Arkansas State University
Environmental Health & Safety

Radiation Safety

9 July 2012

INTRODUCTION

The objectives of the Arkansas State University Radiation Safety Program are to assist in fulfilling the University's commitment to provide a safe and healthy environment for employment and learning and to establish and promote safe practices at all times. Protection of employees, students, the public, and university property and operations are paramount and every attempt will be made to ensure that our facilities are as free as possible from recognized radiation hazards.

The Arkansas Department of Health has issued a Specific Broad Scope License to Arkansas State University. This license authorizes and tightly regulates the responsible use of radionuclides on our campus.

The purpose of Arkansas State University's Radiation Safety Manual is to assist faculty, staff, and students in complying with the objects and terms of the Arkansas Department of Health and the ASU Radiation Safety Committee. This manual is not intended to be an exhaustive or fully comprehensive reference, but rather a guide to enable qualified personnel safe and efficient use of radionuclides and ancillary staff protection from undesirable exposure to the effects of radionuclide use. Further information associated with the use of radioactive materials on this campus can be obtained by contacting the ASU Radiation Safety Officer. For a list of college and university environmental health and safety web sites (most of which include their radiation safety unit), check out the University of Kentucky's Fiscal Affairs site. Notices of recent actions by the Arkansas Department of Health regarding Arkansas State's radiation safety program can be reviewed through the office of Environmental Health & Safety.

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

University Police

972-2093

AND

Radiation Safety Officer

932-3739

or

Environmental Health & Safety

926-3928

For routine information contact the Radiation Safety Officer

972-3082
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1.0 RADIATION SAFETY COMMITTEE (RSC)

1.1 THE PURPOSE OF THE RADIATION SAFETY COMMITTEE

Arkansas Department of Health, Division of Radiation Control and Emergency Management regulations require the establishment of a Radiation Safety Committee (RSC). The purpose of the RSC is to promote the best practice in safe handling and use of radiation sources. The RSC is also established to assure compliance with State regulations and the conditions set forth by the license. Any individual or action, which jeopardizes the license, endangers the permission of all researchers to utilize radioactive materials at Arkansas State University.

1.2 ORGANIZATION OF THE RADIATION SAFETY COMMITTEE

The Radiation Safety Committee, which meets at least annually and as necessary to conduct the business of the radiation safety program, is comprised of the Radiation Safety Officer, Committee Chair (an appropriate representative appointed by the Office of Research and Academic Affairs), University Safety Officer, one (1) licensed user, one (1) physicist with knowledge of radiation physics and two (2) faculty members, one of which must be from outside ABI, Agriculture, and the College of Science and Mathematics, trained and experienced in the safe use of radioactive materials.

1.3 RADIATION SAFETY COMMITTEE RESPONSIBILITIES

This Committee is responsible for establishing procedures and policies for the authorized procurement, protection, use, and disposal of radioactive materials and for the safety and protection of all personnel, students and visitors, on the Arkansas State University Campus. The Committee shall:

1. Provide technical and administrative guidance and aid in the interpretation of various regulations governing the use of radioactive materials.

2. Review and act upon all new, renewal, and amended applications for possession and use 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.

6. Meet, at the call of the chair of the Radiation Safety Committee or designated representative, to review alleged infractions of safety rules and regulations, incidents, and emergencies concerning any radiation program or project.

2.0 RADIATION SAFETY OFFICER (RSO)

2.1 RSO DUTIES AND RESPONSIBILITIES

The Radiation Safety Officer derives authority from the Office of Research and Academic Affairs. The RSO’s duties and responsibilities include ensuring radiological safety and compliance with Arkansas Health Department Division of Radiation Control and Emergency Management and Department Of Transportation regulations and the conditions of the University license. The RSO’s duties and responsibilities include the following:

1. Ensure that the radioactive material possessed by Arkansas State University is limited to the types and quantities of material listed on the license.

2. Oversee all activities involving radioactive material, including monitoring and surveys of all areas in which radioactive material is used and stored.

3. Provide necessary information on all aspects of radiation protection to personnel at all levels of responsibility.

4. Oversee proper delivery, receipt, and radiation surveys of all shipments of radioactive material arriving at the University, as well as proper packaging and labeling of all radioactive material being shipped from the University.

5. Distribute and process personnel radiation monitoring equipment, determine the need for and evaluate bioassays, monitor personnel radiation exposure and bioassay records for trends and high exposures, notify individuals and their supervisors of radiation exposures approaching the limits, and recommend appropriate remedial action.

6. Coordinate or conduct training programs and otherwise instruct personnel in the proper procedures for handling radioactive material prior to use, at periodic intervals (refresher training), and as required by changes in procedures, equipment, regulations, etc.

7. Supervise and coordinate the radioactive waste disposal program, including effluent monitoring and recordkeeping on waste storage and disposal records.

8. Oversee the storage of radioactive material not in current use, including waste.
9. Perform or arrange for leak tests on all sealed sources and for calibration of radiation survey instruments.

10. Immediately terminate any unsafe condition or activity that is found to be a threat to public health and safety or property.

11. Maintain 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. Attend periodic meetings of the Radiation Safety Committee and provide reports to the Committee and Vice Chancellor for Research and Academic Affairs.

13. Ensure that the results of audits, identification of deficiencies, and recommendations for change are documented (and maintained for at least 3 years) and provided to the Radiation Safety Committee and the Vice Chancellor for Research and Academic Affairs for review; ensure that prompt action is taken to correct deficiencies.

14. Ensure that the audit results and corrective actions are made available to all personnel who use licensed material.

15. Ensure that all incidents, accidents, and personnel exposure to radiation 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.

16. Maintain understanding of and up-to-date copies of regulations, the license and revised license procedures, and ensure that the license is amended whenever there are changes in licensed activities or responsible individuals.

**3.0 UNIVERSITY SAFETY OFFICER (USO)**

**3.1 DUTIES AND RESPONSIBILITIES**

The University Safety Officer functions under the Associate Vice Chancellor for Administration. In relation to the Radiation Safety Program, the University Safety Officer is responsible for:

1. Performing periodic audits of the radiation safety program to ensure that the RSO and all associated users are complying with all applicable Arkansas Department of Health regulations and the terms and conditions of the license (i.e., leak tests, inventories, use limited to trained approved users, etc.).

2. Determine compliance with rules and regulations, license conditions, and the conditions of project approval specified by the Radiation Safety Committee.
3. Ensure that all ancillary employees whose assigned duties may involve exposure to radioactive materials in the course of their employment are trained in Radiation Safety.

4. Serve as a member of the Radiation Safety Committee.

**4.0 LICENSING AND REGISTRATION REGULATIONS**

**4.1 FEDERAL REGULATIONS**

There are several areas in which the Federal Government retains regulatory powers in agreement states such as Arkansas.

1. The receipt, possession, use or transfer of by-product, source or special nuclear materials in quantities sufficient to form a critical mass.

2. The construction and operation of any production or utilization facility.

3. The export from or import into the United States of by-product, sources, special nuclear material, or electronic devices.


In all other cases the Arkansas Department of Health, Division of Radiation Control and Emergency Management is given the power to license and regulate the receipt, possession, use and transfer of sources of ionizing radiation.

**4.2 STATE REGULATIONS**

Because Arkansas is an agreement state, the Division of Radiation Control and Emergency Management of the Arkansas Health Department is empowered to license or register radiation sources and to enforce the regulations governing the activities of a licensee or registrant. Arkansas State University has been issued a specific broad scope license.

Within the conditions imposed by the Arkansas Department of Health through the Rules and Regulations, the licensee (ASU) is allowed to state what procedures it will follow in the safe use of radioactive materials. Our radioactive materials license therefore contains both state requirements and self-imposed operating procedures that have been approved by the state. When ASU is inspected, we are examined for compliance with both the Rules and the conditions of our license.

Copies of the Rules and Regulations for Control of Sources of Ionizing Radiation are on file in the following locations: Biology Department, Dean's Office - College of Science and Mathematics, and Environmental Health & Safety. The Radiation Safety Officer also has a copy.
on file. A copy of these 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 http://www.healthyarkansas.com/rules_regs/rules_regs.htm

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

4.3 ARKANSAS STATE UNIVERSITY CAMPUS REGULATIONS

No person may use or transfer radioactive materials into or on the campus of Arkansas State University without prior approval by the Radiation Safety Committee.

All statements related to procurement, use and disposal of radioactive materials appearing in this booklet will be considered as the regulations for Arkansas State University, as they reflect the Rules and Regulations, the ASU license, and the policy decisions of the ASU Radiation Safety Committee. This manual is not intended to be a comprehensive reference. If further information is needed, consult the Arkansas Department of Health, Rules and Regulations for Control for Sources of Ionizing Radiation, the ASU license, or the Radiation Safety Officer.

4.4 POSTING OF NOTICES

The Arkansas Department of Health (ADH) has adopted regulations with standards to protect you from hazards associated with radioactive materials, which are licensed by the ADH. The ADH requires that Arkansas State University post in a conspicuous place for all employees working in any portion of a restricted area a copy of RH-2824 "Notice to Employees" "Standards for Protection Against Radiation". See Appendix VII

5.0 APPROVED USERS

5.1 PRINCIPAL USER

Principal Users are those persons who are permitted by the Radiation Safety Committee to purchase, store and use radioactive materials under the Arkansas State University license (See Appendix II for Training and Experience Requirements). The Principal Users are responsible for the safe use of radiation sources by individuals under their control. The principal user is responsible for:
1. Compliance with the ASU rules and regulations for radiation safety and the State "Rules and Regulations for the Control of Sources of Ionizing Radiation". 
http://www.healthyarkansas.com/rules_regs/rules_regs.htm

2. Obtaining approval of the Radiation Safety Committee prior to obtaining radioactive materials or carrying out a research protocol involving radioactive materials. A "Request to Use/Acquire Radioactive Materials" (Appendix IV) must be completed by the Principal user and must be approved by the RSC prior to beginning research.

3. Ensuring that all authorized users have successfully completed ENVR 4121/5121 and ensure that all individual users are currently enrolled in ENVR 4121/5121. All principal users must have completed the course or show documentation of equivalent knowledge or experience.

4. Developing protocols for the research/experiment, to ensure that appropriate safety precautions are taken.

5. 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.

6. Directing of personnel under their control to comply with all recommendations to wear pocket dosimeters, to survey their hands and clothing, to submit to bioassay, etc. which are designed to control and to reduce their total exposure.

7. Maintenance of required records of receipt, use, storage, and disposal of radioisotopes.

8. Segregation, containment, labeling, and proper disposal of all radioactive waste in accordance with guidelines.

9. Promptly notifying the Radiation Safety Officer of any accidents or incidents.

10. Ensuring that the personnel under their control discharge their individual responsibilities as listed in Section 5.4.

**NOTE:** Cleanup of contaminated equipment or areas is the responsibility of the principal user and the persons creating the contamination. It may **NOT** be assigned or delegated to staff outside the laboratory, such as custodial or maintenance workers.

**5.2 AUTHORIZED USER**

An authorized user is a person who has been added to the Principal User’s Authorization and has completed the appropriate training as outlined in Appendix II. The authorized user is responsible to the Principal User for all actions listed below for radioactive material. This user may work with isotopes or equipment without immediate supervision, and may assume limited responsibilities as defined by the Principal User.
5.3 INDIVIDUAL USER

An individual user is a person who works with radioactive material and has completed the required training as designated in Appendix II. The user must be listed on the Principal Users authorization list as an individual user, and is responsible to the Principal User for all actions listed below. The individual must work under direct supervision of the Principal User or an Authorized User designated by the Principal User.

5.4 RESPONSIBILITIES OF 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. Keep exposure to radiation As Low As Reasonably Achievable (ALARA).
2. Expose liquid or other sources that will disperse in the atmosphere under fume hoods.
3. Wear the recommended radiation monitoring devices for personnel, such as pocket dosimeters and finger badges.
4. Use all recommended protective measures such as protective clothing, remote-handling tools. Mouth pipetting is prohibited.
5. DO NOT smoke, eat, drink, chew gum or tobacco, or apply cosmetics or contact lenses in an area where radioactive materials are used or stored. DO NOT store or prepare food or drink in any area that has been used for radioactive materials, e.g., refrigerators, cabinets, glassware. If food or empty food packaging is found in the normal trash, this is interpreted as “evidence of consumption” by regulators.
6. Maintain good housekeeping and clean working habits. Work surfaces must be covered with a 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 be clearly delimited.
7. Survey work areas at least weekly when less than 200 Ci are used; otherwise survey daily at the end of each laboratory or work period.
8. Label radiation equipment and segregate radioactive waste and equipment to avoid cross contamination.
9. Report immediately to the Principal User and RSO the details of a spill or other accidents involving radioactivity.
10. Maintain a log of all meter and wipe surveys conducted by the user. (See Appendix V for Logbook Guidelines).
11. Carry out decontamination procedures when necessary and take the necessary steps to prevent the spread of contamination to other areas.

12. Clean hands when leaving the laboratory.

When using radioisotopes other than low energy beta emitters, the following extra precautions are required:

13. Place all sources behind suitable shielding.

14. Survey hands, feet, clothing and personal materials at the end of each laboratory or work period.

15. Monitor radiation with a survey meter when radioisotopes are being used.

6.0 PROCUREMENT, RECEIPT AND INVENTORY OF RADIOACTIVE MATERIALS

6.1 PURCHASES

The Principal User must submit to the Radiation Safety Officer a "Request to Use/Acquire Radioactive Material" 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.

6.2 RECEIPT OF RADIOACTIVE MATERIALS

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.

6.3 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:

1. Name of institution receiving radioactive material and a written certification from that institution identifying authorization to receive the type, form and quantity of radioactive material to be transferred. The certification must also include the current license number, expiration date and issuing agency name.

2. Name of Radiation Safety Officer at receiving institution.

3. Isotope, chemical compound, and amount of activity.

This is necessary for compliance with Arkansas State University license and to avoid potential legal prosecution. 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.
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.

6.4 SECURITY AND STORAGE OF RADIOACTIVE MATERIALS

6.4.1 SECURITY

The 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 reads:

(a) 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.

6.4.2 STORAGE:

Radioactive materials shall be stored in sealed containers in such a way as 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".

7.0 RULES FOR THE SAFE HANDLING OF RADIOACTIVE MATERIALS

7.1 CLASSIFICATION OF AREAS

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".

7.1.1 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.

7.1.2 CONTROLLED AREA

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.

7.1.3 RESTRICTED AREAS

All areas within the University in which dose levels do not conform to the standard for unrestricted areas shall be restricted and under the control of the Radiation Safety Officer for radiation safety purposes. The approved user responsible for work with radioisotopes in that area 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.

3. Very High 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.

*NOTE - At 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).
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.

7.2 RADIATION DOSE LIMITS

7.2.1 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 manual are used to control radiation exposure to all personnel occupationally exposed to radiation. It is the policy of Arkansas State University to keep this exposure as low as reasonably achievable (ALARA).

7.2.2 OCCUPATIONAL DOSE 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:

<table>
<thead>
<tr>
<th>Total Effective Dose</th>
<th>5 rems (0.05 Sv), or</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum of deep-dose equivalent and committed dose equivalent to any individual organ or tissue other than the lens of the eye</td>
<td>50 rems (0.5 Sv)</td>
</tr>
<tr>
<td>Lens of the eye (lens dose)</td>
<td>15 rems (0.15Sv) and</td>
</tr>
<tr>
<td>Skin &amp; extremities</td>
<td>Shallow dose equiv. of 50 rems (0.50Sv)</td>
</tr>
</tbody>
</table>

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).

CDE – Committed Dose Equivalent (HT,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 = \sum 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).

7.2.3 MINORS WORKING WITH RADIOACTIVE MATERIALS

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.

7.2.4 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.

7.2.5 EXPOSURE LIMITS TO 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.

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.

7.3 PERSONNEL MONITORING

Personnel monitoring of exposure to radiation and radioactive materials shall be performed to demonstrate compliance with the occupational dose limits. As 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.)

7.3.1 DOSIMETERS

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 periodically checked.
7.3.2 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 IX "Guidelines for Bioassays").

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

7.4 POSTING OF LABORATORIES AND AREAS

All lab areas that contain radioactive material will be indicated by the posting of the standard trefoil warning sign at the entrance to the laboratory. Address and telephone numbers of the principal user involved with the lab will be clearly indicated thereon. Signs are required by regulation to denote areas or containers with levels of radiation or radioactivity specified in the following sections:

**Radiation Areas:** Each radiation area shall be conspicuously posted with a sign or sign bearing the radiation symbol and the words "CAUTION RADIATION AREA" in areas accessible to personnel in which the total effective dose received in any one hour exceeds 0.002 rem (0.02 mSv) and 0.05 rem (0.5 mSv) in a year.

**High Radiation Areas:** Each high radiation area shall be posted with a sign or signs bearing the radiation symbol and words "CAUTION HIGH RADIATION AREA". In addition, one or more of the following features must be utilized at the entrance or access point to the high radiation area:

- A control device that upon entry causes the level of radiation to be reduced below the level at which an individual might receive a deep-dose equivalent of 0.1 rem (1 mSv) in one (1) hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.
- A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry; or

**Very High Radiation Areas:** Each area in which there may exist radiation levels in excess of 500 rads (5 grays) in one (1) hour at one (1) meter from a radiation source or any surface through which the radiation penetrates must be posted with a sign or signs bearing the radiation symbol and "GRAVE DANGER, VERY HIGH RADIATION AREA". Each entrance or access point must be equipped with entry control devices which function automatically to prevent any individual from inadvertently entering the area when very high radiation levels exist.
**Radioactive Materials:** Each laboratory or area where radioactive materials are used or stored must be posted at the entrance with a "CAUTION RADIOACTIVE MATERIALS" sign. Entry and area warning signs are to be posted and removed only after notifying the RSO.

Refrigerators, freezers, and other "in lab" storage areas, and containers in which materials are stored or transported must have a visible label with the radiation caution symbol and the words "Caution Radioactive Materials". The label should also state the kind and approximate quantity (e.g. "< 250 Ci) of radioactive material in the container.

**AIRBORNE RADIOACTIVITY AREAS:** The Radiation Safety Officer must give approval prior to any research utilizing airborne radioactive materials. Any room, area or enclosure in which airborne radioactive materials exist in concentration excess of the amounts specified in RH 2200, Appendix A, Table 1, Column 1 of the ADH Rules and Regulations.

7.5 **POSTING OF EQUIPMENT**

All vessels containing radioactive materials will be clearly marked with radiation warning tape and/or labels stating:

1) Radioisotope

2) Chemical Form of the Radioisotope

3) Total Activity at date of purchase

4) Date of Purchase

All glassware used in experiments involving radioisotopes will be labeled with radiation warning tape, with the particular radionuclide(s) inscribed thereon, until the vessel has been decontaminated and checked for radiation.

7.6 **VACATING LABORATORY SPACES**

The Radiation Safety Officer must be informed of all changes in authorized laboratory spaces. Upon notification, the Radiation Safety Officer will conduct a clearance survey. Radiation Warning Signs can only be removed by the Radiation Safety Officer.

8.0 **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.

**OPERATING PROCEDURES TO BE UTILIZED BY RSO**

1. The following areas will be swipe tested and surveyed at the intervals indicated:

   a.) Areas in which radioactive wastes are stored at least monthly

   b.) Areas in which sealed sources are stored or used: every 6 months

   c.) 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.

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.

**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 cm² or is found to be twice background will be decontaminated and retested.

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 cm² is not exceeded. When removable radioactivity is found above the set limit, the area must be decontaminated and then re-surveyed and documented. Nonremovable 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.

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.

9.0 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.

9.1 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.

9.2 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 can not be disposed in this manner must be accumulated as solid waste and transferred to a licensed radioactive waste hauler for transport and disposal.

9.3 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. in the Rules and Regulations.

9.4 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.

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.

10.0 EMERGENCY PROCEDURES

In any radiation emergency, personnel protection and emergency medical care have priority over radioactive decontamination of the building and equipment. For all cases, contact the Radiation Safety Officer 870-972-3082, after hours 870-932-3739 who must be notified as soon as
Arkansas State University must notify the Arkansas Department of Health as soon as possible but not later than four (4) hours after the discovery of an event that may allow unnecessary exposure to or release of radiation or licensed radioactive material in excess of regulatory limits. Events may include fires, natural disasters, explosions or toxic gas releases, etc.

10.1 ACCIDENT PROCEDURES

In emergency or accident situations involving radioactive material, the following steps should be taken.

1. **Restrict Access:** Persons in the immediate area should be asked to leave the area. Establish a restricted area boundary, limiting access to the area to authorized personnel only.

2. **Maintain Surveillance:** The restricted area must be kept under constant, direct observation.

3. **Notify:**
   - The Radiation Safety Officer 972-3082 or 932-3739
   - If the incident falls under the requirements of Paragraphs RH-1501 and/or RH-1502 of the Arkansas Rules and Regulations for Control of Sources of Ionizing Radiation, the Arkansas Department of Health must also be notified 1-501-661-2136.
   - In the event of any transportation accident involving radioactive material, both the Arkansas Department of Health and the Arkansas State Police MUST be notified.

**IMPORTANT:** DO NOT HANDLE UNATTACHED OR UNSHIELDED SOURCES OF RADIOACTIVE MATERIAL. Decontamination and recovery operations should only be attempted by properly trained individuals, under the direct supervision of the Radiation Safety Officer and using proper handling tools.

11.0 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.

11.1 VIOLATION PROCEDURES

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.

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.
APPENDIX I

RADIATION SAFETY COMMITTEE MEMBERSHIP

Dr. Andrew Sustich, Ph.D., Chair, Radiation Safety Committee, (Dean of Graduate School) (sustich@astate.edu)

Ron Johnson, PhD., RSO, Biological Sciences (rlj@astate.edu)

Ben Rougeau, DVM, Assistant RSO, Chemistry & Physics (brougeau@astate.edu)

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Starr Fenner, MPA, CHMM, Director Environmental Health & Safety (sfenner@astate.edu)

Richard Grippo, Ph.D., Biological Sciences (mailto:rgrippo@astate.edu)

Ray Winters, M.S., RT (R) (CT), Health Professions (rwinters@astate.edu)

Li, Bao, Ph.D., Chemistry and Physics (bali@astate.edu)

APPENDIX II

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.

APPENDIX III

Inventory & Disposal Log for Radioactive Material
<table>
<thead>
<tr>
<th>Sample Inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date Received: 23 Dec 2006</td>
</tr>
<tr>
<td>PO #: DO2314</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>User</th>
<th>Amount Used</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-Dec-2006</td>
<td>Hilburn, Doe</td>
<td>25 uCi / 0.25 mL</td>
<td>225 uCi / 2.25 mL</td>
</tr>
<tr>
<td>23-Jan-2007</td>
<td>Public, John Q</td>
<td>40 uCi / 0.40 mL</td>
<td>185 uCi / 1.85 mL</td>
</tr>
</tbody>
</table>

For Items not used monthly, an amount must be entered into the balance column for the month.
<table>
<thead>
<tr>
<th>Disposal Log</th>
<th>Use separate container for Separate isotopes</th>
<th>Isotope</th>
<th>C-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form: Butyric Acid</td>
<td>Material Added</td>
<td>Total Activity</td>
<td></td>
</tr>
<tr>
<td>ml / uCi</td>
<td>mL / uCi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-Dec-2006</td>
<td>Hilburn, Doe</td>
<td>25 uCi / 0.25 mL</td>
<td>225 uCi / 2.25 mL</td>
</tr>
<tr>
<td>25-Jan-2007</td>
<td>Public, John Q</td>
<td>40 uCi / 0.40 mL</td>
<td>265 uCi / 2.45 mL</td>
</tr>
</tbody>
</table>
APPENDIX IV

REQUEST FOR APPROVAL TO USE and ACQUIRE RADIOACTIVE MATERIAL

Date:_________________ Principal User:___________________________

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 policies, rules, and regulations as outlined in the ASU Radiation Safety Manual, the ASU Radioactive Materials License, and the "Rules and Regulations for Control of Sources of Ionizing Radiation" of the state of Arkansas.

   □ I assume all the responsibilities of Principal user as outlined in the ASU Radiation Safety Manual.

   □ 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 cleanup/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 V

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

<table>
<thead>
<tr>
<th>Date</th>
<th>Activity</th>
<th>Volume</th>
<th>Disposal</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/26/99</td>
<td>received S-35 Methionine 0.5 ml</td>
<td>0.5 mCi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4/28/99</td>
<td>used to label cultures 0.1 ml all-sink 0.4 ml</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4/30/99</td>
<td>used to label cultures 0.1 ml all-sink 0.3 ml</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/3/99</td>
<td>inventory 0.3 ml 0.28 mCi</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>5/10/99</td>
<td>inventory 0.3 ml 0.27 mCi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/12/99</td>
<td>used to label cultures 0.1 ml all (sink) 0.2 ml</td>
<td></td>
<td></td>
<td></td>
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<td>5/7/99</td>
<td>received S-35 Na sulfate 1 ml 1 mCi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/14/99</td>
<td>inventory 1 ml 0.95 mCi</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX VI

Appendix F

PERSONNEL MONITORING

I. PERSONNEL MONITORING

Personnel monitoring devices, more commonly referred to as personnel monitoring badges, shall be provided to measure the radiation dose for all individuals who are likely to receive more than 10% of the annual dose limit permitted by the Rules and Regulations for Control of Sources of Ionizing Radiation, Paragraph RH-1200, “Occupational Dose Limits for Adults.” The whole body radiation dose limit which requires personnel monitoring is 500 millicurie per year or greater.

However, an Applicant may provide calculations which demonstrate that an individual is not likely to exceed the dose limit and is not required to be provided personnel monitoring. Instructions for estimating an individual’s annual radiation dose is provided in Attachment 1 of this Appendix.

Complete Form F, Personnel Monitoring Program, describing the proposed radiation dose monitoring program and submit the completed form with the application.

II. DESCRIPTION OF PERSONNEL MONITORING DEVICES

A. General

Personnel monitoring badges must detect beta, gamma and neutron radiation, so verify the capabilities of available badges before making a selection. Dosimetry processors must hold accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology. A list of NVLAP accredited dosimetry vendors is available on the Internet at www.nist.gov.

Each order of badges includes a control badge for measuring the amount of background radiation the badges receive each monitoring period. This enables the background to be subtracted from the total reading to provide an accurate record of each worker’s occupational radiation dose. When not in use the badges should be stored with the control badge to ensure accurate dosimetry records. The control badge must be stored in a low background radiation location and must be returned with the other badges each monitoring period.
B. **Film Badges**

Film badges are small pieces of x-ray film contained in a plastic holder. The film darkens in proportion to the amount of radiation it has been exposed to, so measurements of the film density provides a measurement of the wearer’s radiation exposure. Film badges should be protected from extreme environmental conditions which may affect their ability to accurately record radiation. Film badges must be exchanged on a **MONTHLY** basis.

C. **Thermoluminescent Dosimeters (TLD)**

TLDs are personnel monitoring badges that contain small crystals capable of storing some of the energy from radiation. If the crystals are then heated to a specific temperature, they release the stored energy as light. The amount of light released is proportional to the amount of radiation the TLD badge received, which can be measured to determine the badge wearer’s dose. TLDs should be protected from extreme environmental conditions which may affect their ability to accurately record radiation. They must be exchanged at least every **THREE** months.

D. **Optically Stimulated Luminescent Dosimeters (OSLDs)**

OSLDs measure radiation through a thin layer of aluminum oxide. A laser light stimulates the aluminum oxide after use, causing it to become luminescent in proportion to the amount of radiation exposure. OSLDs must be exchanged at least every **THREE** months.

III. **INSTRUCTIONS FOR USING PERSONNEL MONITORING DEVICES**

A. **General Instructions**

A whole body personnel monitoring badge (film, TLD or OSLD) will be worn at all times when handling, using, or transporting a portable nuclear gauge. Each Authorized User will be assigned a badge, which can only be worn by the individual to whom it has been assigned. Badges are to be worn on the front of the torso, at or above the waist and below the shoulder. Badges must be promptly returned to the Radiation Safety Officer (RSO) at the end of each monitoring period to ensure rapid processing.

<table>
<thead>
<tr>
<th><strong>Recommended Work Practices for Personnel Monitoring</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>♦ Never leave badges in close proximity to a gauge or other radiation source</td>
</tr>
<tr>
<td>♦ Protect badges from moisture, intense heat or light and chemicals</td>
</tr>
<tr>
<td>♦ When not in use, store badges with their control badge in a low background radiation area</td>
</tr>
</tbody>
</table>

B. **Special Instructions for New Hires and Lost/Damaged Badges**

To ensure accurate monitoring of occupational dose, an assigned badge will be ordered immediately for new gauge operators. A spare/visitor badge may be provided to new workers until the assigned badge arrives. Spare badges may also be used to replace a badge that has been lost or damaged before the end of the monitoring period. To ensure their use by only one individual, spare badges will be imprinted with the
worker’s name or another form of identification. Workers assigned spare badges will have the dose recorded by the badge added to their occupational dose record. In the event of a lost/damaged badge, the RSO will estimate the worker’s dose for the period the badge was worn, and must request approval from the Department to revise the individual’s dosimetry record.

IV. PERSONNEL MONITORING RECORDS REQUIREMENTS

A. Records of Prior Occupational Dose

Prior to assigning a badge to a worker the worker’s occupational radiation dose received during the current year will be determined. In addition, every reasonable effort must be made to obtain the individual’s records indicating the individual’s cumulative occupational radiation dose. If a worker is unable to provide the information, records from their previous employer will be obtained. Prior occupational dose records shall include all of the information required by the Rules and Regulations for Control of sources of Ionizing Radiation, Paragraph RH-2826, “Cumulative Occupational Exposure History”, Department Form Z, or an equivalent form.

B. Records of Individual Monitoring Results

Records of doses received by each monitored worker will be maintained as long as the company’s license remains in effect. Dosimetry records will be kept in accordance with the Rules and Regulations for Control of Sources of Ionizing Radiation, Paragraph RH-2804, “Notifications and Reports to Individuals” on Department Form Y, Paragraph RH-2825, or an equivalent form, and will contain all of the information required by Paragraph RH-2804. These records will be updated annually.

C. Annual Reports to Monitored Individuals

Each worker assigned a personnel monitoring badge will receive a written annual dose report describing the past year’s monitoring results, as required by the Rules and Regulations for Control of Sources of Ionizing Radiation, Paragraph RH-2804, “Notifications and Reports to Individuals”. Records documenting that the reports have been furnished to monitored workers will be maintained for at least 3 years.

D. Termination Reports to Monitored Individuals

Within 30 days of termination of employment, or within 30 days after the individual’s exposure has been determined, whichever is later, each monitored worker will receive a written report summarizing the individual’s occupational radiation dose, as required by Rules and Regulations for Control of Sources of Ionizing Radiation, Paragraph RH-2804, “Notifications and Reports to Individuals”. Records documenting that the reports have been furnished to monitored workers will be maintained for at least 3 years.

E. Records for Declared Pregnancies

The fetal dose will be closely monitored so as not to exceed 500 millirem. Female gauge operators that have declared themselves pregnant will be instructed to always wear their assigned badge at waist level to estimate the embryo/fetus dose.
Recordkeeping requirements specified in the Rules and Regulations for Control of sources of Ionizing Radiation, Paragraph RH-1207, “Dose to an Embryo/Fetus” and RH-1500.f.5., “Records of Individual Monitoring Results”, will be met.

F. **Occupational Dose Limits for Minors**

Minors will not exceed an annual occupational dose of 500 millirem. Recordkeeping requirements specified in Rules and Regulations for Control of sources of Ionizing Radiation, Paragraph RH-1206, “Occupational Dose Limits for Minors” and Paragraph RH-2804, “Notifications and Reports to Individuals”, will be met.

G. **Worker Overexposure Reports**

When a report of an individual’s exposure is sent to the Arkansas Department of Health as required by Rules and Regulations for Control of sources of Ionizing Radiation, Paragraph RH-1505, “Notifications and Reports to Individuals”, the exposed individual will also be notified no later than when the report is sent out.
Appendix F
Form F

PERSONNEL MONITORING PROGRAM

Describe the proposed personnel radiation dose monitoring program by marking the appropriate boxes. Submit the completed Form with the Application

1. Personnel Monitoring Device to be Used:
   □ Film □ OSLD □ TLD

2. Radiation Detected:
   □ Beta □ Gamma □ Neutron

3. Type Monitoring:
   □ Whole body □ Extremity

4. Frequency of exchange:
   □ Monthly □ Quarterly

5. Supplier of Personnel Monitoring Service:__________________________
   Vendor Registration Number:__________________________

□ PERSONNEL MONITORING IS NOT REQUIRED BECAUSE THE PROJECTED PERSONNEL RADIATION DOSE IS CALCULATED TO BE LESS THAN 500 MILLIREM PER YEAR FOR EACH INDIVIDUAL.
   Justification for this decision is provided in the completed Form F, Table 1.
Appendix F
Attachment 1

Guidance for Demonstrating That Unmonitored Individuals Are Not Likely to Exceed 10 Percent of the Allowable Limits

Personnel monitoring is required for individuals who are likely to receive a radiation dose of more than 10% of the annual dose limit permitted by the Rules and Regulations for Control of Sources of Ionizing Radiation, Paragraph RH-1200, “Occupational Dose Limits for Adults.” The whole body radiation dose limit which requires personnel monitoring is 500 millirem per year or greater. However, if individuals are not expected to receive this dose, personnel monitoring may not be required.

To demonstrate that personnel monitoring devices are not required, the applicant must perform an evaluation to estimate the annual radiation dose to workers and must submit the evaluation with the Application. The applicant/licensee must also retain a copy of the evaluation for inspection purposes.

Common ways that individuals may exceed 10% of the applicable limits are by frequently using the gauge and by performing routine cleaning and lubrication of gauges. Thus, a licensee would must evaluate the radiation doses workers might receive in performing these tasks to determine if personnel monitoring is required.

Applicants who wish to demonstrate that they are not required to provide personnel monitoring must prepare a written evaluation that includes all potential pathways of radiation exposure (transport, field use, maintenance) similar to that shown in the following example. The expected dose rates, times, and distances used in the example may not be appropriate to your situation. In the evaluation, you must use information appropriate to your types of gauges that will be possessed and used. This type of information is generally available from the gauge manufacturers or the Sealed Source and Device Catalogue Registration Sheet maintained by the U.S. Nuclear Regulatory Commission and the Agreement States.

Example

One gauge manufacturer has estimated the doses to the whole body and the extremities of an individual performing routine cleaning and lubrication of one of its gauges. The gauge is authorized to contain up to 9 millicuries of Cesium-137 and 44 millicuries of Americium-241. The manufacturer based its estimate on observations of individuals performing the recommended procedure according to good radiation safety practices. The manufacturer determined the following types of information:

- Time needed to perform the entire procedure (e.g., 10 min)
- Expected dose rate received by the whole body of the individual, associated with the shielded source and determined using measured or manufacturer-determined data (e.g., 20 millirem per hour at contact with the shield)
• Time the hands were exposed to the unshielded source (e.g., 3 min)

• Expected dose rate received by the extremities of the individual associated with the unshielded source and determined using measured or manufacturer-determined data for the typical distance that the hands would be from the sealed source (e.g., 900 millirem per hour or 15 millirem per minute)

From this information, the manufacturer estimated that the individual performing each routine cleaning and lubrication could receive the following:

• Less than 4 millirem, dose to the whole body

| Calculation: | 10 min X 20 millirem/hour X 1 hour/60 minutes | = 3.3 millirem |

• 45 millirem, dose to the hands

| Calculation: | 3 minutes X 900 millirem/hour X 1 hour/60 minutes | = 45 millirem |

The applicable limit (whole body) is 5000 millirem per year and 10% of that value is 500 millirem per year. If one cleaning/lubrication results in 4 millirem, then an individual could perform 125 of these operations each year and remain within 10% of the applicable limit.

The applicable limit for the extremities is 50,000 millirem per year and 10% of that value is 5,000 millirem per year. If one cleaning/lubrication results in 45 millirem, then an individual could perform 111 of these operations each year and remain within 10% of the applicable limit. Based only on this specific situation, personnel monitoring may not be required.

However, using the same type of analysis, the applicant must also determine the radiation dose that the workers receive from the routine daily use of the gauge. Specifically, the evaluation must include the following:

• Removal of gauge from permanent storage and securing the gauge in the transport vehicle

• At the job-site, removal of the gauge from the vehicle and transporting the gauge to the work area

• Set up and use of the gauge at the work area (exposing the radiation source, taking measurements, etc.)

• Return the gauge to the vehicle and secure the gauge in the vehicle

• Return the gauge to the permanent storage at the end of the work day

Radiation survey data provided (by the Sealed Source and Device Catalogue Registration Sheet maintained by the U.S. Nuclear Regulatory Commission and the Agreement States) for a typical gauge includes the following:

1. Surface of the gauge in the closed or shielded position:
   - Bottom: 12 millirem per hour
   - Side: 14 millirem per hour
   - Top: 6 millirem per hour

   Front: 21 millirem per hour
   Back: 5 millirem per hour
2. Highest radiation level at 24” from a gauge in the closed or shielded position:
   0.3 millirem per hour

3. Highest radiation level at the surface of the shipping case with gauge for shipment:
   Top: 4 millirem per hour   Side: 3.5 millirem per hour

4. Radiation level to Operator with probe 8” in soil:
   Operator in stooped position at about 18” in back of gauge: About 1 millirem (0.65 millirem)
   Personnel in a position at about 36” front of gauge: About 1 millirem (1.25 millirem)

**Guidance to Licensees**

Table 1, Personnel Dose Evaluation, may be helpful in preparing and documenting an Applicant’s evaluation of the personnel monitoring program.

Licensees should review the evaluation periodically and revise it as needed. Licensees must check assumptions used in their evaluations to ensure that they continue to be up-to-date and accurate. For example, if workers become lax in following good radiation safety practices, in the example used above, the extremities could be closer to the unshielded source, and they would receive more than 15 mrem per minute. Alternatively, workers could perform the task more slowly than the estimated 10 minutes total and 3 minutes with the hands near the unshielded source. Also, the purchase of new gauges containing sources of different activities, different radionuclides, or different cleaning/lubrication procedures would require a new evaluation.
Table 1

Personnel Dose Evaluation

Dosimetry Evaluation for __________________ Portable Gauge, Model __________________

1. USING THE GAUGE

| NOTE: This estimate is for the Annual Whole Body dose and does not include the extremities (hands) |

- Remove gauge from storage: Time _____ hr X Dose Rate ______ millirem/hr = Dose __________ millirem
- Securing gauge in vehicle: Time _____ hr X Dose Rate ______ millirem/hr = Dose __________ millirem
- Remove gauge from vehicle and transport to job-site: Time _____ hr X Dose Rate ______ millirem/hr = Dose __________ millirem
- Set up and use gauge: Time _____ hr X Dose Rate ______ millirem/hr X Number of times gauge is used during work day = Dose __________ millirem
- Transport and secure gauge in vehicle: Time _____ hr X Dose Rate ______ millirem/hr = Dose __________ millirem
- Return gauge to storage: Time _____ hr X Dose Rate ______ millirem/hr = Dose __________ millirem

Add the Dose Column Daily Dose __________ millirem

Number of days gauge used in a year by same individual _____ days /yr X Daily dose ______ millirem/day = Annual Dose __________ millirem
2. MAINTAINING THE GAUGE

NOTE: This estimate is for the Annual Whole Body dose and the Extremities (hands) dose

- Remove gauge from storage
  - **Whole Body** Time _____ hr X Dose Rate ______ millirem/hr = Dose ______________ millirem
- Perform the cleaning and lubrication procedure
  - **Whole Body** Time _____ hr X Dose Rate ______ millirem/hr = Dose ______________ millirem
  - **Extremity** Time _____ hr X Dose Rate ______ millirem/hr = Dose ______________ millirem
- Return gauge to storage
- **Whole Body** Time _____ hr X Dose Rate ______ millirem/hr = Dose ______________ millirem

Add the Dose Column

<table>
<thead>
<tr>
<th>Whole Body Dose</th>
<th>Extremity Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>_______________</td>
<td>_______________</td>
</tr>
</tbody>
</table>

Number of times the gauge is maintained by same individual _____ times/yr X Whole Body Dose ______________ millirem =

**Annual Whole Body Dose** ______________ millirem

Number of times the gauge is maintained by same individual _____ times/yr X Extremity Dose ______________ millirem =

**Annual Extremity Dose** ______________ millirem
3. TOTAL ANNUAL ESTIMATED DOSE

Whole Body Dose
- Whole Body Dose due to Using the gauge: _____________ millirem
- Whole Body Dose due to Maintaining the gauge: _____________ millirem
- Add the Whole Body Dose:
  - Total Annual Estimated Whole Body Dose: _____________ millirem

Extremity Dose
- Extremity Dose due to Maintaining the gauge: _____________ millirem
- Total Annual Estimated Extremity Dose: _____________ millirem

4. REQUIREMENTS FOR PERSONNEL MONITORING

Annual Whole Body Dose equal to or greater than 500 millirem requires personnel monitoring
Annual Extremity Dose equal to or greater than 5000 millirem requires personnel monitoring
Appendix VII

NOTICE TO EMPLOYEES

Arkansas Department of Health
STANDARDS FOR PROTECTION AGAINST RADIATION

The Arkansas Department of Health (ADH) has adopted regulations with standards to protect you from hazards associated with radioactive materials and radiation emitting machines which are licensed or registered by ADH. 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; Inspections
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, 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 ADH regulations, the precautions, the operating procedures, and the emergency procedures which apply to your work.
2. Observe the provisions of 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 ADH.

REPORTS OF YOUR RADIATION EXPOSURE HISTORY
1. The ADH 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 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.

   a. If you work where personnel monitoring is required and request information on your radiation exposures,

   b. your employer must advise you annually of your exposure to radiation, and

   c. upon termination of employment, your employer must give you a written report of your radiation exposures.

   d. 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 ADH.

INQUIRIES
Direct all inquiries on matters outlined above to: ADH, Radiation Control Section, 4815 West Markham Street, Mail Slot 38, Little Rock, Arkansas 72205-3867 or to (501) 661-2301. For emergencies, call (800) 633-1735.

POSTING REQUIREMENT: In accordance with RH-2002, copies of this notice must be posted in every establishment where employees are engaged in activities licensed or registered by the ADH. Posting must permit employees working in or frequenting any portion of a restricted area to observe a copy on the way to or from their place of employment.

Appendix I to Section 3
Form X

Revised 10/01/12
### APPENDIX VIII

MATERIAL LICENSED FOR USE AT

ARKANSAS STATE UNIVERSITY

<table>
<thead>
<tr>
<th>Radioactive Material (Element and Mass Number)</th>
<th>Chemical and/or Physical form</th>
<th>Maximum Radioactivity and/or quantity of material which licensee may possess at any one time.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Radioactive Material between Atomic Numbers 3 and 83</td>
<td>A. Any</td>
<td>A. Not to exceed 50 millicuries per radionuclide, excluding items below.</td>
</tr>
<tr>
<td>B. Americium-241-Beryllium</td>
<td>B. Sealed Source (Troxler Electronics Dwg. No. A-102451)</td>
<td>B. 44 millicuries</td>
</tr>
<tr>
<td>C. Americium-241</td>
<td>C. Monsanto MCR-ASU-AM type source</td>
<td>C. 5 microcuries</td>
</tr>
<tr>
<td>D. Americium-241</td>
<td>D. Isotope Products AF-241</td>
<td>D. 0.1 microcuries</td>
</tr>
<tr>
<td>E. Cs-137</td>
<td>E. Sealed source (Troxler electronics Dwg. No. A-102112)</td>
<td>E. 9 millicuries</td>
</tr>
<tr>
<td>F. Hydrogen-3</td>
<td>F. Any</td>
<td>F. 50 millicuries total</td>
</tr>
<tr>
<td>G. Neptunium-237</td>
<td>G. Any</td>
<td>G. 5 millicuries total</td>
</tr>
<tr>
<td>H. Plutonium-238</td>
<td>H. Any</td>
<td>H. 0.1 millicuries total</td>
</tr>
<tr>
<td>I. Plutonium-239</td>
<td>I. Any</td>
<td>I. 0.1 millicuries total</td>
</tr>
<tr>
<td>J. Plutonium-239</td>
<td>J. Sealed Source (Monsanto MCR-N-SS-W-Pu-Be)</td>
<td>J. 32 grams encapsulated as a 2 curie Pu-Be neutron source.</td>
</tr>
<tr>
<td>K. Radium-226</td>
<td>K. Sealed Sources in liquid scintillation counters.</td>
<td>K. 1 millicuries total</td>
</tr>
<tr>
<td>L. Thorium-228</td>
<td>L. Any</td>
<td>L. 5 millicuries total</td>
</tr>
<tr>
<td>M. Thorium-232</td>
<td>M. Any</td>
<td>M. 20 kilograms total</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>----------------</td>
<td>------------------------</td>
</tr>
<tr>
<td><strong>N. Depleted Uranium</strong></td>
<td><strong>N. Any</strong></td>
<td><strong>N. 5 kilograms total</strong></td>
</tr>
<tr>
<td><strong>O. Uranium</strong></td>
<td><strong>O. Natural</strong></td>
<td><strong>O. 20 kilograms total</strong></td>
</tr>
<tr>
<td><strong>P. Uranium-232</strong></td>
<td><strong>P. Any</strong></td>
<td><strong>P. 5 millicuries total</strong></td>
</tr>
<tr>
<td><strong>Q. Uranium-233</strong></td>
<td><strong>Q. Any</strong></td>
<td><strong>Q. 2 grams total</strong></td>
</tr>
</tbody>
</table>
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>
<thead>
<tr>
<th>TYPES OF OPERATION</th>
<th>VOLATILE OR DISPERSIBLE</th>
<th>BOUND TO NONVOLATILE AGENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTIVITY LEVELS ABOVE WHICH BIOASSAY FOR I-125 OR I-131 IS NECESSARY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACTIVITY HANDLED IN UNSEALED FORM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAKING BIOASSAY NECESSARY</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Processes in open room or bench, with possible escape of iodine from process vessels.

| Processes with possible escape of iodine carried out within a fume hood of adequate design, face velocity, and performance reliability |
| 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. |
| Processes with possible escape of iodine from process vessels. |
| Processes with possible escape of iodine carried out within a fume hood of adequate design, face velocity, and performance reliability |
| 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. |

| 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, $5 \times 10^{-6} \, \mu\text{Ci/ml}$, by $6.3 \times 10^8 \, \text{ml}$ 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 $5 \times 10^{-6} \, \mu\text{Ci/ml}$ 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 $6.3 \times 10^8 \, \text{ml}$ 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 \(5 \times 10^{-6} \, \mu\text{Ci/ml}\) 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 \(\mu\text{Ci/L}\) but are less than 50 \(\mu\text{Ci/L}\), 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 \(\mu\text{Ci/L}\), 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.

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