(BECK)	40.6 ± 4.2 (24) ²	7.2			
Ultima Gold(PACK)	43.1 ± 2.1 (24) ²	5.5			

Fluors containing toxic or flammable solvents may not be purchased without prior approval from the RSO. Examples are:

CP, HP, HP/b, EP, MP, NA, Ready Micro, Ready Solv, Ready Protein, Ready Gel, Ready Value, Ready Organic, Ready Flow II, Ready Flow III (BECK)

Universall (ICN)

Betafluor, Hydrofluor, Liquiscint, Monoflow 4, Ultraflow (NAT)

Aquasol, Aquasol-2, Econofluor, Econofluor-2, Formula 963, Liquifluor, Omnifluor, Atomlight, Aquasure, Biofluor, Riafluor, and all "NEF" numbers (NEN)

Insta-Gel XF, Scint-A XF, Pico-Aqua, Pico-Fluor 15, Pico-Fluor 40, Hionic Fluor, Filter-Count, Pico-Fluor LLT, Insta-Fluor, Pernafluor V, Monophase S, Flo-Scint I, II, III, IV, and V (PACK)

* Tritium counting efficiencies are based on 0.1 mL sample in 4.0 mL fluor; "Flow" represents the time for a fixed volume to flow from a pipette and is inversely proportional to viscosity; data from Klein, RC and Gershey, EL, 'Biodegradable' liquid scintillation counting cocktails, Health Physics 59:461-470, 1990.

1 Non-aqueous cocktail

2 Multipurpose cocktail

AMER = Amersham Corp., Arlington Heights, IL 800-323-9750

ANOR = Anorak Scientific, South Hackensack, NJ

BECK = Beckman Instruments, Fullerton, CA 800-742-2345

ICN = ICN Radiochemicals, Irvine, CA 800-854-0530

ISO = Isolab, Inc., Akron, OH 800-321-9632

NEN = DuPont-NEN Products, Boston, MA 800-551-2121

NAT = National Diagnostics, Manville, NJ 800-526-3867

PACK = Packard Instrument Co., Downers Grove, IL 800-323-1891

RPI = Research Products International Corp., Mount Prospect, IL 800-323-9814

RPR 54A. RADWASTE PICKUP REQUEST

This form is used by the Technical Safety Office to record requests for radioactive waste pickup.

RPR 54A RADWASTE PICKUP REQUEST			
Responsible User: _____			
Prgm #: _____		Phone: _____	
Location: _____		Room: _____	
Type:	Dry	Sharps	Animal
	Liquid	Volume:	_____
MAKE SURE WASTE TAG IS READY			
Comments on back: _____		Date: _____	

RPR 54B. SAMPLE DATA FOR L.S. VIALS

The following 4"x6" card is used for recording counting data from representative samples of liquid scintillation vials.

RPR 54B	SAMPLE DATA FOR L.S. VIALS	7/92
Check one or both categories:		Pkg. ID # _____
<input type="checkbox"/>	Isotopes with half life < 120 days Sampling not require unless contains H-3 or C-14. Held for 10 half lives? (Y) (N)	
<input type="checkbox"/>	H-3 and/or C-14, sampling required. (See back) If H-3 and C-14 only, no other nuclides detected. H-3 + C-14 < 50 microCi/g	
Package exposure rate at surface _____		mR/hr
Check only one category:		
<input type="checkbox"/>	"NENT" L.S. Vials; Released Solid Requirements for package release have been met.	
<input type="checkbox"/>	Requirements for package release are not met. Package placed in Container # _____	
Date _____	Initial _____	

RPR 54B (BACK)

	(H-3)	(C-14)	(Other)
<u>No.</u>	<u>Ch1</u>	<u>Ch2</u>	<u>Ch3</u>
1	_____	_____	_____
2	_____	_____	_____
3	_____	_____	_____
4	_____	_____	_____
5	_____	_____	_____
6	_____	_____	_____
7	_____	_____	_____
8	_____	_____	_____
9	_____	_____	_____
10	_____	_____	_____
Ekg.	_____	_____	_____
Avg. Net cpm	_____	_____	_____
Eff.	_____	_____	_____
Net nCi = cpm / (Eff. x 2200)	_____	_____	_____
Vial size: _____ Std = 15 g /vial			
_____ Mini = 5 g/vial			
Avg. Nci/g (Ch1 + Ch2 must be <50)	_____	_____	_____
Ch3 must be zero!			

RPR 54C. RADWASTE CONTAINER DATA

The following 5"x8" card is to be completed for every container (drum) of radioactive waste at the time it is packaged. The card is to be delivered to the Technical Safety Office before the container is listed for shipment.

FRONT:

RPR 54C (7/92)

CONTAINER # _____

(Last digit of year + 3 digits)

Size: _____ 55 gallon or _____

Type: _____ Spec. 7A or _____ "Strong, tight" Weight: _____ lbs.

Physical Form: _____ Solid _____ Vials _____ Bulk Liquids

Waste Description Code (see back of card): _____

Solidified or Absorbent Media Code (see back of card): _____

Contents/Chemical Form: _____ Paper, plastic, glass, rubber

_____ Scintillation fluor in vials _____ Incinerator ash

_____ Other _____

Shipping Category:

_____ LSA Dry Solids (LSA) _____ LSA Vials (LSA)

_____ LSA Flammable Liquids (LSAF) _____ Type A Quantity (A)

_____ Limited Quantity (LQ) _____ Special Form (SF)

_____ OTHER Description: _____

Preliminary Survey: Date: _____ By: _____

Meter used: _____ Calib. Date: _____

Exposure Rate (mR/hr) at surface: _____ at 1 meter: _____

RPR 54C (back)

Waste Description Codes:

- | | |
|----------------------|-----------------------------|
| 2. Dry Solid | 8. Dewatered Resins |
| 3. Solidified Liquid | 9. Solidified Resins |
| 4. Biological | 10. Absorbed Aqueous Liquid |
| 7. Filter Media | 11. Absorbed Organic Liquid |

- 12. Scintillation or Organic Liquid in Vials in Absorbent
- 13. Aqueous Liquid in Vials in Absorbent
- 14. Animal Carcasses in Absorbent
- 99. Other

Solidified or Absorbent Media Codes:

- | | |
|-------------------------|----------------------------|
| 2. Speedi-Dry | 10. Zonolite, Grades 2,3,4 |
| 3. Celatom (MP-78) | 11. Dow Media |
| 4. Floor Dry/Super Fine | 12. Cement |
| 5. Hi Dri | 13. Asphalt |
| 6. Florco or Florco X | 14. Delaware Custom Media |
| 7. Instant-Dri | 15. Envirostone |
| 8. Safe-T-Sorb | 16. Krolite |
| 99. Other | |

RPR 54J SEWAGE DISPOSAL OF NHNT RADIOACTIVE LIQUIDS

1.0 Purpose

The purpose of the sewage disposal work sheet is to ensure Idaho State University compliance with NRC regulations 10CFR20.2003 for the disposal of non-hazardous, Nontoxic, Nonflammable, aqueous liquid radioactive waste into the sanitary sewer.

2.0 Protective clothing and devices

The minimum required protective clothing to be worn by TSO personnel while disposing of NHNT liquid waste will be a plastic lined lab coat or a lab coat and a plastic apron, plastic sleeves, plastic or rubber gloves, face shield, long pants, and close toed shoes. Any deviation from this requirement will require written permission from the RSO.

3.0 Procedure

Prior to each disposal of NHNT radioactive liquid to the sanitary sewer the TSO representative will complete form RPR 54J and submit it to the RSO for approval. Radioactive material will not be released into the sewer without written approval from the RSO.

The procedure for completing form RPR 54J is:

1. Enter in the space provided the nuclide, activity, and the monthly and yearly release limits for the nuclide (See 10CFR20 appendix B)
2. Obtain the water flow rates for the building for 12 months preceding the proposed discharge, and compute the average monthly flow rate (AMF). Enter the AMF in block 1 of RPR 54J. The water flow rates can be obtained from the budget office. ***Note: The AMF should be converted to milliliters to conform to the units specified in appendix B of 10CFR20.**
3. To ensure the release limits for radionuclides specified in 10CFR20 are not exceeded, the Radiation Safety Committee established a safety factor (SF) of ten. Therefore, the discharge safety Volume (DSV) is computed by dividing the AMF by the SF. The DSV is entered in block 2 of RPR 54J.

4. The discharge activity is calculated by dividing the nuclide activity, in μCi , by the DSV. The discharge activity is entered in block 3 of RPR 54J. Once the Discharge activity is computed, it shall be compared to the release limits for the nuclide. The proposed release shall not exceed the monthly or yearly release limits specified in 10CFR20.2003.
5. A running total of the amount of activity released into the sanitary sewer shall be entered in block 4 of RPR 54J. The total will be zeroed at the beginning of each calendar year.

4.0 Disposition of RPR 54J

The TSO representative, at the completion of each approved radioactive material discharge, will attach form RPR 54J to the Radioactive Isotope Disposition record (RPR 13C) and place these forms in the sewage disposal section of the Radioactive Waste Log.

RPR 54J SEWAGE DISPOSAL PERMIT

NUCLIDE	ACTIVITY (μCi) (A)	MONTHLY CONCENTRATION LIMIT (10CFR20 APP.B)(μCi/ml) (B)	MONTHLY ACTIVITY DISPOSED OF TO DATE (μCi) (C)	MONTHLY FRACTION DISPOSED OF TO DATE (C/B)
	0 μCi	μCi/m	0.00E+00 μCi	
WASTE TAG NUMBER(S)		YEARLY ACTIVITY LIMIT (10CFR20.2003.4 ³ H=5Ci; ¹⁴ C=1Ci; combined others 1Ci) (D)	YEARLY ACTIVITY DISPOSED OF TO DATE (μCi) (E)	YEARLY FRACTION DISPOSED OF TO DATE (E/D)
		μCi	0.00E+00 μCi	
AVERAGE MONTHLY WATER FLOW		2.30E+13 x0.1	2.30E+12	= DSV

MONTHLY LIMIT VERIFICATION

ACTIVITY THIS DISCHARGE	(A)	0	μCi	
TOTAL MONTHLY ACTIVITY	(A+C)	0.00E+00	μCi	
TOTAL MONTHLY CONCENTRATION	[(A+C)/DSV]	0.00E+00	μCi/ml	LESS THAN B (Y) (N)
THE NEW MONTHLY FRACTION TO DATE	[(A+C)/DSV]/B	#DIV/0!		LESS THAN 1 (Y) (N)

ANNUAL LIMIT VERIFICATION

ACTIVITY THIS DISCHARGE	(A)	0	μCi	
TOTAL YEARLY ACTIVITY	(A+E)	0.00E+00	μCi	LESS THAN D (Y) (N)
THE NEW YEARLY FRACTION TO DATE	(A+E)/D	#DIV/0!		LESS THAN 1 (Y) (N)

(1) the average water flow through the Building from which the disposal is made is a calculated average of the 12 previous monthly water flow rates prior to discharge (reports are obtained from the Budget Office)

(2) ensure a safety margin to prevent TSO from exceeding the discharge limits from 10 CFR 20.2003

PREPARED BY _____ DATE _____
TSO REPRESENTATIVE

APPROVED BY _____ DATE _____
RADIATION SAFETY OFFICER

DISPOSED OF BY _____ DATE _____
TSO REPRESENTATIVE

RPR 61 CALIBRATION OF THE RADIATION MONITORING INSTRUMENTS

PURPOSE

This procedure specifies requirements for the calibration of radiation monitoring instruments at ISU.

POLICY

Pursuant to 10 CFR 20.1501, ISU must possess and periodically calibrate radiation monitoring instruments that are necessary to protect health and minimize danger to life or property. ISU must possess an adequate number of radiation detection and measurement instruments as necessary and ensure they are calibrated periodically for the radiation being measured. Contamination and exposure rate instruments will be approved by the RSO prior to use in radioactive material facilities at ISU. The ISU program has a full complement of commercially manufactured instruments suitable for performing surveys for alpha, beta, photon and neutron radiation. Radiation and Contamination survey instruments will be calibrated on an annual basis, after maintenance has been performed (excluding maintenance which does not effect the accuracy of the instrument, i.e. battery replacement, glass meter face replacement), and upon receipt if the manufacturer has not performed a calibration.

Portable radiation survey instruments in active service are calibrated at least annually, or following repair, by personnel of the Technical Safety Office Department. 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 various nuclides, as well as for linearity of response. The detection efficiency will be recorded on the instrument probe.

GENERAL RESPONSIBILITIES

Responsible Users will assure that:

1. Upon TSO notification, all the portable instruments in service will be sent promptly for calibration by TSO;
2. All the portable instrumentation will have recorded on the instrument's calibration sticker: calibration due date (six months hence), any special notations about the instrumentation and the initials of TSO responsible who performed the calibration;

3. Notify promptly TSO if a survey instrument has a suspected abnormal answer, or was damaged, or the calibration due date (on the sticker) is expired;
4. Notify RSO whenever a new survey instrument is necessary because of a change in the lab. conditions or to replace an older meter.
5. All the users know how to perform basic measurements with the survey instruments existed in the lab.

RSO will assure that:

1. The users possess an adequate number of radiation detection and measurement instruments;
2. The survey instruments are calibrated periodically for the radiation being measured.

Technical Safety Office Staff will perform the calibration and will assure that all the survey instruments are calibrated properly following the guidance of this procedure.

DEFINITIONS

Survey instruments: for purposes of this document, survey instruments are defined as any device used to measure the radiological conditions at a licensed facility. The choice of instrument needs to be appropriate for the type of radiation to be measured and for the type of measurement to be taken (count rate, dose rate, etc.).

PROCEDURE

Replacing a Survey Instrument

When it becomes necessary to replace instruments or augment the supply, the RSO will use the following considerations in deciding whether or not to approve an instrument:

1. Is the instrument suitable for measuring the desired quantity (e.g. photons, neutrons, contamination, etc)?
2. Is the dynamic range of the instrument (i.e., lowest and highest values measurable) suitable for the application
3. Can the instrument be calibrated with current ISU equipment (gamma source, neutron source, beta sources, electronic pulse generator)?
4. Is the instrument convenient to use?
5. Is the cost competitive?

6. Has the manufacturer demonstrated that the instrument passed the applicable portions of "Performance Specifications for Health Physics Instrumentation - Portable Instrumentation for Use in Normal Environmental Conditions," ANSI N42.17a-1989?

Radiation Monitoring Instrument Specifications

The specifications in Table 1 will help the responsible users choose the proper radiation detection equipment for monitoring the radiological conditions at their laboratories.

Table 1 Typical Survey Instruments¹

Portable Instruments Used for Contamination and Ambient Radiation Surveys			
Detectors	Radiation	Energy Range	Efficiency
Exposure Rate Meters	Gamma, X-ray	µR-R	N/A
Count Rate Meters GM	Alpha	All energies (dependent on window thickness)	Moderate
	Beta	All energies (dependent on window thickness)	Moderate
	Gamma	All energies	< 1%
Nal Scintillator	Gamma	All energies (dependent on crystal thickness)	Moderate
Plastic Scintillator	Beta	C-14 or higher (dependent on window thickness)	Moderate
Stationary Instruments Used to Measure Wipe, Bioassay, and Effluent Samples			
Detectors	Radiation	Energy Range	Efficiency
LSC*	Alpha	All energies	High
	Beta	All energies	High
	Gamma		Moderate
Gamma Counter (Nal)*	Gamma	All energies	High
Gas Proportional	Alpha	All energies	High
	Beta	All energies	Moderate
	Gamma	All energies	< 1%

¹ Table from *The Health Physics & Radiological Health Handbook*, Revised Edition, edited by Bernard Shleien, 1992 (except for * items).

Model Instrument Calibration Program Training

Before allowing an individual to perform survey instrument calibrations, the RSO will ensure that he or she has sufficient training and experience to perform independent survey instrument calibrations.

Classroom training may be in the form of lecture, videotape, or self-study and will cover the following subject areas:

- Principles and practices of radiation protection
- Radioactivity measurements, monitoring techniques, and using instruments
- Mathematics and calculations basic to using and measuring radioactivity
- Biological effects of radiation.

Appropriate on-the-job-training consists of the following:

- Observing authorized personnel performing survey instrument calibration
- Conducting survey meter calibrations under the supervision and in the physical presence of an individual authorized to perform calibrations.

Facilities and Equipment for Calibration of Dose Rate or Exposure Rate Instruments

To reduce doses received by individuals not calibrating instruments, calibrations will be conducted in an isolated area of the facility or at times when no one else is present. Individuals conducting calibrations will wear assigned dosimetry. Individuals conducting calibrations will use a calibrated and operable survey instrument to ensure that unexpected changes in exposure rates are identified and corrected.

For the calibration of survey instruments using "Shepherd Cs-137 irradiator follow the RPR 61B "HANDLING PROCEDURE FOR SHEPHERD CS-137 IRRADIATOR (S/N 28-6A)".