

Radiation Safety Manual
for
Bowling Green State University



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Radiation Safety Manual

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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.

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 or around x-ray machines and other 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.

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 Luxeltm 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 cm² of alpha activity, and 6600 dpm/300 cm² 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 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 cm² and 6600 dpm/300 cm² for beta-gamma emitters. If these limits are exceeded, the package is quarantined and the shipper and researcher are both notified.

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 cm² (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.

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 MATERIAL

BGSU procedures require that the following items be completed prior to commencing research or instructional work using radioisotopes. Complete the following and return this form to the Radiation Safety Officer, c/o Department of Environmental Health & Safety, 102 College Park Office Building.

Name: _____ Department: _____

Lab Room Number: _____ Telephone: _____

Dates Materials are to be Used: _____ through _____

Radionuclide(s) to be used: _____

Maximum activity anticipated to be held in the laboratory at any given time: _____ millicuries

Physical/Chemical Form: _____

Have you completed the BGSU User Qualification Form? YES NO

Have you read and do you understand:

- | | | |
|---|-----|----|
| a. Administration and Procedures from the BGSU Radiation Safety Manual (Sections 1 and 2) | YES | NO |
| b. OAC 3701:1-38 | YES | NO |
| c. Section 10 of the Manual, Guide to Radiation Safety in the Laboratory | YES | NO |
| d. Section 3 of the BGSU Radiation Safety Manual regarding disposal of waste | YES | NO |

Has your laboratory been posted and labeled in accordance with Sec. 2.13 of the BGSU Radiation Safety Manual? YES NO

Have you held or scheduled a laboratory training session on safety for all personnel expected to frequent the area? YES NO

Date held/to be held: _____

Briefly describe:

- a. Laboratory monitoring technique to be used.

- b. Special precautions to be taken against accidental exposure to lab workers

- c. Proposed disposal method.

(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.

_____ Date: _____
Applicant Signature

<i>RSO Use Only</i>	
Approved: YES NO	Date: _____

Appendix 2

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.

_____ Date: _____
Applicant

Appendix 3

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 _____

Sample #	Location in lab:	CPM
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
Background-1		_____
Background-2		_____

Swab wipe tests: Isotope assayed: _____ LSC Channel _____

Sample #	Location in lab:	CPM
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
Background-1		_____
Background-2		_____

Summary results/comments: _____

Survey performed by: _____ Title: _____

Summary Sent: _____ Date: _____

Appendix 4

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: _____
(mo/day/yr)

Social Security 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
102 College Park Office Building
Bowling Green State University
Bowling Green, Ohio 43403
(419) 372-2171

(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

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. 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
102 College Park Office 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

Appendix 7

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: _____

Comments: _____

Form completed by: _____

Appendix 8

RADIOACTIVE MATERIAL PHYSICAL INVENTORY

Note: This form is to be completed and returned to the University Radiation Safety Officer within two weeks of receipt. See reverse for explanation of terms.

Inventory Date: _____ Lab director or approved user: _____

Building and room number where sources are located: _____

Reported by: _____

___ Check here if inventory remains the same except for decay

Isotope	Chemical and physical form	Method obtained (BGSU PO#)	Amount originally received (mCi)	Amount on hand to use (mCi)	Amount on hand as Waste (mCi)
---------	-------------------------------	----------------------------------	---	--------------------------------------	--

I certify that the information in this inventory is correct and that the materials in question are stored and used in compliance with appropriate University, State and Federal Regulations.

Signed: _____ Date: _____
(Approved User) (cont'd over)

Directions

Complete this form using your inventory as of the inventory date shown.

Isotope should be noted as P-32, S-35, etc.

Chemical and physical form: Indicate, for example, solid, liquid, or gas, and chemical form such as aqueous solution, tritiated thymidine, labeled ATP, CGP, RIA kit, etc.

Method Obtained: Indicate the BGSU PO # for this shipment, or the date you received the shipment if not purchased.

Originally received: Refers to the activity of the sample at the time of receipt, e.g. 1.3 mCi. This is indicated on the Materials Receipt and Use Log which accompanied the material at the time of delivery to the laboratory.

On hand to use: This is the amount (activity) originally received less the amounts used, discounted for decay from the time of delivery to the date of reporting. The amounts used should be noted on the Materials Receipt and Use Log. Rough decay factors can be applied using the date of delivery as a starting point.

For example, suppose 1 mCi of P-32 was received on November 1 and the report is prepared for December 31 of the same year. Inspection of the Materials Use Log Sheet indicates that one-half of the material has been removed, thus leaving only 0.5 mCi as the starting activity. Since P-32 has a roughly two week half life, about four half lives have elapsed in the two months since receipt. The amount remaining is therefore: $(0.5 \text{ mCi}) / 2^4 = 0.5 \text{ mCi} / 16 = 0.031 \text{ mCi}$.

Contact the RSO if assistance is needed with this calculation.

On Hand As Waste: This refers to material in your lab. Do not count waste that has been transferred to the waste storage area.

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

Thomas B. Cobb
Environmental Health & Safety
102 CPOB
372 - 2171

Appendix 9

Appendix 10

QUANTITY LIMITS FOR RADIOACTIVE MATERIALS

Limits in millicuries

Material	Per Order *	University 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

INTENDED USES OF RADIOACTIVE MATERIALS

Isotope	General Use	Maximum Activity per Experiment (millicuries)	Total Activity per Year (millicuries)
Carbon-14	labelling proteins, lipids and/or nucleic acids	.1	5
	measure of C-fixation in benthic algae	.03	1
	ChAT enzyme activity	<.001	.03
Hydrogen-3	labelling proteins, lipids and/or nucleic acids	.125	5
	radioimmunoassay	.01	.25
Iodine-125	radioimmunoassay	.01	.5
	labelling proteins and detecting immunological complexes	.1	10
Iron-55	Nutrient uptake in aquatic ecosystems	.1	5
Phosphorus-32	labelling of DNA molecules	.2	50
	labelling of phosphoproteins	1	20
Phosphorus-33	labelling of proteins	.1	10
Sulfur-35	labelling of proteins	.1	10
	sequencing with labelled dATP analogues	.125	2