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ARKANSAS STATE UNIVERSITY
GOVERNING PRINCIPLES AND PROCEDURES
RADIATION SAFETY

Number: S-008 **Responsible Official: Provost**
Version: 01 **Date: 8/26/2009**

1.0 INTRODUCTION

Arkansas State University (ASU) is committed to the conduct of research that adds to the world's knowledge and recognizes that the conduct of such research may require the use of hazardous materials, including radionuclides. ASU is likewise committed to providing a safe and healthy employment environment and to complying with all regulations that govern the use of radioactive materials.

2.0 PURPOSE

The University has sought and received a **Specific Broad-Scope License** from the **Arkansas Department of Health,** authorizing the responsible use of radionuclides. The ASU Radiation Safety Program has been established .to comply with the terms of the License and with all regulations that govern the use of radioactive materials. Its components include: 1) incorporation of all federal, state and local regulations that govern the safe use of radionuclides[1]; 2) development of policies and procedures for radiation safety[2] to provide guidance to qualified personnel and ancillary staff in the safe use of radionuclides; 3) establishment of a Radiation Safety Committee to evaluate research protocols that mandate the use of radioactive materials, and 4) appointment of a **Radiation Safety Officer** to assure University compliance to all relevant regulations.

3.0 DEFINITIONS

Authorized Users. Authorized users are persons who have been added to the Principal User's Authorization and have completed the appropriate training as outlined in Appendix B. Authorized users are responsible to Principal Users for all actions listed below for radioactive materials. These users may work with isotopes or equipment without immediate supervision, and may assume limited responsibilities as defined by Principal Users.

Individual Users. Individual users are those who work with radioactive materials and have completed the required training as designated in Appendix B. These users must be listed on the Principal Users' authorization lists as individual users, and are responsible to Principal Users for

[1] Radionuclide users are strongly encouraged to read the federal and State regulations that are contained in the Reference section.
[2] The *Radiation Safety Document* is not designed as a comprehensive resource. Contact the **ASU** Radiation Safety Officer for assistance before beginning any experiment that requires the use of radioactive materials

all actions listed below. The individuals must work under the direct supervision of Principal Users or Authorized Users designated by Principal Users.

Principal Users. Principal users are those persons who are permitted by the Radiation Safety Committee to purchase, store, and use radioactive materials in accordance with ASU's license (See Appendix B for Training and Experience Requirements).

4.0 APPLICABILITY

These governing principles pertain to all faculty, staff, students, and ancillary employees who use radiation techniques in the conduct or their research programs or in any teaching environment.

5.0 REGULATIONS

The Federal Government retains regulatory authority for radioactive materials in the State of Arkansas when the receipt, possession, use, or transfer of by-products, sources, or special nuclear materials are in sufficient quantities to form a critical mass; when a facility utilizes or produces radioactive materials; by-products, sources, and special nuclear materials; or electronic devices are imported or exported.

The Arkansas Department of Health Division of Radiation Control and Emergency Management licenses and regulates the receipt, possession, use and transfer of sources of ionizing radiation. The Department of Health has issued a Specific Broad-Scope License[3] to ASU with the stipulation that the University adhere to all relevant federal and state regulations[4] and to internal governing principles and procedures that have been approved by the State. Therefore, when ASU is audited, it is examined for compliance with state and federal

These policies and procedures have been approved by the State of Arkansas. Its provisions are not comprehensive and are intended to be used in conjunction with other state and federal guidelines to procure, use, transport, or dispose of radioactive materials. If further information is needed, consult: 1) the Arkansas Department of Health Rules and Regulations for Control for Sources of Ionizing Radiation; 2) the terms of ASU's Specific Broad-Scope License; or 3) the Radiation Safety Officer.

Notices of recent actions by the Arkansas Department of Health regarding Arkansas State's radiation safety program can be reviewed at the Office of Environmental Health & Safety.

[3] Copies of the current radioactive materials license with all approved amendments can be found in the Environmental Health & Safety Office and with Radiation Safety Officer.

[4] Copies of the Rules and Regulations for Control of Sources of Ionizing Radiation are on file in the Biology Department, Dean's Office - College of Science and Mathematics, Environmental Health & Safety, and in the Office of the Radiation Safety Officer. Regulations may also be obtained by writing to the Division of Radiation Control and Emergency Management, Arkansas Department of Health, 4815 West Markham Street, Slot 30, Little Rock, Arkansas 72205-3867 or can be accessed at **http://www.healthyarkansas.com/rules_regs/rules_regs.htm**

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For a list of college and university environmental health and safety web sites (most of which include their radiation safety unit), visit the University of Kentucky's Fiscal Affairs site. Radiation Event Medical Management at the U.S. Department of Health & Human Services http://remm.nlm.gov/ also contains helpful information.

6.0 GOVERNING PRINCIPLES

6.1 RADIATION SAFETY COMMITTEE (RSC)

Consistent with Arkansas Department of Health Division of Radiation Control and Emergency Management regulations, the ASU Radiation Safety Committee (RSC) has been established to promote best practices in the use of radioactive substances and laser use and to assure compliance with the conditions set forth by the Specific Broad-Scope License. Its personnel are likewise responsible for establishing governing principles and procedures for the authorized procurement, protection, use, and disposal of radioactive materials and for the safe use of lasers on the ASU-Jonesboro campus.

The Radiation Safety Committee is appointed by the Vice Chancellor for Academic Affairs and Research and is composed of:

- the Radiation Safety Officer, Committee Chair University Safety Officer;
- one (1) licensed user;
- one scientist with knowledge of laser use;
- one (1) physicist with knowledge of radiation physics; and
- two (2) faculty members, one of whom must be from outside ABI, Agriculture, and the College of Science and Mathematics, trained and experienced in the safe use of radioactive materials.

Committee members serve three-year, rotating terms and meets at least annually and as necessary to conduct the business of the radiation and laser safety programs. The Committee may conduct business only if a quorum is present. Four committee members constitute a quorum.

6.2 RADIATION SAFETY OFFICER

Consistent with relevant guidelines, ASU has appointed a Radiation Safety Officer (RSO) who reports to the Associate Vice Chancellor for Research and has responsibility for ensuring compliance with the terms of the Specific Broad-Scope License and all relevant federal, state, and University regulations, including but not limited to those issued by the U.S. Department of Transportation and the Arkansas Health Department Division of Radiation Control and Emergency Management, and the *ASU Radiation Safety Document*.

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6.3 PROCUREMENT, RECEIPT, AND INVENTORY

Purchases

The Principal User must submit a "Request to Use/Acquire Radioactive Material" to the Radiation Safety Officer a form detailing the description of the radioactive material, sources or equipment to be ordered, intended use and planned disposal. The description shall indicate the radioisotope, its chemical and physical form, and the total activity in Becquerels, millicuries, or microcuries. Before committee discussions, the RSO checks to insure that all requested radioisotopes are authorized by ASU's license and do not exceed the authorized possession limits.

The Radiation Safety Committee will then check each request for proper use of radioisotopes. The deliberations will include:

1. Whether the training and experience of the proposed user(s) are adequate for the proposed purposes and for possible emergency procedures.
2. Ensure the available facilities and equipment (or those to be obtained) do not compromise safety and are adequate for the stated needs.
3. Review proposed use to ensure all federal, state, and local safety requirements will be met.
4. Review the operating, handling, and emergency procedures to ensure they are adequate for this material.

After approval by the RSC, ordering information is provided to the University purchasing agent, including instructions to have the material sent directly to the Radiation Safety Officer, Arkansas State University, 117 South Caraway Road, Jonesboro, Arkansas 72401. Arrangements must be made for delivery to occur during normal working hours. *Packages must not be sent to Central Receiving.*

Receipt

Upon arrival of the radioisotope (this includes radioisotopes brought to campus personally by a Principal User) the Radiation Safety Officer will check the package for contamination and enter the radioisotope into the inventory (in accordance with RH-1307). Only then will the RSO notify the Principal User of satisfactory receipt and availability of material.

The areas designated for receipt and inspection of newly delivered radioisotopes is LSE 102 E and LSE 303B. Within three hours of receipt, the package is swipe tested, unpacked and checked for shipping damage. A Radioactive Receipt Form is completed and the material is logged in and stored until delivery to the authorized user.

A member of the Radiation Safety Committee is on call to receive packages when the Radiation Safety Officer is unavailable.

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6.4 TRANSFER OF POSSESSION

Outside Agencies

All radioactive material must enter and exit the campus through the Radiation Safety Officer. Before material may be released to anyone not directly associated with Arkansas State University, the RSO will be notified of the desired transfer. The RSO will ensure that all federal and state regulations are followed, in accordance with RH-501 of the ADH Rules and Regulations. The following information must be provided prior to the transfer taking place:

The certification must include the name of the receiving institution and written receiving authorization from that institution for the type, form, and quantity of radioactive material; the issuing agency name, the current license number and expiration date; the name of the Radiation Safety Officer at the receiving institution; the isotope or chemical compound; and the amount of activity.

A documented record of all such transactions will be maintained by the RSO in accordance with RH-3200 of the ADH Rules and Regulations set forth by the Department of Transportation, 49 CFR Parts 170 through 189. The Radiation Safety Officer will prepare the package for shipping.

Internal Transfers

Interdepartmental - Internal transfer of radioactive material will be approved by the RSO. These transfers must be between Committee-approved principal users. The recipient will have a current authorization for the same radioactive material. Receipts of such transfers will be maintained by the parties involved and by the RSO.

6.5 SECURITY AND STORAGE

Arkansas Department of Health rules and regulations require that security of radioactive materials must be in place at all times. Violations of this regulation are frequently cited at institutions utilizing radioactive materials, and place the license to use such materials in jeopardy. Section RH-1308, of the state Rules and Regulations requires that the "Licensee shall control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage." This means that in all locations where radioactive materials are present, the trained user must be in constant attendance. Otherwise the lab must be locked or secured to prevent unauthorized removal or access. If the laboratory is unoccupied access to the lab MUST BE LOCKED.

Radioactive materials shall be stored in sealed containers in to prevent accidental spillage or breakage, and to prevent release into the air. If the material requires shielding, it shall be stored in shielded containers in order to prevent doses to personnel accessing the storage areas. If the radioactive material has been stored in a freezer or ultra freezer, it is recommended that the material be thawed, opened and handled in a certified fume hood or biological safety cabinet. Aerosols from stored radioactive materials may cause contamination of adjacent areas and doses

to personnel if not handled in the proper way after storage. All radioactive materials, whether in storage, waste or use, must be labeled with the radioactive warning symbol and the words "Caution, Radioactive Materials".

6.6 SAFE HANDLING OF RADIOACTIVE MATERIALS

6.6.1 Classification of Areas

Unrestricted Areas. An unrestricted area is any area to which access is not controlled by the licensee or principal user for the purposes of protection of individuals from exposure to radiation and radioactive materials. An area is unrestricted and does not require control measures:

1. if an individual continually present in the area cannot receive more than 0.0002rem (0.02 mSv) in any one hour or 0.05 rem (0.5 mSv) in a calendar year; and
2. if, when allowance is made for expected occupancy and time variations in dose-rate, no individual is likely to receive more than 500 mrem (5 mSv) in a calendar year.

Radioisotopes may be transported through an unrestricted area, but may not be used in an unrestricted area.

Controlled Areas. A controlled area is outside of a restricted area, but inside the site boundary. A controlled area in which radioisotopes are used and access is limited, but the potential exposure rates fall well below the limits that define a Restricted Area.

Restricted Areas. A restricted area is defined as locations: 1) where dose levels do not conform to the standard for unrestricted areas; and 2) that are under the control of the Radiation Safety Officer. The approved user responsible for work with radioisotopes shall be responsible for controlling access to the area. Both Federal and State regulations define restricted areas containing radiation requiring special control measures as follows:

1. Radiation Area - An area accessible to individuals in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in any one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates. A sign bearing the radiation symbol and the words "Caution Radiation Area - No Entrance to Unauthorized Personnel" is to be posted at the entrance.

2. High Radiation Area - An area accessible to individuals in which radiation levels from radiation sources external to the body could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 mSv) in one (1) hour at thirty (30 centimeters from the radiation source or thirty (30) centimeters from any surface that the radiation penetrates. A sign bearing the radiation symbol and the works "Caution High Radiation Area - No Entrance to Unauthorized Personnel" is to be posted at the entrance.

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3. Very High[5] Radiation Area - any area, accessible to individuals, in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads * (5 gray) in one hour at one meter from the radiation source or from the surface that the radiation penetrates.

Within the restricted area, strict surveillance should be maintained to assure that significant exposure levels are not present, whether in the form of contamination, airborne levels of radiation or external exposure levels. All rooms or areas in which licensed quantities of radioactive materials are used or stored must be posted with a "Caution Radioactive Material" sign and a "Notice to Employees."

6.7 RADIATION EXPOSURE LIMITS

6.7.1 ALARA

ALARA is an acronym meaning As Low As Reasonably Achievable. It is a requirement in the law for all facilities possessing radioactive materials licenses to have a formal ALARA program. The radiation protection standards set forth in this document are used to control radiation exposure to all personnel occupationally exposed to radiation. Arkansas State University is committed to keeping the exposure as low as reasonably achievable (ALARA).

6.7.2 Occupational Exposure Limits

Occupational dose limits to individual adults shall be in accordance with RH-200 of the Arkansas Department of Health, Rules and Regulations. No individual may receive in one calendar year, except for planned special exposures, a total occupational exposure in excess of the following:

Total Effective Dose	5 rems (0.05 Sv), or
Sum of deep-dose equivalent and committed dose equivalent to any individual organ or tissue other than the lens of the eye	50 rems (0.5 Sv)
Lens of the eye (lens dose)	15 rems (0.15Sv) and
Skin & extremities	Shallow dose equiv. of 50 rems (0.50Sv)

DE – Dose Equivalent. 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).

[5] For "Very High" doses received at high dose rates, units of absorbed dose (e.g., rads and grays) are appropriate, rather than units of dose equivalent (e.g., rems and sieverts).

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CDE – Committed Dose Equivalent ($H_{T,50}$). 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.

EDE – Effective Dose Equivalent (H_E). The sum of the products of the dose equivalent to the organ or tissue (H_T) and the weighting factors (w_T) applicable to each of the body organs or tissues that are irradiated ($H_E = \sum w_T H_T$).

CEDE – Committed Effective Dose Equivalent ($H_{E,50}$). The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues ($H_{E,50} = \Sigma\ w_T H_{T,50}$).

DDE – Deep Dose Equivalent (H_d), (which applies to external whole-body exposure). The dose equivalent at a tissue depth of 1 cm (1000 mg/cm^2).

TEDE – Total Effective Dose Equivalent. The sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

SDE – Shallow-dose Equivalent (H_s), (which applies to the external exposure of the skin or an extremity). - The dose equivalent at a tissue depth of 0.007 centimeter (7mg/cm^2), averaged over an area of one (1) square centimeter.

LDE – Lens of 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).

6.7.3 Exposure Limits for Minors

The annual occupational dose limits to minors, (individuals under the age of 18) must be limited to ten percent (10%) of the annual dose limits specified for adult workers. For these workers/students, safety training must be completed prior to work with radioactive materials as with other occupational workers and students.

6.7.4 Exposure Limits for the General Public

Any person who is not regularly employed or authorized in using radioactive materials must not receive a radiation dose in excess of either:

- 0.1 rem (1 mSv) in any one year.
- 0.002 rem (0.02 mSv) in any one hour.

6.7.5 Exposure Limits for an Embryo/Fetus

Arkansas State University incorporates radiation dose guidelines, in accordance to RH-1207 of the ADH Rules and Regulations, for ensuring safe radiation limits for the embryo/fetus of occupationally exposed employees. Pregnant radiation workers who wish to declare their pregnancy should notify the Radiation Safety Officer in writing as soon as possible after learning of their pregnancy.

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The regulatory dose limit to the embryo/fetus of a declared pregnant woman is 0.5 rem (5 mSv) for the entire pregnancy period.

The dose equivalent to the embryo/fetus is the sum of the deep-dose equivalent to the declared pregnant woman and the dose equivalent to the embryo/fetus resulting from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman.

6.8 PERSONNEL MONITORING

Overview. Personnel monitoring of exposure to radiation and radioactive materials shall be performed to demonstrate compliance with the occupational dose limits. At a minimum, individual monitoring devices will be required where:

1. An individual receives or is likely to receive in one year from sources external to the body, a dose in excess of ten (10) percent of the applicable limits (Section 7.2.2).
2. An individual enters a high or very high radiation area.
3. A minor or declared pregnant woman is likely to receive, in one year, from sources external to the body, a dose in excess of ten (10) percent of the applicable annual limit RH1206 or RH1207, Arkansas Rules and Regulations; and
4. A declared pregnant woman is likely to receive during the entire pregnancy from radiation sources external to the body, a deep dose equivalent in excess of 0.1 rem (1 mSv) (All of the Occupational Doses in Section 7.2.2 continues to be applicable to the declared pregnant worker as long as the embryo/fetus dose limit is not exceeded.)

6.8.1 Dosimiters

The principal user is responsible for seeing that each person under his/her control is issued a radiation dosimeter when his/her activities may result in exposures greater than the annual dose limits outlined in Section 7.2.

Types of dosimeters include film badges, thermoluminescent dosimeters (TLDs), and pocket dosimeters. Users working with gauges, which are sources of gamma and neutron radiation, must wear a whole body badge on the torso of the body. This badge must never be shared with another individual and be used only for occupational (or class) exposure monitoring. The University will supply film badges or TLDs; one of these types of monitors must be obtained from an accredited dosimetry service approved by the Arkansas Department of Health.

Pocket dosimeters will be worn and readings will be recorded to obtain daily measurement of exposure dose under the conditions required by RH 1302 of the ADH Rules and Regulations. Film badges or TLD's must be turned in as mandated by the Arkansas Department of Health for determining dose. Reading must be recorded daily when entering and after leaving the area to obtain a daily measurement of exposure dose.

The pocket dosimeters will be calibrated (semiannually) and checked periodically.

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6.8.2 Bioassays

The Radiation Safety Officer will request a bioassay if an individual's dose, determined by area contamination or pocket dosimeter, warrants a further medical check, or if a bio-contamination type accident occurs. If the quantity of H-3 or other biohazardous radioisotopes used is large enough (more than 0.1 mCi) to suggest a possible hazard, a bioassay procedure will be instituted (See Appendix H *Guidelines for Bioassays*).

IF YOU SUSPECT THAT YOU HAVE RECEIVED A SIGNIFICANT EXPOSURE, CONTACT THE RADIATION SAFETY OFFICER IMMEDIATELY.

6.9 SURVEYS

The Radiation Safety Officer will make annual independent surveys (audits) of all active radioisotope laboratories. Surveys of laboratory work surfaces and floors will be performed regularly when the laboratory is in use. Labs may be audited on a more frequent schedule depending on the amount of radioactivity in use. Such things as inventory assessment, contamination control, and waste disposal practices will be addressed during these audits. Survey (audit) results will be forwarded to the authorized user, and a recheck may be conducted in the event problems have been detected that need corrective action.

6.10 VIOLATIONS, SUSPENSIONS, AND APPEALS

The Committee, the Radiation Safety Officer, or the University Safety Officer can initiate investigations of safety violations. The Committee may request the Radiation Safety Officer to make special investigations of any facilities where radiation sources are used.

6.10.1 Violations

Upon investigation, should the Radiation Safety Officer find any violations, the following guidelines will be utilized:

1. Verbal warning to user, outlining deficiencies found and how these deficiencies should be corrected.

2. Follow-up investigation to be conducted within 30 days of verbal warning. Failure to correct prior violations will result in a written warning, requiring the Principal User to provide a written response as to how the deficiencies have been corrected.

3. A follow-up investigation will be conducted within 30 days of the second audit. Failure to meet conditions one and two which are previously listed will result in loss of user privileges.

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The Radiation Safety Committee or the Radiation Safety Officer reserve the right to revoke the user's authorization, at any time, if in the Committee's opinion or the Radiation Safety Officers opinion, the health or safety of persons or property are placed in immediate danger.

7.0 RESPONSIBILITIES

7.1 RADIATION SAFETY COMMITTEE

The Radiation Safety Committee shall:

1. Provide technical and administrative guidance and aid in the interpretation of all regulations governing the use of radioactive materials;
2. Review and act upon all new, renewal, and amended applications for acquisition, use, transportation, and disposal of radioactive materials;
3. Determine the adequacy of training and experience of persons requesting permission to use or supervise the use of radioactive materials;
4. Determine the suitability of space, facilities, or equipment designated for use or storage of radioactive materials;
5. Receive and review periodic reports from the RSO on monitoring, contamination, and personnel exposure; and
6. At the request of the Chair of the Radiation Safety Committee or designated representative, meet to: a) review alleged infractions of safety rules and regulations, b) investigate incidents as they arise that allegedly violate safe practice rules and regulations, and c) monitor and oversee emergency situations that involve any radiation program or project.

7.2 RADIATION SAFETY OFFICER (RSO)

The RSO has responsibility for administering the regulations, updating them as required, and communicating updates as needed. S/he also has responsibility for amending the State license when required and for:

1. Overseeing all activities involving radioactive materials, including monitoring and surveying all areas in which radioactive materials are used and stored;
2. Providing ASU personnel with assistance , assuring the safe use of radioactive materials; Surveying and overseeing appropriate receipt of all radioactive materials;
3. Overseeing the proper packaging and labeling of radioactive material that University personnel may ship to off-campus sites;
4. Distributing monitoring equipment, determining the need for and evaluating bioassays, monitoring personnel radiation exposures and bioassay records for trends and high exposures, notifying individuals and their supervisors when radiation exposures approach acceptable limits, and recommending remedial action as appropriate;
5. Coordinating or conducting training programs that include initial orientation, periodic refresher courses, and enhanced guidance mandated by changes in procedures equipment, or regulations;

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6. Monitoring, coordinating, and maintaining records for the University's radioactive waste disposal program;
7. Overseeing the storage of radioactive materials not in current use;
8. Performing or coordinating leak tests on all sealed sources and for calibrating radiation survey instruments;
9. Swipe testing[6] areas where radiation waste is store every month and swipe testing areas where sealed materials are stored every six months.(Swipes will each cover a 100 cm² area. Each swipe will be counted by liquid scintillation counting or other instrument in a low background area.);
10. Immediately terminating unsafe conditions or activities that are a threat to public health and safety or property;
11. Maintaining other records not specifically designated above, including records of receipts, transfers, and surveys as required by Arkansas State Board of Health (ASBH) Rules and Regulations;
12. Attending periodic meetings of the Radiation Safety Committee and provide reports to the Committee and the Associate Vice Chancellor for Research.
13. Ensuring that the results of audits, identification of deficiencies, and recommendations for change are documented and maintained for at least 3 years;
14. Providing the Radiation Safety Committee and the Associate Vice Chancellor for Research with reports of any program deficiencies to ensure their prompt remediation;
15. Ensuring that audit results and corrective actions as mandated are made available promptly to all personnel who use licensed materials;
16. Ensuring that all incidents, accidents, and radiation exposures (as defined by the ASBH Rules and Regulations) are investigated and reported to the Arkansas Department of Health and other appropriate authorities (if required) within the required time limits;

7.3 UNIVERSITY SAFETY OFFICER (USO)

The University Safety Officer reports to the Associate Vice Chancellor for Administration and has responsibility for:

- Performing periodic audits of the radiation safety program to ensure that the RSO and all associated users are complying with all applicable regulations and with the terms and conditions of the license (e.g., conducting periodic leak tests, maintaining inventories, and limiting use to trained, approved personnel, etc.).
- Working collaboratively with the RSO to review rules and regulations as they are developed and assure compliance with conditions imposed by the Radiation Safety Committee following review of projects; Performing periodic audits to ensure that all

[6] Areas authorized for use with radioactive materials in which no radioactive materials have been used or stored during the previous month will not be swipe tested or surveyed until actual use has resumed. Areas in which less than 1 mCi of radioisotopes of low energy (<0.3 MeV) have been used will not require survey with a hand held survey meter.

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employees whose assigned duties may involve exposure to radioactive materials are trained in Radiation Safety.; and
- Serving as a member of the Radiation Safety Committee.

7.4 APPROVED USERS

Principal Users are responsible for the safe use of radiation sources by individuals under their control including the following:

1. Compliance with ASU radiation safety rules and regulations and with the State's "Rules and Regulations for the Control of Sources of Ionizing Radiation found at **http://www.healthyarkansas.com/rules_regs/rules_regs.htm**.
2. Obtaining the Radiation Safety Committee's approval prior to procuring or conducting a research protocol involving radioactive materials. A "Request to Use/Acquire Radioactive Materials" (Appendix D) must be completed by the Principal user and must be approved by the RSC prior to beginning research.
3. Completing ENVR 4121/5121 or providing documentation of equivalent knowledge or experience.
4. Ensuring that all *authorized users* have successfully completed ENVR 4121/5121;
5. Ensuring that all *individual users* are currently enrolled in ENVR 4121/5121.
6. Developing protocols for the research/experiment, to ensure that appropriate safety precautions are taken.
7. Notifying the RSO prior to any personnel changes, including addition or termination of employees/students, or changes in operational procedures, new techniques, or changes of areas where radioactive materials may be used or stored.
8. Directing personnel under their control to comply with all recommendations to wear pocket dosimeters, to survey their hands and clothing, to submit to bioassays, etc. which are designed to control and to reduce exposures.
9. Maintaining records of receipt, use, storage, and disposal of radioisotopes.
10. Segregating, containing, labeling, and disposing of all radioactive waste in accordance with guidelines.
11. Promptly notifying the Radiation Safety Officer of any accidents or incidents.
12. Ensuring that the personnel under their control discharge their individual responsibilities as listed in Section 5.4.Cleanup of contaminated facilities or equipment is the responsibility of the principal user and other authorized users. It may **NOT** be assigned or delegated to staff outside the laboratory, such as custodial or maintenance workers.

7.5 OTHER USERS

One of the basic tenets of safety is that all individuals must take responsibility for their own safety, and ensure that any actions taken do not constitute a hazard to others or to the environment. Each person at Arkansas State University who has any contact with sources of radioactive materials has the following responsibilities:

1. Keeping exposure to radiation As Low as Reasonably Achievable (ALARA).
2. Exposing liquid or other sources that will disperse in the atmosphere under fume hoods.

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3. Wearing the recommended radiation monitoring devices for personnel, such as pocket dosimeters and finger badges.
4. Taking all recommended protective measures including, but not limited to, using protective clothing and/or remote-handling tools. Mouth pipetting is specifically prohibited.
5. Refraining from smoking, eating, drinking, chewing gum or tobacco, or applying cosmetics or contact lenses in an area where radioactive materials are used or stored.
6. Refraining from storing or preparing food or drink in any area that has been used for radioactive materials, e.g., refrigerators, cabinets, glassware. Note that if food or empty food packaging is found in the normal trash, this is interpreted as "evidence of consumption" by regulators.
7. Maintaining good housekeeping and clean working habits. Work surfaces must be covered with plastic-backed absorbent paper. Where practical, an impervious tray or pan should be used under the paper in order to ensure containment of spills. Working areas must also be clearly delimited.
8. Surveying work areas at least weekly when less than 200 Ci are used; otherwise survey daily at the end of each laboratory or work period.
9. Labeling radiation equipment and segregating radioactive waste and equipment to avoid cross contamination.
10. Immediately reporting the details of a spill or other accidents involving radioactivity to the Principal User and RSO.
11. Maintaining a log of all meter and wipe surveys conducted by the user. (See Appendix E for Logbook Guidelines).
12. Carrying out decontamination procedures when necessary and taking the necessary steps to prevent the spread of contamination to other areas.
13. Cleaning hands when leaving the laboratory.
14. When using radioisotopes other than low energy beta emitters, the following extra precautions are required:
    a. Placing all sources behind suitable shielding.
    b. Surveying hands, feet, clothing and personal materials at the end of each laboratory or work period.
    c. Monitoring radiation with a survey meter when radioisotopes are being used.

8.0 PROCEDURES

8.1 USER GUIDELINES FOR CONDUCTING SURVEYS

1. Surveys will be conducted each day that loose or uncontained radioactive material is used. Use areas will be swipe-tested and surveyed with a survey meter (if appropriate for the radioisotope) after use for the purpose of detecting contamination. Areas in which only small quantities of radioactive material (less than 200 Ci) are used will be surveyed weekly, rather than daily. Swipe tests will be done after a known or suspected spill of radioactive material. Areas where the contamination level exceeds 200 dpm/ 100 cm^2 or is found to be twice background will be decontaminated and retested.

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2. Swipes will each cover a 100 cm² area. Each swipe will be counted by liquid scintillation counting or other instrument in a low background area.

3. Prior to disposing of radioactive material, a survey will be performed of all material that will be disposed to ensure that radiation levels are at or below background. Measurement will be performed with an appropriate instrument. All records of disposal will be kept until the ADH terminates the license.

4. Records of all surveys must be maintained for a minimum of 3 years after the record is made, for review in accordance with RH-1500 of the ADH Rules and Regulations. The minimum information will include:

    a. Location, date and identification of equipment used, including the serial number, calibration date and pertinent counting efficiencies.
    b. Name of person conducting the survey.
    c. Drawing of area surveyed, identifying relevant features such as active storage areas, active waste areas, etc.
    d. Measured exposure rates, keyed to location on the drawing (point out rates that require corrective action).
    e. Detected contamination levels, keyed to locations on drawing.
    f. Corrective action taken in the case of contamination (as defined above) or excessive exposure rates (exposures likely to exceed 10% of the exposure limits defined in RH-1200 of the ADH Rules and Regulations); reduced contamination levels or exposure rates after corrective action, and any appropriate comments.

8.2 CONTAMINATION LEVELS

Removable surface contamination levels shall be controlled such that a level of 200 dpm per 100 cm^2 is not exceeded. When removable radioactivity is found above the set limit, the area must be decontaminated and then re-surveyed and documented. Non-removable contamination should be labeled and shielded whenever possible in order to maintain ALARA limits.

It is understood, that certain areas may be routinely contaminated, such as internal parts of equipment and inside areas of glassware, and that it may not be practical to decontaminate these surfaces after each use. The equipment should be monitored routinely and cleaned periodically. Signs must be posted and protective clothing and gloves should be used when in contact with these areas.

Radioactive contamination levels of air and water in restricted areas must be controlled such that the levels specified in RH 2200 Appendix A, Table I, of the ADH Rules and Regulations are not exceeded. In unrestricted areas, contamination levels of air and water shall not exceed those specified in RH 2200, Appendix A, Table II.

Subject to the approval of the State.

8.3 LEAK TESTS

A sealed source is 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 (RH-200.av).

Each sealed source, other than Hydrogen-3 (Tritium) with a half-life greater than thirty (30) days and in any other form other than gas shall be tested for leakage and/or contamination prior to initial use and at six month intervals. If there is reason to suspect that a sealed source might have been damaged, it shall be tested for leakage before further use in accordance with RH 1212 of the ADH Rules and Regulations.

Leak tests shall be capable of detecting the presence of 0.005 microcurie of removable contamination. Any test which reveals the presence of 0.005 microcurie or more of removeable contamination shall be considered evidence that the sealed source is leaking. The source should be decontaminated and repaired or disposed of. The RSO will file a report with the ADH within five days of the leak test describing the equipment involved, the test results and the corrective action taken.

8.4 SURVEY INSTRUMENTS AND CALIBRATION

To facilitate safe practice in the University, the Radiation Safety Committee requires that an appropriate calibrated survey meter be available to users. The calibration procedures will be conducted by the RSO in accordance to the Arkansas State University license.

Instruments must be calibrated at least annually and after servicing. Calibrations will be performed by the RSO or the manufacturer utilizing radionuclide sources. The Radiation Safety Officer must be informed prior to the purchase of a new instrument or repair and factory calibration of an existing instrument.

If the instrument contains an internal radioactive standard, the Radiation Safety Officer must be notified prior to disposal of the instrument, so that proper inventory and disposition can be assured.

8.5 RADIOACTIVE WASTE

All radioactive waste must be disposed of in accordance with State Rules and Regulations. Actual disposal of wastes must be carried out by a Principal or Authorized User or by an Individual User under the direct supervision of a Principal or Authorized User. Waste disposal protocols must be approved in advance by the Radiation Safety Committee as part of a Principal Users application. Complete records of all waste disposals must be maintained. Detailed regulations for waste disposal are found in sections RH-1400 through RH-1407 of the ADH Rules and Regulations.

Subject to the approval of the State.

8.6 DECAY IN STORAGE

Waste containing radioisotopes with short half-lives may be stored in an area approved by the Radiation Safety Committee until the radioactivity has decayed to background levels. Liquid wastes must be stored in plastic containers, and solid wastes must be stored in a plastic barrel lined with a plastic bag and covered with a lid. All wastes must be clearly labeled as radioactive with the radioisotope indicated. It is the responsibility of the user to wipe test the waste storage area monthly to ensure no leakage of wastes and record results in a logbook. After the amount of residual radioactivity has been determined to be at background levels and this information recorded, liquid wastes may be poured down a laboratory sink and solid wastes should be carefully and securely wrapped and placed in a normal wastebasket.

8.7 DISPOSAL OF LIQUID WASTES

The ADH Rules and Regulations for disposal of liquid wastes are such that this is the least expensive and most preferred method of radioactive waste disposal. The regulation that limits release of radioactive materials into uncontrolled areas is RH-1210; actual limits for disposal of radioactive wastes to the sewer system are found in RH-2792. In calculating whether disposal of radioactivity in this manner is permitted, please note that the volume of water leaving the ASU campus in a month is approximately 38,000,000 liters. The radioactivity in liquid wastes must be readily soluble (or readily dispersible biological material) in water. Radioactive material can only be disposed into the sewer system through a designated, well marked sink that has been approved by the Committee in the user's application. Radioactivity contained in scintillation vials can also be disposed via the sewer system as long as it does not contain ingredients that cause disposal to be in violation of EPA or other agency regulations for the control of hazardous chemicals. The committee recommends the use of so-called biodegradable scintillation fluid for this reason. Scintillation vials that cannot be disposed of in this manner must be accumulated as solid waste and transferred to a licensed radioactive waste hauler for transport and disposal.

8.8 DISPOSAL OF SOLID WASTE

Radioactive material that cannot be dissolved in water or decayed in storage must be treated as solid waste. This generally entails transfer of control to a low-level waste processor for disposal. Disposal in this manner is expensive, and details of the process are found in RH-1406 of the Rules and Regulations.

8.9 DISPOSAL OF ANIMAL WASTE

Radioactive animal tissue may be disposed without regard to radioactivity or incinerated if the amount of radioactivity is below 0.05 microcuries (1.86kBq) or less Hydrogen-3, Carbon-14, and Iodine-125 per gram averaged over the weight of the entire animal. This manner of disposal requires careful documentation of the amount of radioactivity. Dead animals or animal tissue must be double bagged and disposed in an outside dumpster or you may contact the Environmental Health & Safety Department at extension 2862 for procedures relating to incineration of animals or animal tissue.

Subject to the approval of the State.

Regardless of the radioactivity involved, the user is responsible for complying with all applicable federal, state, and local regulations relating to disposal of hazardous or toxic materials.

Subject to the approval of the State.

APPENDIX A

LOGBOOK FOR RADIOACTIVE MATERIAL

Each principal user must maintain a logbook in the laboratory that contains records of radioisotope use, and disposal. The log book must be separate of other lab notebooks and readily accessible to the RSO or other inspectors.

Contents:

1) **Log of Radioactive Materials On Hand**

Every time radioactive material is **received**, the following information must be entered into the log: Isotope, chemical form, amount (Ci or mCi), volume, and date of arrival. Each entry must be on a separate page with ample room after the entry to record changes in amounts during usage.

Every time radioactive material is **used**, the following information must be entered into the log: Date of use, the volume (or mass) of material used, the volume (or mass) disposed, and the volume (or mass) remaining. At least once a week, the remaining balance of radioactivity must be entered; decay of short half life radioisotopes must be taken into account.

2) Log of Swipe Tests

Swipe tests must be performed at least weekly when using 200uCi or less. Workers using in excess of 200 uCi in a day must perform swipe tests daily at the conclusion of the experiment. The logbook should contain a map of the laboratory with radioactive use areas clearly indicated.

Numbered swipe tests should be keyed to the map and the areas briefly described. It is highly recommended that the same core swipe areas be numbered the same from week to week. Core areas should include the work area, around the work area, any sink for radioactive disposal, and high traffic areas that may have been contaminated (floor near door, doorknobs, telephone). Additional locations should include any place a spill may have occurred (bench, floor) or places that have been handled (lid of micro fuge, controls for gel dryer). Background (paper disk in scintillation fluor) should be determined each time; you may use the same background vial over and over. Vials that register background levels can be utilized for repeated swipe tests.

Swipe tests twice background must be redone following decontamination of the affected area. Swipe test data must be dated and legibly entered into the log. Scintillation counter printouts may be saved as additional documentation.

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Sample Log
S-35

Date _ Activity Volume Disposal Balance

Used Volume Activity

4/26/99 received S-35 Methionine 0.5 ml 0.5 mCi

4/28/99 used to label cultures 0.1 ml all-sink 0.4 ml

4/30/99 used to label cultures 0.1 ml all-sink 0.3 ml

5/3/99 inventory 0.3 ml 0.28 mCi

5/10/99 inventory 0.3 ml 0.27 mCi

5/12/99 used to label cultures 0.1 ml all (sink) 0.2 ml

5/7/99 received S-35 Na sulfate 1 ml 1 mCi

5/14/99 inventory 1 ml 0.95 mCi

APPENDIX B

RH-2824

NOTICE TO EMPLOYEES

Arkansas Department of Health and Human Services
STANDARDS FOR PROTECTION AGAINST RADIATION

The Arkansas Department of Health and Human Services (ADHHS) has adopted regulations with standards to protect you from hazards associated with radioactive materials and radiation emitting machines which are licensed or registered by ADHHS. In particular, the following information is available for your review:

Section 3: Standards for Protection Against Radiation
Part N: Notice, Instructions, and Reports to Workers. Any other documents your employer must provide.

These may be found at the following location:

YOUR EMPLOYER'S RESPONSIBILITY
Your employer is required to:

1. Comply with all applicable regulations and the conditions of the license or registration.
2. Post or otherwise make available to you a copy of the regulations, licenses, regulations, and operating procedures which apply to work in which you are engaged, and explain the provisions to you.

YOUR RESPONSIBILITY AS A WORKER

You should:

1. Know the provisions of the ADHHS regulations the precautions, the operating procedures, and the emergency procedures which apply to your work.
2. Observe the provisions for your own protection and for the protection of your co-workers.
3. Report unsafe working conditions or violations of the license or registration conditions, or regulations to ADHHS.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The ADHHS regulations specify the occupational limits for radiation exposure including concentrations of radioactive material in air and water. These regulations require your employer to give you a written report if you receive an exposure in excess of any applicable limit. The limits on your exposure are contained in RH-1200, RH-1206, and RH-1207. While these are the maximum allowable limits, your employer should keep your radiation exposure below those limits as is reasonably achievable.
2. If you work where personnel monitoring is required and request information on your radiation exposures;
   a. your employer must advise you annually of your exposure to radiation; and
   b. upon termination of employment, your employer must give you a written report of your radiation exposures. A report of any exposure in excess of a limit must be reported to you.

INSPECTIONS: All licensed or registered activities are subject to inspection by the ADHHS.

INQUIRIES

Direct all inquiries on matters outlined above to: ADHHS, Division of Health, Radiation Control Section, P.O. Box 1437, Mail Slot H-30, Little Rock, AR 72203-1437; (501) 661-2301 Emergencies only (800) 633-1735

POSTING REQUIREMENT: Copies of this notice must be posted in every establishment where employees are engaged in activities licensed or registered by the ADHHS. Posting must permit employees working in or frequenting any portion of a restricted area to observe a coy on the way to or from their place of employment.

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APPENDIX C

MATERIAL LICENSED FOR USE AT ARKANSAS STATE UNIVERSITY

Radioactive Material (Element and Mass Number)	**Chemical and/or Physical form**	**Maximum Radioactivity and/or quantity of material which licensee may possess at any one time**.
A. Radioactive Material between Atomic Numbers 3 and 83	A. Any	A. Not to exceed 50millicuries per radionuclide,excluding items below.
B. Americium-241-Beryllium	B. Sealed Source (Troxler Electronics Dwg.No. A-102451)	B. 44 millicuries
C. Americium-241	C. Monsanto MCR-A- SS-U-AM type source	C. 5 microcuries
D. Americium-241	D. Isotope Products AF-241	D. 0.1 microcuries
E. Cs-137	E. Sealed source (Troxler electronics Dwg. No. A-102112)	E. 9 millicuries
F. Hydrogen-3	F. Any	F. 50 millicuries total
G. Neptunium-237	G. Any	G. 5 millicuries total
H. Plutonium-238	H. Any	H. 0.1 millicuries total
I. Plutonium-239	I. Any	I. 0.1 millicuries total
J. Plutonium-239	J. Sealed Source (Monsanto MCR-N-SS-W-Pu-Be)	J. 32 grams encapsulated as a 2 curie Pu-Be neutron source.
K. Radium-226	K. Sealed Sources in liquid scintillation counters.	K. 1 millicuries total
L. Thorium-228	L. Any	L. 5 millicuries total
M. Thorium-232	M. Any	M. 20 kilograms total
N. Depleted Uranium	N. Any	N. 5 kilograms total

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O. Uranium	O. Natural	O. 20 kilograms total
P. Uranium-232	P. Any	P. 5 millicuries total
Q. Uranium-233	Q. Any	Q. 2 grams total

Subject to the approval of the State.

APPENDIX D
GUIDELINES FOR BIOASSAYS

PART I Conditions under which bioassays may be necessary for the use of Iodine-125 and Iodine-131:

1. When an individual handles in open form unsealed quantities of radioactive iodine that exceed those shown in Table 1 below. The quantities shown in Table 1 apply to both the quantity handled at any one time or integrated as the total amount of activity introduced into a process by an employee over any 3-month period.

2. When quantities handled in unsealed form are greater than 10% of Table 1 values, routine bioassay may still be necessary under certain circumstances. A written justification for not performing such measurements should be prepared and recorded whenever bioassay is not performed and the quantities handled exceed 10% of the levels in Table 1.

3. Bioassay is generally not required when process quantities handled by a worker are less than 10% of those in Table 1.

Types of bioassays that should be performed are:

1. **Baseline:** Prior to beginning work with radioactive iodine in sufficient quantity that bioassay is specified in Item 1 above.
2. **Routine:** At the frequency specified.
3. **Emergency:** As soon as possible after any incident that might cause thyroid uptakes to exceed burdens given below, so that recommended actions can be most effective.

Show in the application that the need for bioassays has been thoroughly considered and that the proposed bioassay program is appropriate for the intended use of radioactive material.

Submit procedures for bioassays that address at least the following:

1. Frequency of testing.
2. Methods used for testing (e.g., thyroid scan, urinalysis), including a description of the procedures involved.
3. Determination of baseline values on individuals involved.
4. Instrumentation used.
5. Provisions for monitoring excretion of radioactive material in any individual who shows radionuclide uptake.

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6. Action levels for the tests and the corrective action to be taken when these levels are exceeded. Recommended action levels for thyroid burden at the time of measurement is 0.12 microcurie of I-125 and 0.04 microcurie of I-131.[7]

[7] Guidance on bioassay program for I-125 and I-131 is provided in NRC Regulatory Guide 8.20. If bioassays are not considered appropriate for the proposed program, specify the reasons for this conclusion.

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TABLE 1

ACTIVITY LEVELS ABOVE WHICH BIOASSAY FOR I-125 OR I-131 IS NECESSARY

ACTIVITY HANDLED IN UNSEALED FORM

MAKING BIOASSAY NECESSARY

TYPES OF OPERATION	VOLATILE OR DISPERSIBLE	BOUND TO NONVOLATILE AGENT
Processes in open room or bench, with possible escape of iodine from process vessels.	1 mCi	10 mCi
Processes with possible escape of iodine carried out within a fume hood of adequate design, face velocity, and performance reliability	10 mCi	100 mCi
Processes carried out within glove boxes, ordinarily closed, but with possible release of iodine from process and occasional exposure to contaminated box and box leakage.	100 mCi	1000 mCi

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PART II Additional information for Use of Tritium (Hydrogen –3)

I. **Special Surveys**

A. Airborne Tritium

If Tritium is requested in sufficient quantity and form as to be airborne, air monitoring for Tritium may be necessary. Describe the procedures and equipment used to perform this monitoring, including appropriate action levels. Specific regulatory requirements for airborne radioactive material concentrations in restricted areas are contained in Paragraph RH-1201 of the Arkansas Board of Health's Rules and Regulations for Control of Sources of Ionizing Radiation.

B. Contamination Surveys

Since Tritium tends to be a persistent and pervasive contamination problem, a rigorous program for conducting wipe surveys (smears) of Tritium use and storage areas should be implemented. Wipes should be taken of any surface that may have been contaminated on at least a weekly basis. Action levels for these surveys should be no higher than 200 dpm/100 cm. Describe the procedures and equipment involved in performing wipe surveys of Tritium use and storage area, including frequency, action levels, materials involved and the person responsible for conducting surveys.

II. **Handling of Contaminated Material**

Some materials, which may become contaminated by Tritium during routine operations, include soil, building materials and transformer and lubricating oils in particle accelerators with Tritium targets. Describe the procedures used to decontaminate and/or dispose of material that has been contaminated. Also, describe the control procedures that will be implemented to reduce the possibility of Tritium contamination.

III. **Bioassays**

Bioassays may be required for persons working with millicuries (or higher) quantities of Tritium. Submit procedures for Tritium bioassay, which address at least the following:

A. Frequency of testing.
B. Method of testing (e.g., urinalysis) including a description of the specific procedures involved.
C. Determination of baseline values on individuals involved.
D. Instrumentation used.
E. Action levels for bioassays.
F. Corrective actions to be taken when action levels are exceeded, including provisions for monitoring excretion of Tritium or for retesting of individuals which show uptake.
G. A bioassay should be performed within one month of the last possible exposure to Tritium, when operations are being discontinued, or when the worker is terminating activities with potential exposure.

Routine bioassay is necessary when quantities processed by an individual at any one time or the total amount processed per month exceed those for the forms of Tritium shown in Table 2.

Under certain circumstances, routine bioassay may still be necessary when quantities are less than the levels in Table 2 but more than 10% of those levels. A written justification for not performing bioassays should be presented in these cases.

Special bioassay measurements may be needed to verify the effectiveness of respiratory protective devices or protective clothing used to prevent inhalation or absorption of Tritium. These special bioassays should be performed to determine the actual Tritium intake of an individual wearing a respiratory protective device or protective clothing if the concentration of Tritium (in any form) in the air is such that exposure for 40 hours per week for 12 weeks to the uniform concentration of Tritium in air specified in Table 1, Column 1, of Paragraph RH-2200. Special bioassay procedures should also be conducted for personnel wearing respirators if, for any reason, the average Tritium concentration in air and the duration of exposure are unknown or cannot be conservatively estimated by calculation.

Bioassays should be performed when air monitoring indicates exposures may exceed 25% of the quarterly limit on intake (inhalation plus absorption) in Paragraph RH-1201 (a)(1). This 25% value should be taken to be 1.6 millicuries. *

Multiplying the concentration given in RH-2200, $5x10^{-6}$ μCi/ml, by $6.3x10^{8}$ ml gives the corresponding quarterly intake of Tritium by inhalation. In the case of inhaled HTO, which mixes instantly with other water molecules after entering body fluids, the intake may be assumed equal to the uptake. The uptake of Tritium (as HTO) by absorption through the skin is assumed equal to the uptake by inhalation unless the form of Tritium in the air can be demonstrated to have lower uptakes. The total uptake, including skin absorption, would be assumed to be about 6.3 mCi, which delivers a dose commitment of about 1.25 rems to standard man (using Q = 1.7). A 40-hour occupational exposure at a concentration of $5x10^{-6}$ μCi/ml would thus result in an intake of 6.3/13=0.48 mCi and a dose commitment of about 0.1 rem. An acute intake (in less than one day) of 0.48 mCi would result in an initial body water concentration of about 11 μCi/liter.

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TRITIUM BIOASSAY FREQUENCY GUIDELINES

Initial Routine

A bioassay sample of at least 100 ml of urine should be taken within 72 hours following entry of an individual into an area where operations require bioassay according to the criteria in this guide and then every two weeks or more frequently thereafter as long as the individual is working with Tritium. When work with Tritium is on an infrequent basis (less frequently than every two weeks), bioassay should be performed within 10 days of the end of the work period during which Tritium was handled.

After Three Months

A sampling frequency selected in accordance with the above paragraph may be changed to quarterly if, after three months, the following three conditions are met:

A. The average urinary Tritium concentration from specimens obtained during the 3-month period does not exceed 3 μCi/L,

B. If measurements of the concentration of Tritium in air are required as a condition of the license, the quarterly average concentration (μCi/ml) to which the workers are exposed multiplied by the factor 6.3×10^8 ml does not exceed 0.8 mCi, and

C. The working conditions during the 3 month period, with respect to the potential for Tritium exposure, are representative of working conditions during the period in which a quarterly urinalysis frequency is employed, and there is no reasonable expectation that the criteria given in items a and b above will be exceeded.

After Use of Respiratory Protective Devices or Protective Suits

A bioassay sample should be taken within 72 hours after respiratory protective devices; suits, hoods or gloves are used to limit exposure as stated in this guide.

TRITIUM BIOASSAY ACTION LEVEL AND CORRESPONDING ACTION GUIDELINES

Biweekly or More Frequent Sampling

A. Whenever the intake of Tritium within any 40-hour work period exceeds the amount that would be taken into the body from uniform exposure for 40 hours at the air concentration (5×10^{-6} μCi/ml) specified in Table 1, Column 1 of Appendix A, paragraph RH-2200, the licensee is required to make evaluations, take necessary corrective actions and maintain records by Paragraph RH-1201 (b) (2).

B. If urinary excretion rates exceed 5 μCi/L but are less than 50 μCi/L, the following course of action should be taken:

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1. A survey of the operations involved, including air and surface contamination monitoring, should be carried out to determine the causes of the exposure and evaluate the potential for further larger exposures or for the possible involvement of other employees.
2. Any reasonable corrective actions that the survey indicates may lower the potential for further exposures should be implemented.
3. A repeat urine sample should be taken within one week of the previous sample and should be evaluated within a week after collection. Internal dose commitments should be estimated using at least these two urine sample evaluations and other survey data, including the probable times of the intake of Tritium.
4. Any evidence indicating that further work in the area might result in an employee receiving a dose commitment in excess of the limits established in RH-1200 should serve as cause to remove the employee from work in the operation until the source of exposure is discovered and corrected.
5. Reports or notification must be provided as required by RH-1504 and RH-2804, or as required by conditions of the license pursuant to RH-1205.

C. If urinary excretion rates exceed 50 μCi/L, the following course of action should be taken:

1. Carry out all steps in Item above.
2. If the projected dose commitment exceeds levels for whole body as provided in RH-1502, provide appropriate notification to the Department.
3. Refer the case to appropriate medical/health physics consultations for recommendations regarding immediate therapeutic procedures that may be carried out to accelerate removal of Tritium from the body and reduce the dose to as low as is reasonably achievable.
4. Carry out repeated sampling (urine collections of at least 100 ml each) at approximately one-week intervals at least until samples show an exception rate less than 5 μCi/L. If there is a possibility of long-term organic compartments of Tritium that require evaluation, continue sampling as long as necessary to ensure that appreciable exposures to these other compartments do not go undetected and to provide estimates of total dose commitments.

Quarterly Sampling

Carry out the actions called for when any of the levels indicated in the above paragraphs are exceeded. In addition, reinstitute biweekly (or more frequent) sampling for at least the next 6-month period, even when urinary excretion falls below 5 μCi/L.

APPENDIX E
ACCEPTABLE TRAINING AND EXPERIENCE REQUIREMENTS FOR USERS OF RADIATION SOURCES

1. Principal User: This individual is expected to be faculty wishing to utilize radioisotopes in teaching or research. To be approved as a principal user, an individual must demonstrate previous experience or successfully complete ENVR 4121/5121 Radiation Safety.

Demonstration of previous experience can consist of a training certificate from another institution, first authorship on a paper in which radioisotopic use was a major component of the research methods, or a passing score on an exam administered by the RSO based on material taught in ENVR 4121/5121. Individuals without previous experience must successfully complete the radiation safety course. ENVR 4121/5121 Radiation Safety includes the following subject areas:

A) radiation terminology

B) basic radiation physics

C) biological effects of radiation

D) radiation instruments

E) radiation in everyday life

F) regulations and responsibilities

G) standard safety procedures

H) emergency procedures

2. Authorized user: This individual is expected to be a student or staff member working with radioisotopes under the authority of a Principal user. To become an Authorized user, an individual must successfully complete ENVR 4121/5121 and be approved by the Radiation Safety Committee. An

Authorized user may work with radioactive material without direct supervision and may be designated to supervise an individual user.

3. Individual user: This individual is expected to be a student working with radioactivity under the direct supervision of a Principal or designated Authorized user. Direct supervision means that a supervisor is present and attentive to the activities of the individual user. Allowing an Individual user to work unsupervised is a violation of the license and could result in the termination of the project. An Individual user must receive adequate training from the RSO, the USO, or the principal user, and this training will be documented by an exam given by the RSO covering most of the same topics listed above but in lesser depth. Informal instruction by the Principal user and enrollment and satisfactory progress in ENVR 4121/5121 prior to handling radioisotopes will also be considered for approval by the Radiation Safety Committee.

4. Ancillary personnel: These are individuals with access to controlled areas (faculty, students, and staff such as housekeeping) that do not work with radioactive materials. All individuals with such access will receive simple, documented training on the basics of radiation safety from the USO. Any individuals who do not agree to be trained or violate regulations will have their access to these areas revoked.

Subject to the approval of the State.

APPENDIX F

Inventory & Disposal Log for Radioactive Material

Sample Inventory								
Date Received: 23 Dec 2006			Isotope	C-14			Activity (uCi): 250 uCi	
PO #	DO2314		Form:	Butyric Acid			Volume (mL): 2.5 mL	
Date	User		Amount Used			Balance		
			ml / uCi			mL / uCi		
25-Dec-2006	Hilburn, Doe		25 uCi/ 0.25 mL			225 uCi / 2.25mL		
23-Jan-2007	Public , John Q		40 uCi / 0.40 mL			185 uCi / 1.85 mL		
For Items								

not used monthly, an amount must be entered into the balance column for the month.								
Disposal Log								
Use separate container for Separate isotopes								
Isotope	C-14							
Form:	Butyric Acid		Material Added			Total Acitivity		
			ml / uCi			mL / uCi		
30-Dec-2006	Hilburn, Doe		25 uCi/ 0.25 mL			225 uCi /		

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						2.25mL		
25-Jan-2007	Public , John Q		40 uCi / 0.40 mL			265 uCi / 2.45 mL		

APPENDIX G
REQUEST FOR APPROVAL TO USE and ACQUIRE RADIOACTIVE MATERIAL

Principal User:_____

Date:_____

Department:_____

Campus Phone: _____

Email:_____

Radioisotope (type, max. amount, and chemical form):

_____

Expected Period of Use:

_____

1. On an attached sheet, describe how and where the radioisotope will be used. Include an outline of the research protocol in sufficient detail for the Committee to review. Include the equipment which may be used, handling procedures, the types of waste that will be generated, and how the waste will be disposed in accordance with state and federal regulations and ASU policy.

Include a list of expected authorized and individual users whom you expect to be working on this project.

2. Your signature below indicates that you have read, understood, and agreed to the following:

❑ I will comply with all governing principles, rules, and regulations as outlined in the ASU Radiation Safety Document, the ASU Radioactive Materials License, and the "Rules and Regulations for Control of Sources of Ionizing Radiation" of the State of Arkansas.

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❑ I assume all the responsibilities of Principal user as outlined in the ASU Radiation Safety Document.

❑ I will maintain all necessary records to document use and disposal of radioactive materials.

❑ All radioactive materials sent or brought to campus must be shipped directly to the RSO and not to Central Receiving to check for contamination and for addition to the inventory.

❑ The RSO will inspect and swipe test my facility at least twice yearly.

❑ I and my project are responsible for the cost of all clean-up, disposal, testing required/recommended by the RSO or by State or federal authorities.

_____ _____

Signature Date

Transmit original and 6 copies to ASU Radiation Safety Committee, c/o Ron Johnson, RSO, P.O. Box 519, Dept. of Biology (ext. 3082).

RSC use only: Approved Tabled for clarification Rejected

Conditionally approved if

_____

_____

RSO Signature Date

APPENDIX H
LOGBOOK FOR RADIOACTIVE MATERIAL

Each Principal user must maintain a logbook in the laboratory that contains records of radioisotope use, and disposal. The log book must be separate of other lab notebooks and readily accessible to the RSO or other inspectors.

Contents:

1) **Log of Radioactive Materials On Hand**

Every time radioactive material is **received**, the following information must be entered into the log: Isotope, chemical form, amount (Ci or mCi), volume, and date of arrival. Each entry must be on a separate page with ample room after the entry to record changes in amounts during usage.

Every time radioactive material is **used**, the following information must be entered into the log: Date of use, the volume (or mass) of material used, the volume (or mass) disposed, and the volume (or mass) remaining. At least once a week, the remaining balance of radioactivity must be entered; decay of short half life radioisotopes must be taken into account.

2) Log of Swipe Tests

Swipe tests must be performed at least weekly when using 200uCi or less. Workers using in excess of 200 uCi in a day must perform swipe tests daily at the conclusion of the experiment. The logbook should contain a map of the laboratory with radioactive use areas clearly indicated.

Numbered swipe tests should be keyed to the map and the areas briefly described. It is highly recommended that the same core swipe areas be numbered the same from week to week. Core areas should include the work area, around the work area, any sink for radioactive disposal, and high traffic areas that may have been contaminated (floor near door, doorknobs, telephone). Additional locations should include any place a spill may have occurred (bench, floor) or places that have been handled (lid of micro fuge, controls for gel dryer). Background (paper disk in

scintillation fluor) should be determined each time; you may use the same background vial over and over. Vials that register background levels can be utilized for repeated swipe tests.

Swipe tests twice background must be redone following decontamination of the affected area. Swipe test data must be dated and legibly entered into the log. Scintillation counter printouts may be saved as additional documentation.

Sample Log

S-35

Date, Activity, Volume, Disposal, Balance, Used, Activity

4/26/99 received S-35 Methionine 0.5 ml 0.5 mCi

4/28/99 used to label cultures 0.1 ml all-sink 0.4 ml

4/30/99 used to label cultures 0.1 ml all-sink 0.3 ml

5/3/99 inventory 0.3 ml 0.28 mCi

5/10/99 inventory 0.3 ml 0.27 mCi

5/12/99 used to label cultures 0.1 ml all (sink) 0.2 ml

5/7/99 received S-35 Na sulfate 1 ml 1 mCi

5/14/99 inventory 1 ml 0.95 mCi

APPENDIX I
ADH Form Y

MATERIAL LICENSED FOR USE AT ARKANSAS STATE UNIVERSITY

Radioactive Material (Element and Mass Number)	**Chemical and/or Physical form**	**Maximum Radioactivity and/or quantity of material which licensee may possess at any one time**.
A. Radioactive Material between Atomic Numbers 3 and 83	A. Any	A. Not to exceed 50millicuries per radionuclide,excluding items below.
B. Americium-241-Beryllium	B. Sealed Source (Troxler Electronics Dwg.No. A-102451)	B. 44 millicuries
C. Americium-241	C. Monsanto MCR-A- SS-U-AM type source	C. 5 microcuries
D. Americium-241	D. Isotope Products AF-241	D. 0.1 microcuries
E. Cs-137	E. Sealed source (Troxler electronics Dwg. No. A-102112)	E. 9 millicuries
F. Hydrogen-3	F. Any	F. 50 millicuries total
G. Neptunium-237	G. Any	G. 5 millicuries total
H. Plutonium-238	H. Any	H. 0.1 millicuries total
I. Plutonium-239	I. Any	I. 0.1 millicuries total
J. Plutonium-239	J. Sealed Source	J. 32 grams

	(Monsanto MCR-N-SS-W-Pu-Be)	encapsulated as a 2 curie Pu-Be neutron source.
K. Radium-226	K. Sealed Sources in liquid scintillation counters.	K. 1 millicuries total
L. Thorium-228	L. Any	L. 5 millicuries total
M. Thorium-232	M. Any	M. 20 kilograms total
N. Depleted Uranium	N. Any	N. 5 kilograms total
O. Uranium	O. Natural	O. 20 kilograms total
P. Uranium-232	P. Any	P. 5 millicuries total
Q. Uranium-233	Q. Any	Q. 2 grams total

APPENDIX J
GUIDELINES FOR BIO-ASSAYS

PART I Conditions under which bioassays may be necessary for the use of Iodine-125 and Iodine-131:

1. When an individual handles in open form unsealed quantities of radioactive iodine that exceed those shown in Table 1 below. The quantities shown in Table 1 apply to both the quantity handled at any one time or integrated as the total amount of activity introduced into a process by an employee over any 3-month period.

2. When quantities handled in unsealed form are greater than 10% of Table 1 values, routine bioassay may still be necessary under certain circumstances. A written justification for not performing such measurements should be prepared and recorded whenever bioassay is not performed and the quantities handled exceed 10% of the levels in Table 1.

3. Bioassay is generally not required when process quantities handled by a worker are less than 10% of those in Table 1.

Types of bioassays that should be performed are:

1. **Baseline:** Prior to beginning work with radioactive iodine in sufficient quantity that bioassay is specified in Item 1 above.

2. **Routine:** At the frequency specified.

3. **Emergency:** As soon as possible after any incident that might cause thyroid uptakes to exceed burdens given below, so that recommended actions can be most effective.

Show in the application that the need for bioassays has been thoroughly considered and that the proposed bioassay program is appropriate for the intended use of radioactive material.

Submit procedures for bioassays that address at least the following:

1. Frequency of testing.

2. Methods used for testing (e.g., thyroid scan, urinalysis), including a description of the procedures involved.

3. Determination of baseline values on individuals involved.

4. Instrumentation used.

5. Provisions for monitoring excretion of radioactive material in any individual who shows radionuclide uptake.

6. Action levels for the tests and the corrective action to be taken when these levels are exceeded. Recommended action levels for thyroid burden at the time of measurement is 0.12 microcurie of I-125 and 0.04 microcurie of I-131.

NOTE: Guidance on bioassay program for I-125 and I-131 is provided in NRC Regulatory Guide 8.20. If bioassays are not considered appropriate for the proposed program, specify the reasons for this conclusion.

TABLE 2
ACTIVITY LEVELS ABOVE WHICH BIOASSAY FOR I-125 OR I-131 IS NECESSARY

ACTIVITY HANDLED IN UNSEALED FORM

MAKING BIOASSAY NECESSARY

TYPES OF OPERATION	VOLATILE OR DISPERSIBLE	BOUND TO NONVOLATILE AGENT
Processes in open room or bench, with possible escape of iodine from process vessels.	1 mCi	10 mCi
Processes with possible escape of iodine carried out within a fume hood of adequate design, face velocity, and performance reliability	10 mCi	100 mCi
Processes carried out within glove boxes, ordinarily closed, but with possible release of iodine from process and occasional exposure to contaminated box and box leakage.	100 mCi	1000 mCi

PART II Additional information for Use of Tritium (Hydrogen –3)

I. Special Surveys

A. Airborne Tritium

If Tritium is requested in sufficient quantity and form as to be airborne, air monitoring for Tritium may be necessary. Describe the procedures and equipment used to perform this monitoring, including appropriate action levels. Specific regulatory requirements for airborne radioactive material concentrations in restricted areas are contained in Paragraph RH-1201 of the Arkansas Board of Health's Rules and Regulations for Control of Sources of Ionizing Radiation.

B. Contamination Surveys

Since Tritium tends to be a persistent and pervasive contamination problem, a rigorous program for conducting wipe surveys (smears) of Tritium use and storage areas should be implemented. Wipes should be taken of any surface that may have been contaminated on at least a weekly basis. Action levels for these surveys should be no higher than 200 dpm/100 cm. Describe the procedures and equipment involved in performing wipe surveys of Tritium use and storage area, including frequency, action levels, materials involved and the person responsible for conducting surveys.

II. Handling of Contaminated Material

Some materials, which may become contaminated by Tritium during routine operations, include soil, building materials and transformer and lubricating oils in particle accelerators with Tritium targets. Describe the procedures used to decontaminate and/or dispose of material that has been contaminated. Also, describe the control procedures that will be implemented to reduce the possibility of Tritium contamination.

III. **Bioassays**

Bioassays may be required for persons working with millicuries (or higher) quantities of Tritium. Submit procedures for Tritium bioassay, which address at least the following:

1. Frequency of testing.

2. Method of testing (e.g., urinalysis) including a description of the specific procedures involved.

3. Determination of baseline values on individuals involved.

4. Instrumentation used.

5.. Action levels for bioassays.

6. Corrective actions to be taken when action levels are exceeded, including provisions for monitoring excretion of Tritium or for retesting of individuals which show uptake.

7. A bioassay should be performed within one month of the last possible exposure to Tritium, when operations are being discontinued, or when the worker is terminating activities with potential exposure.

Routine bioassay is necessary when quantities processed by an individual at any one time or the total amount processed per month exceed those for the forms of Tritium shown in Table 2.

Under certain circumstances, routine bioassay may still be necessary when quantities are less than the levels in Table 2 but more than 10% of those levels. A written justification for not performing bioassays should be presented in these cases.

Special bioassay measurements may be needed to verify the effectiveness of respiratory protective devices or protective clothing used to prevent inhalation or absorption of Tritium. These special bioassays should be performed to determine the actual Tritium intake of an individual wearing

a respiratory protective device or protective clothing if the concentration of Tritium (in any form) in the air is such that exposure for 40 hours per week for 12 weeks to the uniform concentration of Tritium in air specified in Table 1, Column 1, of Paragraph RH-2200, Appendix A. Special bioassay procedures should also be conducted for personnel wearing respirators if, for any reason, the average Tritium concentration in air and the duration of exposure are unknown or cannot be conservatively estimated by calculation.

Bioassays should be performed when air monitoring indicates exposures may exceed 25% of the quarterly limit on intake (inhalation plus absorption) in Paragraph RH-1201 (a)(1). This 25% value should be taken to be 1.6 millicuries. *

Multiplying the concentration given in RH-2200, $5x10^{-6}$ μCi/ml, by $6.3x10^{8}$ ml gives the corresponding quarterly intake of Tritium by inhalation. In the case of inhaled HTO, which mixes instantly with other water molecules after entering body fluids, the intake may be assumed equal to the uptake. The uptake of Tritium (as HTO) by absorption through the skin is assumed equal to the uptake by inhalation unless the form of Tritium in the air can be demonstrated to have lower uptakes. The total uptake, including skin absorption, would be assumed to be about 6.3 mCi, which delivers a dose commitment of about 1.25 rems to standard man (using Q = 1.7). A 40-hour occupational exposure at a concentration of $5x10^{-6}$ μCi/ml would thus result in an intake of 6.3/13=0.48 mCi and a dose commitment of about 0.1 rem. An acute intake (in less than one day) of 0.48 mCi would result in an initial body water concentration of about 11 μCi/liter.

TRITIUM BIOASSAY FREQUENCY GUIDELINES

Initial Routine

A bioassay sample of at least 100 ml of urine should be taken within 72 hours following entry of an individual into an area where operations require bioassay according to the criteria in this guide and then every two weeks or more frequently thereafter as long as the individual is working

with Tritium. When work with Tritium is on an infrequent basis (less frequently than every two weeks), bioassay should be performed within 10 days of the end of the work period during which Tritium was handled.

After Three Months

A sampling frequency selected in accordance with the above paragraph may be changed to quarterly if, after three months, the following three conditions are met:

A. The average urinary Tritium concentration from specimens obtained during the 3-month period does not exceed 3 μCi/L,

B. If measurements of the concentration of Tritium in air are required as a condition of the license, the quarterly average concentration (μCi/ml) to which the workers are exposed multiplied by the factor 6.3 x 10^8 ml does not exceed 0.8 mCi, and

C. The working conditions during the 3 month period, with respect to the potential for Tritium exposure, are representative of working conditions during the period in which a quarterly urinalysis frequency is employed, and there is no reasonable expectation that the criteria given in items a and b above will be exceeded.

After Use of Respiratory Protective Devices or Protective Suits

A bioassay sample should be taken within 72 hours after respiratory protective devices; suits, hoods or gloves are used to limit exposure as stated in this guide.

TRITIUM BIOASSAY ACTION LEVEL AND CORRESPONDING ACTION GUIDELINES

Biweekly or More Frequent Sampling

A. Whenever the intake of Tritium within any 40-hour work period exceeds the amount that would be taken into the body from uniform exposure for 40 hours at the air concentration (5 x 10^{-6} μCi/ml) specified

in Table 1, Column 1 of Appendix A, paragraph RH-2200, the licensee is required to make evaluations, take necessary corrective actions and maintain records by Paragraph RH-1201 (b) (2).

B. If urinary excretion rates exceed 5 μCi/L but are less than 50 μCi/L, the following course of action should be taken:

1. A survey of the operations involved, including air and surface contamination monitoring, should be carried out to determine the causes of the exposure and evaluate the potential for further larger exposures or for the possible involvement of other employees.

2. Any reasonable corrective actions that the survey indicates may lower the potential for further exposures should be implemented.

3. A repeat urine sample should be taken within one week of the previous sample and should be evaluated within a week after collection. Internal dose commitments should be estimated using at least these two urine sample evaluations and other survey data, including the probable times of the intake of Tritium.

4. Any evidence indicating that further work in the area might result in an employee receiving a dose commitment in excess of the limits established in RH-1200 should serve as cause to remove the employee from work in the operation until the source of exposure is discovered and corrected.

5. Reports or notification must be provided as required by RH-1504 and RH-2804, or as required by conditions of the license pursuant to RH-1205.

C. If urinary excretion rates exceed 50 μCi/L, the following course of action should be taken:

1. Carry out all steps in Item above.

2. If the projected dose commitment exceeds levels for whole body as provided in RH-1502, provide appropriate notification to the Department.

3. Refer the case to appropriate medical/health physics consultations for recommendations regarding immediate therapeutic procedures that may be carried out to accelerate removal of Tritium from the body and reduce the dose to as low as is reasonably achievable.

4. Carry out repeated sampling (urine collections of at least 100 ml each) at approximately one-week intervals at least until samples show an exception rate less than 5 μCi/L. If there is a possibility of long-term organic compartments of Tritium that require evaluation, continue sampling as long as necessary to ensure that appreciable exposures to these other compartments do not go undetected and to provide estimates of total dose commitments.

Quarterly Sampling

Carry out the actions called for when any of the levels indicated in the above paragraphs are exceeded. In addition, reinstitute biweekly (or more frequent) sampling for at least the next 6-month period, even when urinary excretion falls below 5 μCi/L.

This page is maintained by Starr Fenner and was last updated 7 August 2007

FOR Emergency Assistance

In case of an emergency or accident situation:

Notify:

Radiation Safety Officer at 972-3082

or

Environmental Health & Safety at 972-2862

Nights, Weekends or Holidays:

Notify

Subject to the approval of the State.

University Police

972-2093

AND

Radiation Safety Officer

932-3739
or

Environmental Health & Safety

926-1043

For routine information contact the Radiation Safety Officer

972-3082