

**Radiation Safety Manual**  
**for**  
**Bowling Green State University**



**Radiation Safety Office**  
**Environmental Health and Safety**  
**1851 N. Research Drive**  
**Bowling Green, Ohio 43403**  
**419-372-2171**

**Updated: April 2019**

**Reviewed: April 2019**

# **Radiation Safety Manual**

## **Table of Contents**

<b>Section 1</b>	<b>ADMINISTRATIVE ORGANIZATION, FUNCTIONS AND RESPONSIBILITIES</b>	
1.1	Introduction	4
1.2	Organization	4
1.3	Functions and Responsibilities	4
<b>Section 2</b>	<b>PROCEDURES FOR THE USE OF RADIOACTIVE MATERIALS</b>	
2.1	Scope	7
2.2	Exemptions	7
2.3	Control of Radiation Exposure; the ALARA principle	7
2.4	Compliance with Regulations of Government Agencies	8
2.5	Registration of Performance Areas and Workers	8
2.6	Radiation Surveys and Monitoring	9
2.7	Sealed Sources	9
2.8	Personnel Monitoring	10
2.9	Storage of Radioactive Material	12
2.10	Transportation of Radioactive Material	12
2.11	Disposal of Radioactive Material	12
2.12	Emergency Procedures	12
2.13	Caution Signs and Labels	13
2.14	General Radiation Protection Requirements and Precautions	13
2.15	Ordering Radioactive Materials	14
2.16	Receiving and Opening Radioactive Shipments	15
2.17	Radiation Survey Meters	17
<b>Section 3</b>	<b>DISPOSAL OF RADIOACTIVE WASTES</b>	
3.1	Introduction	18
3.2	Disposal Into Sewer System	18
3.3	Disposal Into Waste Collection Containers	19
3.4	Release of Radioactive Materials into Ventilation Exhaust System	20
3.5	Exempt Waste Disposal	20
3.6	Waste Not Otherwise Covered	21
<b>Section 4</b>	<b>EMERGENCY PROCEDURES</b>	
4.1	Serious Injury with Contamination Involved	22
4.2	Minor Injury with Contamination Involved	23
4.3	Contamination Incident Without Injury	24
4.4	Notifications and Reporting	25
4.5	Decontamination Procedures	26

## **APPENDICES**

- Appendix 1      APPLICATION FOR USE OF RADIOACTIVE MATERIALS**
- Appendix 2      RADIATION USER QUALIFICATIONS**
- Appendix 3      QUARTERLY SURVEY OF RADIATION LABORATORY**
- Appendix 4      REQUEST FOR DOSIMETRY BADGE**
- Appendix 5      RADIATION EXPOSURE REPORT**
- Appendix 6      SINK DISPOSAL OF RADIOACTIVE WASTE**
- Appendix 7      RADIOACTIVE MATERIAL RECEIPT INSPECTION**
- Appendix 8      RADIOACTIVE MATERIAL PHYSICAL INVENTORY**
- Appendix 9      RADIOACTIVE MATERIAL USE AND DISPOSITION LOG**
- Appendix 10     QUANTITY LIMITS FOR RADIOACTIVE MATERIALS**

## **SECTION 1**

### **ADMINISTRATIVE ORGANIZATION, FUNCTIONS AND RESPONSIBILITIES**

#### **1.1 Introduction**

Persons who use materials or equipment involving ionizing radiation at Bowling Green State University can be divided into four categories: (a) those who use small amounts of radioactive substances that are exempt from licensing requirements, (b) those who are approved to use specific amounts and types of isotopes for education and research, (c) those who are using ionizing radiations emanating from sealed or fixed sources, and (d) those who are using non-radioactive ionizing radiation sources (X-ray machines, electron microscopes and X-ray spectrographs). Health and safety hazards exist in each category and therefore all of these activities come under the purview of the Department of Environmental Health and Safety at the University.

#### **1.2 Organization**

The Radiation Safety Office, a division of the Department of Environmental Health and Safety at BGSU, is the administrative focal point at BGSU for health and safety matters involving ionizing radiation. The director of this office and the university's Radiation Safety Officer (RSO), is responsible for insuring that the University satisfies licensing requirements and for overseeing the implementation of appropriate radiation protection standards to safeguard personnel, installations and the general community from hazards arising from work employing radioactive substances or other sources of ionizing radiation.

The RSO is selected jointly by the Vice President for Academic Affairs and the Vice President for Finance and Administration at the University, subject, of course, to approval of the Ohio Department of Health. For day-to-day operations, the RSO reports directly to the Director of the Department of Environmental Health and Safety, but line authority for the office originates from the Vice President for Finance and Administration who exercises budgetary control over both operational and academic divisions of the university. Accordingly, the RSO has access to all physical locations on campus where radioactive materials or radiation producing equipment are used or stored, and has the authority to terminate a project that he/she determines to be a threat to health and safety.

#### **1.3 Functions and Responsibilities**

The function and responsibilities of the RSO are:

- To specify adequate and reasonable health and safety regulations for the use of radioactive substances and radiation sources on campus.
- To provide assistance in the preparation of applications for the various amendments and registrations relating to the utilization of radioactive substances
- To maintain contact with approved users of radioactive substances to insure that unnecessary hazards are avoided, and to terminate any work in progress which is not

performed in compliance with Chapter 3701:1-38 of the Ohio Administrative Code regarding General Radiation Standards for Sources of Radiation and policies of the University Radiation Safety Program

- To maintain a file of the annual physical inventory of radioactive substances under the University jurisdiction and files of all correspondence
- To establish procurement and disposal procedures for all radioactive substances
- To make recommendations on the location and design of new laboratories and facilities or on the modification of existing laboratories and facilities in which radioactive materials or sources will be used
- To provide consultation, advice, and aid in solving health and safety problems encountered by users in their work with radioactive substances and other radiation sources
- To make periodic inspections of working and storage areas to ensure that radioactive materials are properly secured against unauthorized removal when not in use.
- To make routine inspections, including confirmatory radiation surveys, of all areas where radioactive materials are used or stored
- To enforce the safety regulations, policies, and procedures of the University's Radiation Safety Program
- To assist all users (when appropriate) in obtaining and using personnel monitoring equipment when using radioactive materials
- To ensure that radioactive materials are used only by individuals authorized to do so in the institutional license or by persons under their direct supervision
- To ensure that the terms and conditions of the license (such as periodic leak tests) are met and that the required records (such as personnel exposure records, leak test records, and calibration records of instruments) are maintained
- To provide appropriate education and training programs for workers using radioactive materials and for support personnel who also must frequent these laboratories.
- Ensure to notify individuals who work with radiological substances (i.e. radioactive material, x-rays, or lasers).

The functions and responsibilities of approved users of radioactive materials and sources are:

- To insure that they, and any persons working with radioactive materials or with radiation producing instruments under their supervision, receive proper training in the use of the materials or instruments for the intended purpose.
- To regularly inspect their radiation use sites for contamination.
- To ensure that radioactive materials in their possession are properly secured against unauthorized removal when not in use.
- To ensure that use of radiation sources by persons under their supervision is done in accordance with regulations of the NRC, the State of Ohio, and the University Radiation Safety Program regulations.
- To ensure that all persons under their supervision (when appropriate) wear personnel monitoring equipment when using radioactive materials or radiation producing equipment.
- To maintain an accurate inventory of radioactive materials in their possession and proper documentation and records for any waste generated in the course of working with these materials or instruments.

## SECTION 2

### PROCEDURES FOR THE USE OF RADIOACTIVE MATERIALS

#### 2.1 Scope

These procedures apply to all departments, laboratories, and persons at the University or at its off-campus sites, which receive, possess, use, transport or dispose of radioactive material.

#### 2.2 Exemptions

Exempt amounts of radioactive materials are defined as items in form acquired directly from the environment (*e.g.* geological samples), self-luminous radium dials on watches, clocks or other instruments, and radioactive material of activity less than 1 microcurie (not as a sealed source) or less than 10 microcuries (as a sealed source).

The RSO need not approve users and laboratories having exempt amounts. However, the RSO reserves the right to examine laboratories using these materials. Exempt users must follow proper labeling, disposal, operating and safety procedures, including the general radiation protection requirements outlined below. All radioactive isotopes, including exempt amounts, must be included in the annual isotope inventory.

#### 2.3 Control of Radiation Exposure; the ALARA principle

Pursuant to OAC 3701:1-38-12(A) and OAC 3701:1-38-13 (A) and (B), the external and internal exposure from each source of radiation shall be controlled in such a way as to provide reasonable assurance that no individual shall receive an absorbed dose in excess of the values listed in Table 2.1.

**Table 2.1 Maximum Permissible Dose Equivalent Values For Occupational Exposure**

Category	Rems Per Year
Whole Body: head; trunk; arms above elbow; legs above knee; and gonads	5.0
Individual organs (other than lens of the eye)	50
Lens of the eye	15
Skin of whole body	15
Occasionally exposed individual	0.5
Students, public, uncontrolled areas	0.1

**NOTE:** The annual occupational dose limits for minors are 10 percent of the annual dose limits specified for adult workers. (Ref. OAC 3701:1-38-12 (G))

The doses referenced in Table 2.1 are in addition to those received by the individual from all sources of ionizing radiation naturally present in the environment and from that administered for medical purposes.

Special precautions must be taken for female workers of child-bearing age. In accordance with OAC 3701:1-38-12 (H), the maximum permissible dose for a declared pregnant female during the entire pregnancy must not exceed 0.5 rem, and separate records for these individuals must be maintained in accordance with OAC 3701:1-38-20 (I).

Irrespective of the dose limits specified above, procedures shall be implemented to insure that all exposure to ionizing radiation as a result of normal operations is kept As Low As Reasonably Achievable (ALARA). The ALARA principle means that, even if doses are below allowances, and procedures reasonably can be implemented which can make them lower, then those procedures should be implemented. Conforming with the ALARA principle implies that a regular review of personnel exposure and operating procedures takes place. The University is committed to this principle and will provide support and assistance to researchers and lab workers with its implementation.

## **2.4 Compliance with Regulations of Governmental Agencies**

The use, storage, transportation, and disposal of radioactive materials must conform with the applicable regulations of the State of Ohio. Regulatory authority for the use of radioactive materials and radiation generating devices resides with the Ohio Department of Health through their Bureau of Radiation Protection. Applicable regulations are found in the Ohio Administrative Code, Sec. 5, 3701:1-38, which are incorporated herein by reference.

## **2.5 Registration of Performance Areas and Workers**

Each room or laboratory in which radioactive material is to be handled or stored must be registered with the RSO and approved for this use. Individuals who wish to use radioactive materials on a one-time basis, and who are not approved users for the isotope, will submit an "Application for Use of Radioactive Materials" form to the RSO (See Appendix 1). The RSO must approve the application prior to the individual using the radioactive material.

One-time users must work under the direct supervision of an approved user. The authorized user is responsible for making available to those working under his/her direct supervision the pertinent training and instruction on isotope use.

Each person who may handle radioactive material or who may be exposed to external radiation (except for prescribed medical purposes) in excess of 10% of the applicable maximum permissible dose values set forth in Table 2.1 of this manual, must receive training and instruction on isotope use.

Individuals wishing to be placed on the University's Radioactive Material License will submit a "Radiation User Qualifications" form to the RSO (See Appendix 2). The RSO will review the application and, if approved, submit a request to the Ohio Department of Health for an amendment to the license. All persons using radioactive sources and/or substances within the University are responsible for adhering to the procedures outlined in the University Radiation Safety Manual and, ultimately, to provisions of the State of Ohio as prescribed in OAC 3701-1-38.



## **2.6 Radiation Surveys and Monitoring**

Each laboratory using radioactive material must have appropriate radiation detection instruments to enable personnel to monitor for radiation exposure and surface contamination.

The Radiation Safety Office quarterly conducts safety inspections of laboratories that use radioactive materials and radiation sources. These inspections include leak tests, radiation surveys, swab wipe tests of areas where radioisotopes are used, a check of operating procedures and security measures, signs and safety equipment, and a review of records (See Appendix 3).

Researchers using x-ray machines must annually conduct equipment monitoring for stray radiation, and at least every six months conduct tests to insure that safety devices such as interlocks, lights, and alarms are in proper working order. A log recording the date of monitoring, activity found from equipment, points of leakage, and the name of the surveyor will be kept. If the researcher suspects abnormally high readings or problems with the equipment, he or she should contact the Radiation Safety Officer.

Following each use of radioactive materials, researchers will routinely conduct laboratory surveys including checks for contamination of work areas, benches, tables, sinks, etc. A log will be kept recording the date, activity and location of contamination, names of surveyor and principal investigator and actions taken, if any. If problems are found within the laboratory, the investigator should contact the Radiation Safety Officer.

## **2.7 Sealed Sources**

Each registered sealed source shall be tested for leakage and/or contamination at intervals not to exceed six (6) months, or prior to each use. In the absence of a certificate from a transferor indicating that a test has been made within six (6) months prior to the transfer, a sealed source received from another person shall not be put into use until tested.

The test shall be capable of detecting the presence of 0.005 microcurie of radioactive material on the test sample. The test sample shall be taken from the surfaces of the device in which the source is mounted or stored on, where one might expect contamination to accumulate.

Records of leak test results shall be maintained for inspection by ODH.

If the test reveals the presence of 0.005 microcuries or more of removable contamination, the source will be immediately withdrawn from use and must be decontaminated and repaired, or disposed of in accordance with NRC regulations. A report shall be filed within five (5) days of the test with the Ohio Department of Health describing the equipment involved, the test results, and the corrective action taken.

Tests for leakage and/or contamination shall be performed by the licensee, Radiation Safety Officer or by other persons specifically authorized by the Radiation Safety Officer to perform such service.

## 2.8 Personnel Monitoring

The University has implemented a radiation dosimetry program to monitor the dose equivalents received by those persons working with sources of ionizing radiation. The monitors provide a permanent personal record of external exposure to radiation that the user may have received during the period of use. Benefits of the monitoring program include: alerting the Radiation Safety Officer of equipment mishandling and/or of equipment malfunctions; generating occupational exposure history records for the individual and a reference in the event of future industrial or legal claims; and providing a quantitative basis for evaluating laboratory procedures and a means of assessment for meeting the ALARA component of the University's radiation safety program. Persons working in labs with radioisotopes or with radiation generating equipment can request a badge free of charge by completing a "Request for Dosimetry Badge" form (Appendix 4).

The wearing of monitors and proper utilization of the monitoring program is of great significance, but cannot replace safety attitudes and practices by users. Personnel monitoring equipment is required for:

- persons in or entering restricted areas who are likely to receive 10 percent of the applicable permissible dose values set forth in Table 2.1 of this manual;
- individuals under 18 years of age who enter a restricted area and are likely to receive in excess of 5 percent of the applicable permissible dose values set forth in Table 2.1 of this manual; and
- individuals who enter a high radiation area.

Personnel monitoring equipment is NOT required for personnel who are using closed beam analytical units, per OAC 3701-1-66-02(G)(6). However, regulatory leak testing and inspections will still be followed to ensure exposure limits are still similar to background. In the event that a closed beam analytical device fails an inspection, dosimeters will be required for users of that particular device.

Infrequent users: If desired, spare personnel monitors can be placed in some labs for use by visitors or infrequent users of radioactive materials. These "temporary" monitors will be coded by numbers. Only one person can be assigned a temporary badge and/or ring number during the monthly monitoring period, and the Maximum Permissible Dose (MPD) Equivalent Values for such persons is limited to 10% of the MPD for an ordinary radiation worker. The laboratory director is responsible for keeping records of the name, social security number, sex, birth date, dates of exposure, and corresponding badge number of any person using a temporary dosimetry badge, and a copy of this information must be submitted with the used monitors each month.

Pregnant females: Special precautions must be taken for pregnant women. All female users should be informed that the recommended MPD for pregnant women during the gestation period is 10% of the ordinary MPD for other workers, and, if a pregnancy declaration is made and the woman so requests, her dosimetry records will be separately maintained. If the accumulated dose

of the individual already exceeds 10% of MPD at the time of declaration, she will be so informed and given an opportunity either to work elsewhere during the remainder of the pregnancy or to proceed with the personal knowledge of her exposure.

Collection: On approximately the first of each month all dosimetry badges and rings, used or not, are collected by the University Radiation Safety Officer. Control badges are kept in the Environmental Health and Safety office, combined with the collected badges, and returned to the service provider for analysis.

Exposure: The dosimetry badges presently in use will record a radiation exposure of 1 millirem or more of gamma and 10 millirem or more of hard beta radiation. If an exposure of 10% or more of the monthly averaged MPD is indicated on a badge, the user will be contacted and asked to complete a "Radiation Exposure Report" (Appendix 5). This report provides a written explanation of how the exposure might have been obtained and provides a basis for recommendations of revised procedures to prevent further exposure.

For example, the whole body exposure MPD for an adult worker is 5 rems per year or an average of about 400 mR per month. If a user acquires 40 millirem in a one month monitoring period, or if 125 millirem is accumulated prior to the end of a calendar quarter, the user would complete the explanatory report.

This procedure is for the benefit of the user and may detect malfunctions in the equipment, personal protective equipment and/or shielding. Inquiries will commence immediately after the exposure analysis is received from the analysis service company.

The personnel monitors used at BGSU are thermoluminescence detectors (TLD rings) for fingers, and Luxel<sup>tm</sup> solid-state whole body dosimetry badges for the torso. The RSO will distribute whole body badges and rings to persons utilizing x-ray equipment and whole body badges only to those using radioisotopes with hard beta and/or gamma emissions. The badges and rings will be worn at all times when working with x-ray equipment and other sources of ionizing radiation. Body badges must be worn in the area between the neck and the waistline. Rings will be worn on the dominant hand. Rings are to be worn under gloves with the label facing the palm of the hand. If using lead aprons while working with radiation sources, badges will be worn underneath the apron.

When not in use, all badges and rings are to be kept away from all radiation sources. Badges should be stored in a secure place in the laboratory known both to the user and the RSO. Similar to lab coats, gloves, and goggles, dosimetry badges are a normal part of personal protective equipment, and are not to be shared with others nor taken home or out of the work place.

***PERSONNEL MONITORS ARE TO BE WORN ONLY  
BY THE ASSIGNED INDIVIDUAL***

Dosimetry records are maintained by the University Radiation Safety Office and will be reported to individuals annually or more frequently upon request. Upon termination of employment at

BGSU, dosimetry records are archived by the University. These records will be given to the employee or can be transferred to another employer upon request.

## **2.9 Storage of Radioactive Material**

Radioactive material must be kept or stored in a manner that will provide minimum exposure to personnel. Suitable storage precautions will be taken against fire, explosion, flood, or unauthorized removal. Volatile materials shall be appropriately labeled and stored in chemical fume hoods with adequate filtering and ventilation.

## **2.10 Transportation of Radioactive Material**

To comply with regulations, radioactive material to be transported outside of the University property boundaries must be packaged in accordance with Department of Transportation regulations. The RSO will advise on the requirements for packaging, radiation control, measurements, and documentation needed for such shipments.

Except for the transfer of radioactive materials during the course of standard laboratory procedures, transportation of radioactive material within BGSU property boundaries must be in conformity with the following:

- The material shall be transported in a closed shatterproof container that is properly labeled.
- The measured dose rates shall not exceed:
  - (a) 200 millirem/hour at any point on the external surface of the container
  - (b) 10 millirem/hour at one meter from any external surface of the package
- The transferable surface contamination as measured by a wipe-test shall not exceed 600 dpm/300 cm<sup>2</sup> of alpha activity, and 6600 dpm/300 cm<sup>2</sup> of beta plus gamma activity.

## **2.11 Disposal of Radioactive Material**

Radioactive material must be disposed of in accordance with the provisions of Section 3 of this manual. Radioactive waste material shall not be incinerated.

## **2.12 Emergency Procedures**

In the event of personal radiation exposure or accidental release of radioactive material in excess of the amounts listed in Section 2.8, the Radiation Safety Officer must be notified immediately.

Emergency procedures to be followed in the event of a radiation contamination accident are specified in Section 4. Note particularly the distinctions for situations involving:

- (a) serious injury with contamination
- (b) minor injury with contamination, and
- (c) contamination without injury.

### **2.13 Caution Signs and Labels**

In conformity with OAC 3701:1-38-10, each laboratory storing or using radioactive material will be posted with appropriate signs as follows:

- A. A notice of where a copy of the institutional materials license or certificate of registration is located.
- B. A notice of where a complete copy of the Ohio Administrative Code, OAC 3701:1-38, can be found.
- C. A notice of where the BGSU Radiation Safety Manual is located.
- D. Any notice of violation involving working conditions.
- E. The Ohio Department of Health "Notice to Employees" issued by the Bureau of Radiation Protection.
- F. A listing of emergency contacts and telephone numbers.

Each container holding radioactive material of the types and amounts prescribed in OAC 3701:1-38-18, must have a durable, clearly visible label bearing the three bladed radiation symbol and the words: "CAUTION RADIOACTIVE MATERIAL". These labels must also state the quantities and kinds of radioactive materials in the containers and the date of measurement of the quantities.

Labeling is not required for laboratory containers, such as beakers, flasks, and test tubes used transiently in laboratory procedures while the user is present.

### **2.14 General Radiation Protection Requirements and Precautions**

There will be no smoking, eating, drinking, applying of cosmetics, chewing of gum, or storing of food in any area where unsealed and unpackaged sources of radioactive materials are being used, handled, transferred, or stored, unless otherwise specifically authorized by the RSO.

There will be no mouth pipetting of radioactive solutions.

Whenever practical, the user will perform a trial-experimental run using inactive (or low activity) material to establish the adequacy of procedures and equipment.

When performing operations that might produce airborne contamination (i.e., evaporations, sanding or grinding, transfers of unsealed powdered or volatile radioactive material), approved exhaust ventilation will be used.

Protective eye wear also is required in laboratories where chemical or mechanical agents are a potential hazard. Gloves and a lab coat must be worn while handling radioactive materials. After handling unsealed radioactive material, hands must be washed before leaving the laboratory, and exposed skin, hair, and clothing surveyed. Sandals, open toed shoes, or bare feet are also not allowed in the lab.

Materials and equipment will be surveyed prior to removal from a potentially contaminated area.

## **2.15 Ordering Radioactive Materials**

All orders for radioactive materials must be approved by the RSO or the RSO's designee to ensure that the requested materials and quantities are authorized by the license for use by the requesting user and that institutional possession limits are not exceeded. Only Approved Radiation Users may order radioactive materials, and only the isotopes, chemical forms and quantities for which the user is currently approved will be approved.

Orders for radioactive materials must be made using paper requisitions bearing the special stamp "RADIOACTIVE MATERIALS" clearly indicated in the body of the requisition. No electronic orders are allowed. The requisition must include

- Vendor's Name
- Isotope name and/or symbol
- Activity in millicuries
- Chemical Form
- Approved User's Name
- User's Signature
- Location where material is to be delivered

After completion, the requisition should be sent to the RSO for approval. The RSO will verify the requested material in terms of institutional allowances, will enter the order in the university's official log of radioactive material, and forward a copy of the form to the Purchasing Department for processing. A copy of the requisition is retained by the RSO to verify when ordered materials are received.

## 2.16 Receiving and Opening Radioactive Shipments

All radioactive material orders are shipped to and received by the RSO. Upon receipt, packages are monitored with a hand-held survey meter for external radiation levels and are tested for surface contamination via liquid scintillation counting of a swab sample. Per requirements of 49 CFR 173.443 as delineated in OAC 3701:1-50-05 (A), limits on removable contamination for packages with alpha emitters are 660 dpm/300 cm<sup>2</sup> and 6600 dpm/300 cm<sup>2</sup> for beta-gamma emitters. If these limits are exceeded, the package is quarantined and the shipper and researcher are both notified. A form for use in inspection of radioactive packages is included in Appendix 7.

The following procedure for opening each package is followed by the RSO or designee prior to delivery to the Approved User:

- a. Put on gloves to prevent hand contamination.
- b. Visually inspect the package for any signs of damage (*e.g.* wet or crushed). If damage is noted, stop the procedure and notify the RSO.
- c. Measure the exposure rate at the package surface and at a distance of 1 meter. If it is higher than expected, stop and notify the RSO. (The "transport index" noted on the packages with "Yellow II" or "Yellow III" labels is the approximate dose rate, in millirem per hour, at 1 meter from the package surface pursuant to OAC 3701:1-50-17 J(1), the surface dose rate from such packages should not exceed 200 millirem per hour. The dose rate from packages with "White I" labels should be less than 0.5 millirem per hour at the package surface. (see OAC 3701:1-50-05)
- d. Wipe all package surfaces (top, sides, and bottom) with a swab sample. Be sure to wipe areas of the package likely to exhibit contamination (*e.g.* seams and bottom) and to cover a total area of at least 300 cm<sup>2</sup> (roughly an area of 7 inches x 7 inches). Insert this sample into a vial of scintillation fluid, and analyze with the liquid scintillation counter using channel(s) appropriate for the isotope in question. For packages containing beta-gamma sources, if the swab sample exhibits more than 6,600 dpm of activity (660 dpm for alpha sources), stop the procedure, quarantine the package, and immediately notify the RSO, the shipper, and the user who ordered the material. Otherwise, proceed to the next step.
- e. Open the package with the following precautionary steps:
  - (1) Remove the packing slip.
  - (2) Open the outer package following the supplier's instructions, if provided.

- (3) Open the inner package and verify that the contents agree with the packing slip. (Note: It may be necessary to use thermal protection gloves when container is shipped in dry ice).
- f. Check the user request to ensure that the material received is the material that was ordered.
- g. Make a record of the receipt.
- h. Deliver the package, and copies of the paperwork, to the approved user, or a radiation safety trained employee in the lab or stockroom.

Upon receipt of a radioactive material package, the Approved User (or the Approved User's designee) will follow the following procedures:

- a. Put on gloves to prevent hand contamination.
- b. Visually inspect the package for any signs of damage (*e.g.* wet or crushed). If damage is noted, stop the procedure and notify the RSO.
- c. Measure the exposure rate from the package at 1 meter and at the package surface. If higher than expected (see item c. above), stop and notify the RSO.
- d. Open the package with the following precautionary steps:
  - (1) Open the outer package following the supplier's instructions, if provided.
  - (2) Open the inner package and verify that the contents agree with the packing slip and with the original requisition. (CAUTION: It may be necessary to use thermal protection gloves when container is shipped in dry ice).
  - (3) Check the integrity of the final source container. Look for broken seals or vials, loss of liquid, condensation, or discoloration of the packing material. If anything is other than expected, stop and notify the RSO.
- e. If there is any reason to suspect contamination, wipe the external surface of the final source container and remove the sample to a low-background area. Assay the wipe sample to determine if there is any removable radioactivity. Take precautions against potential spread of contamination.
- f. Assuming all is in order, place the source container in the agreed upon secured location in the laboratory (locked freezer, etc.) and be sure the storage location is secure.
- g. Place the associated Radioactive Materials Receipt Log Sheet in the lab notebook or post this sheet in the agreed upon location in the lab for access by users of these materials.



h. Monitor the packing material and the empty cartons for contamination with a survey meter before discarding.

(1) If contaminated, treat this material as radioactive waste.

(2) If not contaminated, remove or obliterate the radiation labels before discarding in ordinary trash.

## **2.17 Radiation Survey Meters**

Hand held radiation survey meters suitable for measuring beta and gamma radiation for the majority of isotopes in use at BGSU are supplied by the Radiation Safety officer to each laboratory where such isotopes are used. These meters are calibrated annually by an external service company (presently Ludlum and Associates), and appropriate stickers indicating the date of calibration and meter sensitivities are included on each meter. Calibration records for each instrument are maintained in the Radiation Safety Office.

Maintaining a working meter with fresh batteries and current calibration ultimately is the responsibility of the Approved User, but the RSO provides assistance with this function. Survey meters are checked by the RSO monthly when dosimetry badges are exchanged in the labs, and are tested or exchanged at the time of quarterly inspections in the labs.

Spare survey meters are maintained by the RSO, and a replacement meter can be requested in the event of equipment failure or breakage.



## SECTION 3

### DISPOSAL OF RADIOACTIVE WASTES

#### 3.1 Introduction

Radioactive waste must be disposed of in a manner that protects the health and safety of the public. The means of accomplishing this are outlined in OAC 3701:1-38-19. For the type and amounts of materials used at BGSU, three basic methods of disposal are employed:

1. Discharge to sanitary sewer.
2. Decay in storage.
3. Transfer to an authorized agent for disposal at a licensed radioactive waste disposal facility.

Restrictions and special procedures apply for each disposal method, as prescribed in OAC 3701:1-38-12 and 19.

#### 3.2 Disposal To Sanitary Sewer

Radioactive material discharged into laboratory drains must be readily soluble or dispersible in water. Laboratories will designate sinks for disposal of radioactive waste, and only these sinks should be used for this purpose. The sinks will be labeled "**FOR USE OF RADIOACTIVE WASTE ONLY**". The amounts of radioactivity that can be discharged into the university's sewerage system are limited both in terms of concentration as well as total activity.

Average concentrations of radioactive material discharged into the laboratory drains in any one month when diluted by the average monthly water quantities released by the University to the public sewerage system, must not exceed values listed in OAC 3701:1-38-12, Appendix C, Table III. Based on University average monthly water usage, these concentration limits would allow discharges far in excess of the total disposal limits permitted under OAC 3701:1-38-19 (D) (4). Accordingly, we have chosen to restrict drain disposal based on institutional possession limits and actual usage of isotopes at BGSU. For this purpose, no more than 30 microcuries per day of Carbon-14 or 100 microcuries of Hydrogen-3 may be released by a lab into the sewerage system, and no more than 30 microcuries per day total of all other approval isotope. These limits are sufficiently restrictive to insure that the total activity of radioactive material discharged into the laboratory drains per year remains well below the five (5) curies of Tritium (H-3), one curie of Carbon 14 (C-14) and one curie of all other combined licensed material as required by OAC:1-38-19 (D) (4).

Records must be kept of the quantity and kind of radioactive material disposed of into the laboratory drains. Forms to be used to record such disposals are included as Appendix 6.

The RSO will maintain a calendar quarterly summary record of the total amount of activity being discharged from the institution, and, if indicated by this record, restrict the amount to be discharged during the latter quarter(s) of the year sufficiently to ensure that less than one curie is discharged per year.

In summary, liquid waste may be disposed via the sanitary sewer system at BGSU provided that the following conditions are met:

1. Unless an exception is made by the Radiation Safety Officer, each approved user of radionuclides must use only one sink for the disposal of liquid waste,
2. Each sink must be identified as being approved for radioactive waste disposal with the appropriate caution sign displayed.
3. The daily limits of radioactive material released must not be exceeded. These limits must be posted on each sink.
4. All releases of radioactive material must be followed by flushing the sink with copious amount of water.
5. The liquid waste must be readily soluble or dispersible in water.
6. Flammable solvents that are not miscible with water must not be flushed down the drain.
7. Radioactive material that can be conveniently decayed in storage (e.g., P-32 and I-125) must not be disposed via the sewer.
8. High concentrations of radioactive material should not be disposed of via the sewer system.

### **3.3 Disposal into Waste Collection Containers**

All radioactive waste not discharged into the laboratory drains shall be put into special collection containers labeled as "**RADIOACTIVE WASTE**" according to the following rules:

Isotopes must be disposed of separately in containers specifically marked to receive these materials, *e.g.* P-32, C-14, S-35, I-125, etc. **DO NOT MIX ISOTOPES IN THE WASTE STREAM.** Short-lived isotopes such as P-32 and I-125 will be held for decay-in-storage and ultimately placed in the ordinary trash for landfill. Long lived isotopes such as C-14 and H-3 are stored temporarily pending transfer to an approved landfill by a certified waste hauler.

The total amount of radioactive material put into any container must be controlled so that the radiation level one foot from the container is less than 5 millirems/hour, and the radiation level at contact with any surface of the container is less than 200 millirems/hour.

Material must not be put into the waste collection containers if there is any possibility of a chemical reaction during storage that might cause an explosion or cause the release of chemically toxic or radioactive gases.

Solutions must be neutralized to a pH range between 4 and 10 prior to disposal into the waste container.

Volatile compounds shall not be put into a radioactive material waste collection container, unless the procedure has been specifically authorized by the RSO.

Highly reactive materials must be reacted to completion prior to disposal into the waste container.

Animal tissue or excreta solid shall not be put into a radioactive material waste collection container, unless the procedure has been specifically authorized by the RSO. Special disposal procedures should be arranged with the RSO prior to the start of work that will produce this kind of waste material.

A record must be kept of the estimated activity and kinds of radioactive material disposed into the solid waste collection containers. A summary disposal record must be presented to the Radiation Safety Officer at the time of collection of the container.

### **3.4 Release into Ventilation Exhaust System**

Unless otherwise authorized by the RSO, the 24-hour average concentration of radioactive material entering the duct system of each laboratory must not exceed the limits of OAC 3701:1-38-12, Appendix C, Table II.

The RSO must be notified immediately if there is a release into the environs of airborne radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed the limits specified for such materials.

Determinations of the average concentration of radioactive material may be made with respect to the point where the material leaves the exhaust duct. Concentrations may not be averaged over a period longer than one day, without prior authorization of the RSO.

### **3.5 Exempt Waste Disposal**

The following licensed radioactive materials may be disposed of as if they were not radioactive (Ref. OAC 3701:1-38-19(G)):

0.05 microcurie (1.85 kBq), or less, of Hydrogen-3 or Carbon-14 per gram of medium used for liquid scintillation counting.

0.05 microcurie (1.85 kBq), or less of Hydrogen-3 or Carbon-14 per gram of animal tissue, averaged over the weight of the entire animal.

### **3.6 Waste Not Otherwise Covered**

The RSO must be notified prior to the start of work which will produce radioactive waste material not covered by the above regulations. Isotopes may not be ordered, and work may not begin, until the user and RSO have agreed upon a waste disposal procedure.

## SECTION 4

### EMERGENCY PROCEDURES

#### 4.1 Serious Injury with Contamination Involved

*Notification:* Dial 911 (Public Safety)

*Tell the person who answers:*

- Somebody has been seriously injured in the \_\_\_\_\_ building, room \_\_\_\_\_.
- Radioactivity is involved.
- Your name.
- Telephone extension being used.

*Care of the injured:*

- Apply first aid if necessary.
- Stay with the injured person until physician or emergency assistance arrives.
- Advise on extent of injured person's contamination.

*Contamination control while waiting for help.*

For a localized, non-volatile spill:

- Rope off or guard the spill area against entry.
- Assemble potentially contaminated people in one area and monitor them for contamination.
- Wait for a member of the Radiation Safety Office.

For a release of powdered, volatile or gaseous material:

- Evacuate personnel from room immediately, turning off any laboratory apparatus that needs constant attention.
- Assemble personnel immediately outside of the room and instruct them to stay in one location to prevent the spread of contamination.
- Close and lock the room doors to prevent entry. If hood fans are off, try to seal the accessible openings into the laboratory to prevent further spread of the radioactive material.
- Isolate the adjacent corridor against traffic and spectators.
- Wait for a member of the Radiation Safety Office to arrive.

## 4.2 Minor Injury with Contamination Involved

*Notification:* Dial 911 (Public Safety)

*Tell the person who answers:*

- Somebody has been injured in the \_\_\_\_\_ building, room \_\_\_\_\_.
- Radiation is involved
- Your name
- Telephone extension being used

*Care of the injured:*

- Apply first aid if necessary.
- Survey clothing for contamination.
- Remove significantly contaminated clothing and, if necessary, clothe the injured person in an uncontaminated laboratory coat.
- Escort injured person to the Emergency Room of the Wood County Hospital. Notify medical personnel of the contamination.

*Contamination control.*

For a localized, non-volatile spill:

- Rope off or guard the spill area against entry.
- Assemble potentially contaminated people in one area and monitor them for contamination.
- Assign a responsible person to control the area and wait for a member of the Radiation Safety Office

For a release of powdered, volatile or gaseous material:

- Evacuate personnel from room immediately, turning off any laboratory apparatus that needs constant attention.
- Assemble personnel immediately outside of the room and instruct them to stay in one location to prevent the spread of contamination.
- Close and lock the room doors to prevent entry. If hood fans are off, try to seal the accessible openings into the laboratory to prevent further spread of the radioactive material.
- Isolate the adjacent corridor against traffic and spectators.
- Assign a responsible person to control the area and wait for a member of the Radiation Safety Office to arrive.

## 4.3 Contamination Incident Without Injury

*Notification:* Dial 911 (Public Safety)



*Tell the person who answers:*

- Radioactive material has been spilled in the \_\_\_\_\_ building, room \_\_\_\_\_.
- Your name.
- Telephone extension being used.

*Contamination control while waiting for help.*

For a localized, non-volatile spill:

- Rope off or guard the spill area against entry.
- Assemble potentially contaminated people in one area and monitor them for contamination.
- Wait for a member of the Radiation Safety Office.

For a release of powdered, volatile or gaseous material:

- Evacuate personnel from room immediately, turning off any laboratory apparatus that needs constant attention.
- Assemble personnel immediately outside of the room and instruct them to stay in one location to prevent the spread of contamination.
- Close and lock the room doors to prevent entry. If hood fans are off, try to seal the accessible openings into the laboratory to prevent further spread of the radioactive material.
- Isolate the adjacent corridor against traffic and spectators.
- Wait for a member of the Radiation Safety Office.

#### **4.4 Notifications and Reporting**

Requirements of notification for incidents and reports involving licensed materials are listed in OAC 3701:1-38-21. In general, reportable incidents include (1) stolen, lost, or missing materials, (2) excess doses, (3) release of material outside restricted areas, or (4) loss of control or accidental release of materials. Contact the University Radiation Safety Officer prior to, and for guidance in reporting to the Ohio Department of Health. Report any non-routine contamination incidents, including all incidence of personnel contamination. Report any persistent contamination.

Furthermore, if any updates to this Manual or other BGSU policies occur, affected personnel will be notified via e-mail and an updated version will be posted to the Environmental Health and Safety webpage.

## 4.5 Decontamination Procedures

### *Personnel:*

- Remove loose contamination. Use care to prevent the spread of contamination and be extra careful around wounds
- Wash contaminated areas. Use a mild soap or detergent initially; use a mild abrasive soap for more persistent contamination

### *Persistent Contamination:*

- After washing hands, clipping the fingernails may be helpful in reducing contamination at finger tips
- Contact the Radiation Safety Officer, or a member of the Department of Environmental Health and Safety for additional assistance.

### *Equipment and Buildings*

#### Decontamination

- Isolate contaminated area
- Clean with damp towel and cleaner
- Resurvey
- Repeat cleaning if required

#### Decay

- Allow to decay, protect with absorbent paper and warning signs
- For longer half-life, seal with paint or wax

# **APPENDIX 1**

## **APPLICATION FOR USE OF RADIOACTIVE MATERIALS**



(cont'd over)

Briefly describe the experiment or activity you will be performing, including procedures used in handling materials, chemical/physical form of isotope, dilution procedures (if any), maximum activity used in a procedure and any other information pertinent to radiation safety in your laboratory. It is not necessary to repeat information already provided in other sections above.

I understand this information will be maintained and used by the Radiation Safety Office and is subject to inspection by the Ohio Department of Health.

\_\_\_\_\_

Applicant Signature

Date: \_\_\_\_\_

*RSO Use Only*

Approved: YES    NO

Date: \_\_\_\_\_

## **APPENDIX 2**

### **RADIATION USER QUALIFICATIONS**

## RADIATION USER QUALIFICATIONS

Name: \_\_\_\_\_ Department: \_\_\_\_\_

Laboratory Room # \_\_\_\_\_ Telephone: \_\_\_\_\_

Type of Training	Where Training Occurred	Duration of Training (clock hours)	Date Ended	Indicate whether training was formal or on-the-job
------------------	-------------------------	------------------------------------	------------	--

Principals and practices of radiation protection

Radioactivity measurement, standardization, monitoring techniques and instruments

Instrumentation, mathematics and calculations basic to the use and measurement of radioactivity

Biological effects of radiation

Experience with radiation (actual use of isotopes or equivalent experience)

Isotope	Max Amount Used (mCi)	Where	Duration	Ending Use
---------	-----------------------	-------	----------	------------

I understand this information is subject to inspection by the Ohio Department of Health. The information will be maintained by the BGSU Radiation Safety Office as required by Federal and State regulations.

\_\_\_\_\_  
Applicant

Date: \_\_\_\_\_

## **APPENDIX 3**

### **QUARTERLY SURVEY OF RADIATION LABORATORY**



## QUARTERLY SURVEY OF RADIATION LABORATORY

Department: \_\_\_\_\_ Date: \_\_\_\_\_

Approved user: \_\_\_\_\_ Room Number: \_\_\_\_\_

Isotopes Used: \_\_\_\_\_

### Survey Meter

Type/Model: \_\_\_\_\_ Operating condition: \_\_\_\_\_

Serial #: \_\_\_\_\_ Next calibration due date: \_\_\_\_\_

### Laboratory Procedures

Material inventory maintained:	Yes / No	Storage locations marked:	Yes / No
Safety manual available:	Yes / No	Notice to workers posted:	Yes / No
Areas of activity clearly marked:	Yes / No	Emergency Phone # posted:	Yes / No
Appropriate shielding in place:	Yes / No	Ohio Notice to Workers:	Yes / No
Dosimetry badges in use:	Yes / No	Doors and cabinets secure:	Yes / No
Lab coats and gloves in use:	Yes / No	Evidence of food absent:	Yes / No
Material logbook complete:	Yes / No	Trash needs removal:	Yes / No
Sink disposal records maintained:	Yes / No	If so, isotope(s) and amount:	_____
Trash containers adequate:	Yes / No		_____

### Results of survey meter and swab wipe tests:

Survey meter model: \_\_\_\_\_ S/N \_\_\_\_\_ Last Calibrated: \_\_\_\_\_

Location:	Counts (mr/h)
_____	_____
_____	_____
_____	_____
_____	_____

Background check: \_\_\_\_\_

(cont'd over)

Swab wipe tests: Isotope assayed: \_\_\_\_\_ LSC Channel \_\_\_\_\_



## **APPENDIX 4**

### **REQUEST FOR DOSIMETRY BADGE**

# REQUEST FOR DOSIMETRY BADGE

Radiation dosimetry badges are provided free of charge to persons working with radioisotopes and to workers using radiation generating equipment such as x-rays. Badges are replaced monthly and are sent for analysis to an independent agent who provides personal exposure records for each badge holder. Certain information is required in order for you to be included in our dosimetry reporting service. Please complete this page and return it to the address below. If you have previously participated in a dosimetry program, either at BGSU or elsewhere also complete the reverse of this form.

Name: \_\_\_\_\_ Date of Birth: \_\_\_\_\_  
(MM/DD/YY)

BGSU ID Number: \_\_\_\_\_

Dominant Hand: (circle one) Left / Right

Gender: Male / Female

Isotopes to be used or anticipated source(s) of radiation exposure: \_\_\_\_\_

Building and room number where work is to be performed: \_\_\_\_\_

Name of laboratory director or immediate supervisor: \_\_\_\_\_

## FOR PREVIOUS BADGE HOLDERS:

If you have previously worn a dosimetry badge, either here or elsewhere, records of previous occupational exposures will be needed. In order to facilitate obtaining this information, please fill in the reverse of this form with the address of the most recent location where a dosimetry reporting service was used. In addition, please sign the authorization block on the back so the information may be released to us.

When complete, return this form to:

Radiation Safety Office  
Department of Environmental Health & Safety  
101C Huntington Building  
Bowling Green State University  
Bowling Green, Ohio 43403  
(419) 372-2173

(cont'd over)

**Previous Dosimetry Service**

Most Recent Employer: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Dates of Employment

From: \_\_\_\_\_

To: \_\_\_\_\_

**AUTHORIZATION**

Authorization for the release of my radiation exposure history to Bowling Green State University is hereby given.

Name: \_\_\_\_\_

Please Print

Signed: \_\_\_\_\_ Date: \_\_\_\_\_

## **APPENDIX 5**

### **RADIATION EXPOSURE REPORT**

## RADIATION EXPOSURE REPORT

The purpose of personnel radiation monitoring is to measure occupational exposures and to aid in the detection of unnecessary radiation dosages and/or equipment malfunctions. If an exposure of 10% or more of the monthly averaged Maximum Permissible Dose (MPD) is obtained, the approved user is required to complete this written explanation of how this dose might have occurred. Even for exposures less than 10% of MPD, but significantly higher than average compared to other workers performing similar activity, this report should be filed. This is necessary not only to protect the individual concerned but also to maintain institutional efforts to minimize radiation exposures consistent with the ALARA principles of our license.

Name: \_\_\_\_\_ Department \_\_\_\_\_

During the period from \_\_\_\_\_ to \_\_\_\_\_, your personnel radiation monitoring devices (badge and/or ring # \_\_\_\_\_) indicated an exposure of \_\_\_\_\_ millirem.

The maximum permissible dose for ionizing radiation is 5 rems per calendar year (whole body), or about 400 millirems per month, and the average dose of persons on this campus who perform similar functions in other labs is \_\_\_\_\_ millirems per month.

The fact that this dosimetry badge reflected an exposure higher than normal suggests that either an unusual event may have occurred or that improper laboratory procedures may have been used while working with the radiation producing materials or equipment. In either event, an understanding of the events which could have led to this exposure is necessary in order to take action to prevent future exposure. After investigation, if a true exposure were to occur, the RSO must notify the ODH Director of Health in writing within 30 days. Accordingly, please answer the questions on the reverse of this form, and return this statement as quickly as possible to:

Radiation Safety Officer  
Department of Environmental Health & Safety  
101C Huntington Building, BGSU

Feel free to call if you have questions or need further clarification.

(cont'd over)

**Describe the procedures leading to the exposure.**

**Do you know how the excess exposure occurred? Explain why or why not.**

**Describe what has been done since the incident or list suggestions which might help to prevent the reoccurrence of such an exposure.**

**Other comments:**

Signed: \_\_\_\_\_ Date: \_\_\_\_\_



## **APPENDIX 6**

### **SINK DISPOSAL OF RADIOACTIVE WASTE**



## **APPENDIX 7**

### **RADIOACTIVE MATERIAL RECEIPT INSPECTION**

## RADIOACTIVE MATERIAL RECEIPT INSPECTION

**NOTE:** Gloves must be worn to handle package until wipe test results have been completed.

Date: \_\_\_\_\_ BGSU PO Number: \_\_\_\_\_

Isotope: \_\_\_\_\_ Physical form of material: \_\_\_\_\_

Quantity received: \_\_\_\_\_ mCi

Visual inspection of package: \_\_\_\_\_

Verification of shipping manifest with purchase order: \_\_\_\_\_

Gross survey of package with hand held survey meter:

Exposure Rate

At surface of package: \_\_\_\_\_ mR/hr

3 feet from package: \_\_\_\_\_ mR/hr

Wipe test result, outside of package: \_\_\_\_\_ CPM *cf.* Blank sample: \_\_\_\_\_ CPM

Condition of source container: \_\_\_\_\_

Was dry ice present at check-in time: \_\_\_\_\_

Verification of label on source container with shipping manifest: \_\_\_\_\_

Material receipt entered in institutional notebook and log record: \_\_\_\_\_

Package delivered to: \_\_\_\_\_

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_

Form completed by: \_\_\_\_\_

## **APPENDIX 8**

### **RADIOACTIVE MATERIAL PHYSICAL INVENTORY**

## Semi-Annual Physical Inventory of Radioactive Material

Inventory Date: June 12, 2012

Approved User: \_\_\_\_\_

Department: \_\_\_\_\_

Reported by: \_\_\_\_\_

**Table 1: Physical Inventory of Radioactive Material**

Isotope Information					Amounts (millicuries)				
(1) Location of Isotope	(2) Isotope	(3) Receipt date	(4) BGSU PO #	(5) Chemical/physical form	(6) Originally Received	(7) Remaining Stock Available For Use	(8) On Hand As Prepared Samples	(9) On Hand As Solid Waste	(10) Disposed Down Sink
PSLB; Room 219	P-32	3/15/03	345678	Labeled ATP	1.00	0.40	0.54	0.06	0.00

### Directions

Complete this form using material inventory as of the date shown at the top of the page. For columns labeled "Amount", enter activity (in millicuries) based on fractions of the amount originally received. Do NOT account for isotope decay. The first row of the above table has been highlighted as an example. Ignore this row when you complete your own report.

Column (1): Identify the isotope using the notation P-32, S-35, etc.

Column (2): To obtain this date, refer to the *Radioactive Material Use and Disposition Log* that accompanied the material when it was delivered to the lab.

Column (3): Refer to the *Radioactive Material Use and Disposition Log* for this number.

*Column (4):* Indicate, for example, whether material is solid, liquid, or gas, and chemical form such as aqueous solution, tritiated thymidine, labeled ATP, CGP, RIA kit, etc.

*Column (5):* Amount “Originally Received” refers to the activity of the sample (in millicuries) at the time of receipt. This is indicated on the *Radioactive Material Use and Disposition Log*.

*Column (6):* Amount “Remaining in Stock” refers to the activity of the material (not accounting for natural decay) still held in the original shipping container and still available for use. This can be determined by subtracting from the original volume the total volume removed (as indicated on the *Radioactive Material Use and Disposition Log*), and by using volume fractions to determine activity of the remaining stock.

EXAMPLE: Suppose that a shipment of  $^{32}\text{P}$ -labeled ATP with an activity of 1 mCi and a volume of 50  $\mu\text{l}$  was received in the lab on March 15. By the end of the year, suppose that a total volume of 30  $\mu\text{l}$  had been removed from this container as evidenced through entries on the *Radioactive Material Use and Disposition Log*. The “Remaining Stock” therefore would be  $(50 - 30) = 20 \mu\text{l}$  with an undecayed activity of  $(20/50) \times 1 \text{ mCi} = 0.4 \text{ mCi}$ . Enter this number in column six (6) of the table.

*Column (7):* Amount “On Hand as Prepared Samples” refers to the amount of material removed from the shipping container that was successfully incorporated into prepared samples. Amounts removed but not incorporated into samples would be included as waste in *Column (8)*.

*Column (8):* “On Hand as Solid Waste” refers to material removed from the shipping container but not incorporated into samples. This would include residue on pipette tips, spill clean up materials, etc., and undoubtedly will involve estimates on the part of the researcher. Samples stored for disposal that no longer are being held for use in experiments also would be included in this category.

EXAMPLE: In the above illustration the 30  $\mu\text{l}$  of material removed represents an activity of  $(30/50) \times 1 \text{ mCi} = 0.6 \text{ mCi}$ . Suppose that 90% of this material was successfully incorporated into prepared samples, with 10% remaining as waste either in the form of excess source material, as residue on micropipette tips, spills on waste paper, etc. Then the amount “On Hand as Prepared Samples” would be  $0.9 \times 0.6 \text{ mCi} = 0.54 \text{ mCi}$ , and the amount “On Hand as Solid Waste” would be  $0.1 \times 0.6 = 0.06 \text{ mCi}$ . Enter these numbers, respectively, in columns (7) and (8) of the table.

*Column (9):* “Disposed Down Sink” refers to the total activity of the isotope in question that was disposed down an approved sink. Refer to the records of such disposal that are posted above each such sink as indicated on the form, *Sink Disposal of Radioactive Waste*.

Remember, do NOT account for natural decay of isotopes. That calculation will be done collectively by the Radiation Safety Officer prior to submitting the report to the State.

Please return this completed form within two weeks from the date of receipt to the Radiation Safety Office, c/o Dept. of Environmental Health and Safety, 101C Huntington Building.

**For further information or assistance, contact the University Radiation Safety Officer.**

Jeremy Dick  
Environmental Health & Safety  
101E Huntington Building  
(419) 372-2131

## **APPENDIX 9**

### **RADIOACTIVE MATERIAL USE AND DISPOSITION LOG**





## **APPENDIX 10**

### **QUANTITY LIMITS FOR RADIOACTIVE MATERIALS**

## QUANTITY LIMITS FOR RADIOACTIVE MATERIALS

### Limits in millicuries

Material	Per Order*	Possession
Carbon-14	5	50
Hydrogen-3	15	75
Iodine-125	5	50
Iron-55	5	50
Phosphorus-32	10	150
Phosphorus-33	10	100
Sulfur-35	10	100

\* Contact the Radiation Safety Officer if you need to order more than this limit.

**Only the isotopes listed above may be ordered. Use of other isotopes will require approval of the Ohio Department of Health.**

# **APPENDIX 11**

**UNITED STATE NUCLEAR REGULATORY COMMISSION  
REGULATORY GUIDE 8.13**



U.S. Nuclear Regulatory Commission  
**REGULATORY GUIDE**  
Office of Nuclear Regulatory Research

REGULATORY GUIDE 8.13  
(Draft was issued as DG-8014)

INSTRUCTION CONCERNING PRENATAL RADIATION EXPOSURE

A. INTRODUCTION

The Code of Federal Regulations in 10 CFR Part 19, "Notices, Instructions and Reports to Workers: Inspection and Investigations," in Section 19.12, "Instructions to Workers," requires instruction in "the health protection problems associated with exposure to radiation and/or radioactive material, in precautions or procedures to minimize exposure, and in the purposes and functions of protective devices employed." The instructions must be "commensurate with potential radiological health protection problems present in the work place."

The Nuclear Regulatory Commission's (NRC's) regulations on radiation protection are specified in 10 CFR Part 20, "Standards for Protection Against Radiation"; and 10 CFR 20.1208, "Dose to an Embryo/Fetus," requires licensees to "ensure that the dose to an embryo/fetus during the entire pregnancy, due to occupational exposure of a declared pregnant woman, does not exceed 0.5 rem (5 mSv)." Section 20.1208 also requires licensees to "make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman." A declared pregnant woman is defined in 10 CFR 20.1003 as a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

This regulatory guide is intended to provide information to pregnant women, and other personnel, to help them make decisions regarding radiation exposure during pregnancy. This Regulatory Guide 8.13 supplements Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure" (Ref 1), which contains a broad discussion of the risks from exposure to ionizing radiation.

Other sections of the NRC's regulations also specify requirements for monitoring external and internal occupational dose to a declared pregnant woman. In 10 CFR 20.1502, "Conditions Requiring Individual Monitoring of External and Internal Occupational Dose," licensees are required to monitor the occupational dose to a declared pregnant woman, using an individual monitoring device, if it is likely that the declared pregnant woman will receive, from external sources, a deep dose equivalent in excess of 0.1 rem (1 mSv). According to Paragraph (e) of 10 CFR 20.2106, "Records of Individual Monitoring Results," the licensee must maintain

records of dose to an embryo/fetus if monitoring was required, and the records of dose to the embryo/fetus must be kept with the records of dose to the declared pregnant woman. The declaration of pregnancy must be kept on file, but may be maintained separately from the dose records. The licensee must retain the required form or record until the Commission terminates each pertinent license requiring the record.

The information collections in this regulatory guide are covered by the requirements of 10 CFR Parts 19 or 20, which were approved by the Office of Management and Budget, approval numbers 3150-0044 and 3150-0014, respectively. The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

## **B. DISCUSSION**

As discussed in Regulatory Guide 8.29 (Ref. 1), exposure to any level of radiation is assumed to carry with it a certain amount of risk. In the absence of scientific certainty regarding the relationship between low dose exposure and health effects, and as a conservative assumption for radiation protection purposes, the scientific community generally assumes that any exposure to ionizing radiation may cause undesirable biological effects and that the likelihood of these effects increases as the dose increases. At the occupational dose limit for the whole body of 5 rem (50 mSv) per year, the risk is believed to be very low.

The magnitude of risk of childhood cancer following in utero exposure is uncertain in that both negative and positive studies have been reported. The data from these studies "are consistent with a lifetime cancer risk resulting from exposure during gestation which is two to three times that for the adult" (NCRP Report No. 116, Ref. 2). The NRC has reviewed the available scientific literature and has concluded that the 0.5 rem (5 mSv) limit specified in 10 CFR 20.1208 provides an adequate margin of protection for the embryo/fetus. This dose limit reflects the desire to limit the total lifetime risk of leukemia and other cancers associated with radiation exposure during pregnancy.

In order for a pregnant worker to take advantage of the lower exposure limit and dose monitoring provisions specified in 10 CFR Part 20, the woman must declare her pregnancy in writing to the licensee. A form letter for declaring pregnancy is provided in this guide or the licensee may use its own form letter for declaring pregnancy. A separate written declaration should be submitted for each pregnancy.

## **C. REGULATORY POSITION**

### **1. Who Should Receive Instruction**

Female workers who require training under 10 CFR 19.12 should be provided with the information contained in this guide. In addition to the information contained in Regulatory Guide 8.29 (Ref. 1), this information may be included as part of the training required under 10 CFR 19.12.

### **2. Providing Instruction**

The occupational worker may be given a copy of this guide with its Appendix, an explanation of the

contents of the guide, and an opportunity to ask questions and request additional information. The information in this guide and Appendix should also be provided to any worker or supervisor who may be affected by a declaration of pregnancy or who may have to take some action in response to such a declaration.

Classroom instruction may supplement the written information. If the licensee provides classroom instruction, the instructor should have some knowledge of the biological effects of radiation to be able to answer questions that may go beyond the information provided in this guide. Videotaped presentations may be used for classroom instruction. Regardless of whether the licensee provides classroom training, the licensee should give workers the opportunity to ask questions about information contained in this Regulatory Guide 8.13. The licensee may take credit for instruction that the worker has received within the past year at other licensed facilities or in other courses or training.

### **3. Licensee's Policy on Declared Pregnant Women**

The instruction provided should describe the licensee's specific policy on declared pregnant women, including how those policies may affect a woman's work situation. In particular, the instruction should include a description of the licensee's policies, if any, that may affect the declared pregnant woman's work situation after she has filed a written declaration of pregnancy consistent with 10 CFR 20.1208.

The instruction should also identify who to contact for additional information as well as identify who should receive the written declaration of pregnancy. The recipient of the woman's declaration may be identified by name (e.g., John Smith), position (e.g., immediate supervisor, the radiation safety officer), or department (e.g., the personnel department).

### **4. Duration of Lower Dose Limits for the Embryo/Fetus**

The lower dose limit for the embryo/fetus should remain in effect until the woman withdraws the declaration in writing or the woman is no longer pregnant. If a declaration of pregnancy is withdrawn, the dose limit for the embryo/fetus would apply only to the time from the estimated date of conception until the time the declaration is withdrawn. If the declaration is not withdrawn, the written declaration may be considered expired one year after submission.

### **5. Substantial Variations Above a Uniform Monthly Dose Rate**

According to 10 CFR 20.1208(b), "The licensee shall make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the limit in paragraph (a) of this section," that is, 0.5 rem (5 mSv) to the embryo/fetus. The National Council on Radiation Protection and Measurements (NCRP) recommends a monthly equivalent dose limit of 0.05 rem (0.5 mSv) to the embryo/fetus once the pregnancy is known (Ref. 2). In view of the NCRP recommendation, any monthly dose of less than 0.1 rem (1 mSv) may be considered as not a substantial variation above a uniform monthly dose rate and as such will not require licensee justification. However, a monthly dose greater than 0.1 rem (1 mSv) should be justified by the licensee.

## D. IMPLEMENTATION

The purpose of this section is to provide information to licensees and applicants regarding the NRC staff's plans for using this regulatory guide.

Unless a licensee or an applicant proposes an acceptable alternative method for complying with the specified portions of the NRC's regulations, the methods described in this guide will be used by the NRC staff in the evaluation of instructions to workers on the radiation exposure of pregnant women.

## REFERENCES

1. USNRC, "Instruction Concerning Risks from Occupational Radiation Exposure," Regulatory Guide 8.29, Revision 1, February 1996.
2. National Council on Radiation Protection and Measurements, *Limitation of Exposure to Ionizing Radiation*, NCRP Report No. 116, Bethesda, MD, 1993.



## APPENDIX

### QUESTIONS AND ANSWERS CONCERNING PRENATAL RADIATION EXPOSURE

#### 1. Why am I receiving this information?

The NRC's regulations (in 10 CFR 19.12, "Instructions to Workers") require that licensees instruct individuals working with licensed radioactive materials in radiation protection as appropriate for the situation. The instruction below describes information that occupational workers and their supervisors should know about the radiation exposure of the embryo/fetus of pregnant women.

The regulations allow a pregnant woman to decide whether she wants to formally declare her pregnancy to take advantage of lower dose limits for the embryo/fetus. This instruction provides information to help women make an informed decision whether to declare a pregnancy.

#### 2. If I become pregnant, am I required to declare my pregnancy?

No. The choice whether to declare your pregnancy is completely voluntary. If you choose to declare your pregnancy, you must do so in writing and a lower radiation dose limit will apply to your embryo/fetus. If you choose not to declare your pregnancy, you and your embryo/fetus will continue to be subject to the same radiation dose limits that apply to other occupational workers.

#### 3. If I declare my pregnancy in writing, what happens?

If you choose to declare your pregnancy in writing, the licensee must take measures to limit the dose to your embryo/fetus to 0.5 rem (5 millisievert) during the entire pregnancy. This is one-tenth of the dose that an occupational worker may receive in a year. If you have already received a dose exceeding 0.5 rem (5 mSv) in the period between conception and the declaration of your pregnancy, an additional dose of 0.05 rem (0.5 mSv) is allowed during the remainder of the pregnancy. In addition, 10 CFR 20.1208, "Dose to an Embryo/Fetus," requires licensees to make efforts to avoid substantial variation above a uniform monthly dose rate so that all the 0.5 rem (5 mSv) allowed dose does not occur in a short period during the pregnancy.

This may mean that, if you declare your pregnancy, the licensee may not permit you to do some of your normal job functions if those functions would have allowed you to receive more than 0.5 rem, and you may not be able to have some emergency response responsibilities.

#### 4. Why do the regulations have a lower dose limit for the embryo/fetus of a declared pregnant woman than for a pregnant worker who has not declared?

A lower dose limit for the embryo/fetus of a declared pregnant woman is based on a consideration of greater sensitivity to radiation of the embryo/fetus and the involuntary nature of the exposure. Several scientific advisory groups have recommended (References 1 and 2) that the dose to the embryo/fetus be limited to a fraction of the occupational dose limit.

**5. What are the potentially harmful effects of radiation exposure to my embryo/fetus?**

The occurrence and severity of health effects caused by ionizing radiation are dependent upon the type and total dose of radiation received, as well as the time period over which the exposure was received. See Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Exposure" (Ref. 3), for more information. The main concern is embryo/fetal susceptibility to the harmful effects of radiation such as cancer.

**6. Are there any risks of genetic defects?**

Although radiation injury has been induced experimentally in rodents and insects, and in the experiments was transmitted and became manifest as hereditary disorders in their offspring, radiation has not been identified as a cause of such effect in humans. Therefore, the risk of genetic effects attributable to radiation exposure is speculative. For example, no genetic effects have been documented in any of the Japanese atomic bomb survivors, their children, or their grandchildren.

**7. What if I decide that I do not want any radiation exposure at all during my pregnancy?**

You may ask your employer for a job that does not involve any exposure at all to occupational radiation dose, but your employer is not obligated to provide you with a job involving no radiation exposure. Even if you receive no occupational exposure at all, your embryo/fetus will receive some radiation dose (on average 75 mrem (0.75 mSv)) during your pregnancy from natural background radiation.

The NRC has reviewed the available scientific literature and concluded that the 0.5 rem (5 mSv) limit provides an adequate margin of protection for the embryo/fetus. This dose limit reflects the desire to limit the total lifetime risk of leukemia and other cancers. If this dose limit is exceeded, the total lifetime risk of cancer to the embryo/fetus may increase incrementally. However, the decision on what level of risk to accept is yours. More detailed information on potential risk to the embryo/fetus from radiation exposure can be found in References 2-10.

**8. What effect will formally declaring my pregnancy have on my job status?**

Only the licensee can tell you what effect a written declaration of pregnancy will have on your job status. As part of your radiation safety training, the licensee should tell you the company's policies with respect to the job status of declared pregnant women. In addition, before you declare your pregnancy, you may want to talk to your supervisor or your radiation safety officer and ask what a declaration of pregnancy would mean specifically for you and your job status.

In many cases you can continue in your present job with no change and still meet the dose limit for the embryo/fetus. For example, most commercial power reactor workers (approximately 93%) receive, in 12 months, occupational radiation doses that are less than 0.5 rem (5 mSv) (Ref. 11). The licensee may also consider the likelihood of increased radiation exposures from accidents and abnormal events before making a decision to allow you to continue in your present job.

If your current work might cause the dose to your embryo/fetus to exceed 0.5 rem (5 mSv), the licensee has various options. It is possible that the licensee can and will make a reasonable accommodation that will allow you to continue performing your current job, for example, by having another qualified employee do a small part of the job that accounts for some of your radiation exposure.

**9. What information must I provide in my written declaration of pregnancy?**

You should provide, in writing, your name, a declaration that you are pregnant, the estimated date of conception (only the month and year need be given), and the date that you give the letter to the licensee. A form letter that you can use is included at the end of these questions and answers. You may use that letter, use a form letter the licensee has provided to you, or write your own letter.

**10. To declare my pregnancy, do I have to have documented medical proof that I am pregnant?**

NRC regulations do not require that you provide medical proof of your pregnancy. However, NRC regulations do not preclude the licensee from requesting medical documentation of your pregnancy, especially if a change in your duties is necessary in order to comply with the 0.5 rem (5 mSv) dose limit.

**11. Can I tell the licensee orally rather than in writing that I am pregnant?**

No. The regulations require that the declaration must be in writing.

**12. If I have not declared my pregnancy in writing, but the licensee suspects that I am pregnant, do the lower dose limits apply?**

No. The lower dose limits for pregnant women apply only if you have declared your pregnancy in writing. The United States Supreme Court has ruled (in *United Automobile Workers International Union v. Johnson Controls, Inc.*, 1991) that "Decisions about the welfare of future children must be left to the parents who conceive, bear, support, and raise them rather than to the employers who hire those parents" (Reference 7). The Supreme Court also ruled that your employer may not restrict you from a specific job "because of concerns about the next generation." Thus, the lower limits apply only if you choose to declare your pregnancy in writing.

**13. If I am planning to become pregnant but am not yet pregnant and I inform the licensee of that in writing, do the lower dose limits apply?**

No. The requirement for lower limits applies only if you declare in writing that you are already pregnant.

**14. What if I have a miscarriage or find out that I am not pregnant?**

If you have declared your pregnancy in writing, you should promptly inform the licensee in writing that you are no longer pregnant. However, if you have not formally declared your pregnancy in writing, you need not inform the licensee of your nonpregnant status.

**15. How long is the lower dose limit in effect?**

The dose to the embryo/fetus must be limited until you withdraw your declaration in writing or you

inform the licensee in writing that you are no longer pregnant. If the declaration is not withdrawn, the written declaration may be considered expired one year after submission.

**16. If I have declared my pregnancy in writing, can I revoke my declaration of pregnancy even if I am still pregnant?**

Yes, you may. The choice is entirely yours. If you revoke your declaration of pregnancy, the lower dose limit for the embryo/fetus no longer applies.

**17. What if I work under contract at a licensed facility?**

The regulations state that you should formally declare your pregnancy to the licensee in writing. The licensee has the responsibility to limit the dose to the embryo/fetus.

**18. Where can I get additional information?**

The references to this Appendix contain helpful information, especially Reference 3, NRC's Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure," for general information on radiation risks. The licensee should be able to give this document to you.

For information on legal aspects, see Reference 7, "The Rock and the Hard Place: Employer Liability to Fertile or Pregnant Employees and Their Unborn Children—What Can the Employer Do?" which is an article in the journal *Radiation Protection Management*.

You may telephone the NRC Headquarters at (301) 415-7000. Legal questions should be directed to the Office of the General Counsel, and technical questions should be directed to the Division of Industrial and Medical Nuclear Safety.

You may also telephone the NRC Regional Offices at the following numbers: Region I, (610) 337-5000; Region II, (404) 562-4400; Region III, (630) 829-9500; and Region IV, (817) 860-8100. Legal questions should be directed to the Regional Counsel, and technical questions should be directed to the Division of Nuclear Materials Safety.

## REFERENCES FOR APPENDIX

1. National Council on Radiation Protection and Measurements, *Limitation of Exposure to Ionizing Radiation*, NCRP Report No. 116, Bethesda, MD, 1993.
2. International Commission on Radiological Protection, *1990 Recommendations of the International Commission on Radiological Protection*, ICRP Publication 60, Ann. ICRP 21: No. 1-3, Pergamon Press, Oxford, UK, 1991.
3. USNRC, "Instruction Concerning Risks from Occupational Radiation Exposure," Regulatory Guide 8.29, Revision 1, February 1996.<sup>11</sup> (Electronically available at [www.nrc.gov/NRC/RG/index.html](http://www.nrc.gov/NRC/RG/index.html))
4. Committee on the Biological Effects of Ionizing Radiations, National Research Council, *Health Effects of Exposure to Low Levels of Ionizing Radiation (BEIR V)*, National Academy Press, Washington, DC, 1990.
5. United Nations Scientific Committee on the Effects of Atomic Radiation, *Sources and Effects of Ionizing Radiation*, United Nations, New York, 1993.
6. R. Doll and R. Wakeford, "Risk of Childhood Cancer from Fetal Irradiation," *The British Journal of Radiology*, 70, 130-139, 1997.
7. David Wiedis, Donald E. Jose, and Timm O. Phoebe, "The Rock and the Hard Place: Employer Liability to Fertile or Pregnant Employees and Their Unborn Children—What Can the Employer Do?" *Radiation Protection Management*, 11, 41-49, January/February 1994.
8. National Council on Radiation Protection and Measurements, *Considerations Regarding the Unintended Radiation Exposure of the Embryo, Fetus, or Nursing Child*, NCRP Commentary No. 9, Bethesda, MD, 1994.
9. National Council on Radiation Protection and Measurements, *Risk Estimates for Radiation Protection*, NCRP Report No. 115, Bethesda, MD, 1993.

---

<sup>11</sup>Single copies of regulatory guides, both active and draft, and draft NUREG documents may be obtained free of charge by writing the Reproduction and Distribution Services Section, OCIO, USNRC, Washington, DC 20555-0001, or by fax to (301)415-2289, or by email to <DISTRIBUTION@NRC.GOV>. Active guides may also be purchased from the National Technical Information Service on a standing order basis. Details on this service may be obtained by writing NTIS, 5285 Port Royal Road, Springfield, VA 22161. Copies of active and draft guides are available for inspection or copying for a fee from the NRC Public Document Room at 2120 L Street NW., Washington, DC; the PDR's mailing address is Mail Stop LL-6, Washington, DC 20555; telephone (202)634-3273; fax (202)634-3343.

10. National Radiological Protection Board, *Advice on Exposure to Ionising Radiation During Pregnancy*, National Radiological Protection Board, Chilton, Didcot, UK, 1998.
11. M.L. Thomas and D. Hagemeyer, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities, 1996," Twenty-Ninth Annual Report, NUREG-0713, Vol. 18, USNRC, 1998.<sup>22</sup>

---

<sup>22</sup>Copies are available at current rates from the U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20402-9328 (telephone (202)512-1800); or from the National Technical Information Service by writing NTIS at 5285 Port Royal Road, Springfield, VA 22161. Copies are available for inspection or copying for a fee from the NRC Public Document Room at 2120 L Street NW., Washington, DC; the PDR's mailing address is Mail Stop LL-6, Washington, DC 20555; telephone (202)634-3273; fax (202)634-3343.

## FORM LETTER FOR DECLARING PREGNANCY

This form letter is provided for your convenience. To make your written declaration of pregnancy, you may fill in the blanks in this form letter, you may use a form letter the licensee has provided to you, or you may write your own letter.

---

### DECLARATION OF PREGNANCY

To: \_\_\_\_\_

In accordance with the NRC's regulations at 10 CFR 20.1208, "Dose to an Embryo/Fetus," I am declaring that I am pregnant. I believe I became pregnant in \_\_\_\_\_ (only the month and year need be provided).

I understand the radiation dose to my embryo/fetus during my entire pregnancy will not be allowed to exceed 0.5 rem (5 millisievert) (unless that dose has already been exceeded between the time of conception and submitting this letter). I also understand that meeting the lower dose limit may require a change in job or job responsibilities during my pregnancy.

\_\_\_\_\_  
(Your signature)

\_\_\_\_\_  
(Your name printed)

\_\_\_\_\_  
(Date)

## REGULATORY ANALYSIS

A separate regulatory analysis was not prepared for this regulatory guide. A regulatory analysis prepared for 10 CFR Part 20, "Standards for Protection Against Radiation" (56 FR 23360), provides the regulatory basis for this guide and examines the costs and benefits of the rule as implemented by the guide. A copy of the "Regulatory Analysis for the Revision of 10 CFR Part 20" (PNL-6712, November 1988) is available for inspection and copying for a fee at the NRC Public Document Room, 2120 L Street NW, Washington, DC, as an enclosure to Part 20 (56 FR 23360).